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6th Iberoamerican Conference on Applications and Usability for Interactive TV

12+13 OCTOBER

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DIGIMEDIA DIGITAL MEDIA AND INTERACTION

RedAUTI

TITLE

Proceedings of the 6th Iberoamerican Conference on Applications and Usability of Interactive TV - jAUTI 2017

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Prefácio

Damos as boas-vindas a todos os participantes da 6ª Conferência Ibero Americana em Usabilidade e Aplicações de TV Interativa - **jAUTI'2017**. Esta conferência é uma organização conjunta do grupo **Social iTV** da Unidade de Investigação **DigiMedia** da **Universidade de Aveiro** e da **RedAUTI** (Red temática en Aplicaciones y Usabilidad de la Television digital Interactiva).

A edição deste ano (12 e 13 de outubro de 2017 - Universidade de Aveiro, Portugal), reúne investigadores de várias universidades e da indústria para a partilha dos seus trabalhos de investigação. Este livro de atas integra um conjunto de cerca de duas dezenas de trabalhos, apresentados durante a conferência, nas áreas de acessibilidade em TV Digital, Serviços e Design de Interfaces de Utilizador para TV Digital e Interativa, bem como as suas Audiências, Conteúdos e Tecnologias.

Para além da apresentação dos artigos científicos, a conferência conta, ainda, com 2 Keynotes: "Los dispositivos móviles, un complemento para la televisión. Caso prácticos" (por Angel García Crespo, da Universidade Carlos III de Madrid) e "Como será a TV do futuro" (por Tiago Silva Lopes, da Altice-MEO).

Conta-se, ainda, durante os dois dias da conferência, com demonstrações dos projetos UltraTV e +TV4E.

Num quadro de novos desafios para a RedAUTI, os chairs da conferência reconhecem a importância da realização deste evento para o reforço de uma rede Ibero americana, ímpar, de investigadores na área da TV Digital e Interativa.

Não podemos deixar de agradecer o empenho e a dedicação de todos os elementos da Comissão Científica e da Comissão Organizadora, em especial do staff dos projetos UltraTV e +TV4E e da Unidade de Investigação DigiMedia da Universidade de Aveiro.

A todos, um abraço amigo,

Jorge Ferraz de Abreu, María José Abásolo, Pedro Almeida e Telmo Silva

Prefacio

Damos la bienvenida a todos los participantes de las 6ª Jornadas Iberoamericanas sobre Aplicaciones y Usabilidad de la TV Interactiva - **jAUTI'2017**. Esta conferencia es una organización conjunta del grupo **Social iTV** de la Unidad de Investigación **DigiMedia** de la **Universidad de Aveiro** y la **RedAUTI** (Red temática en Aplicaciones y Usabilidad de la Televisión digital Interactiva).

La edición de este año se realiza el 12 y 13 de octubre de 2017 en la Universidad de Aveiro, Portugal, y reúne a investigadores de varias universidades y de la industria para la presentación de sus trabajos de investigación. Este libro de actas integra un conjunto de casi dos decenas de trabajos presentados durante la conferencia en las áreas de Accesibilidad en TV Digital, Servicios y Diseño de Interfaces de usuario para TV Digital Interactiva, así como sus Audiencias, Contenidos y Tecnologías.

Además de la presentación de los artículos científicos, la conferencia cuenta además con 2 Keynotes: "Los dispositivos móviles, un complemento para la televisión. Casos prácticos" por Ángel García Crespo de la Universidad Carlos III de Madrid, y "Cómo será la TV del futuro" por Tiago Silva Lopes de Altice-MEO.
Se cuenta además durante los dos días de la conferencia con demostraciones de los proyectos UltraTV y + TV4E.

En un cuadro de nuevos desafíos para la RedAUTI los organizadores de la conferencia reconocen la importancia de la realización de este evento para el refuerzo de una red Iberoamericana de investigadores en el área de la TV Digital Interactiva.

No podemos dejar de agradecer el empeño y la dedicación de todos los miembros de la Comisión Científica y de la Comisión Organizadora, en especial del personal de los proyectos UltraTV y + TV4E y de la Unidad de Investigación DigiMedia de la Universidad de Aveiro.

A todos, un abrazo amigo

Jorge Ferraz de Abreu, María José Abásolo, Pedro Almeida y Telmo Silva

Foreward

We welcome all participants of the 6th Ibero-American Conference on Usability and Interactive TV Applications - **jAUTI'2017**. This conference is a joint organization of the **Social iTV** group of the **DigiMedia** Research Unit of the **Universidade de Aveiro** and **RedAUTI** (Red temática en Aplicaciones y Usabilidad de la Television digital Interactiva).

This year's edition (October 12 and 13, 2017 - Universidade de Aveiro, Portugal) brings together researchers from various universities and the industry to share their research work. This book collects a set of about two dozen papers, presented during the conference, in the fields of accessibility in Digital TV, Services and Design of User Interfaces for Digital and Interactive TV, as well as their Audiences, Contents and Technologies.

In addition to the presentation of the scientific articles, the conference also has 2 Keynotes presentations: "Los dispositivos móviles, un complemento para la televisión. Caso prácticos" (by Angel García Crespo, from Universidade Carlos III of Madrid) and "Como será a TV do futuro" (by Tiago Silva Lopes, from Altice-MEO).
Additionally, during the two days of the conference, there are demonstrations of the UltraTV and + TV4E projects.

In a framework of new challenges for RedAUTI, the conference chairs recognize the importance of holding this event to strengthen an unrivaled Ibero-American network of researchers in the area of Digital and Interactive TV.
We are truly grateful to all the members of the Scientific Committee and the Organizing Committee for the commitment and dedication, especially to the staff of the UltraTV and + TV4E projects and the DigiMedia Research Unit of the University of Aveiro.

Our warm regards,

Jorge Ferraz de Abreu, María José Abásolo, Pedro Almeida and Telmo Silva

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DTV Accessibility

OpenSigns: An Open Platform for Machine Translation of Spoken Languages into Sign Languages

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Abstract. The purpose of this paper is to investigate the feasibility of offering a multilingual platform for text-to-sign translation, i.e., a solution where a machine translates digital contents in several spoken languages to several sign languages in scenarios such as Digital TV, Web and Cinema. This solution called **OpenSigns**, is an open platform that has several common components for generic functionalities, initially originated from the **Suíte VLibras**, including the creation and manipulation of 3D animation models, and interchangeable mechanisms specific for each sign language, such as a text-to-gloss machine translation engine, a sign dictionary for each sign language, among others. Our motivation is that the concentration of efforts and resources around a single solution could provide some state-of-the-art improvement, such as a standard solution for the industry and a greater functional flexibility for common components. In addition, we could also share techniques and heuristics between the translation mechanisms, reducing the effort to make a new sign language available on the platform, which may further enhance digital inclusion and accessibility, especially for poorest countries.

Keywords: digital video; online video; accessibility; sign language; machine translation

1 Introduction

In Brazil, according to the 2010 census of the Brazilian Institute of Geography and Statistics (IBGE), there are approximately 9.7 million Brazilians with some type of hearing loss, representing 5.1% of its population[9]. The World Health Organization estimates that approximately 360 million people worldwide have some level of hearing loss[13].

This relevant part of the population faces several challenges in accessing information, usually made available through written or spoken language. The main problem is that most deaf people spend several years in school, but are not proficiency in reading and writing the spoken language of their country. One of the possible explanations is the fact that these languages are based on sounds[16].

A study carried out in 2005 with 7 to 20 years old Dutch deaf persons found that only 25% of them had a reading capacity equal or greater than a 9-year-old child without disability [18].

One of the reasons for this difficulty is that the deaf communicate naturally through sign languages (SL), and spoken languages are only a "second language". Each SL is a natural language, with its own lexicon and grammar, developed by each deaf community over time, just as each hearing community developed its spoken language. Thus, there is no unique SL. Although there are many similarities between all these languages, each country usually has its own, some even more than one - by 2013, there were already over 135 sign languages cataloged around the world[1].

In order to allow adequate access, one solution is to translate/interpret spoken contents into the associated SL. However, considering the volume and dynamism of information in some environments and platforms, such as on the Web, performing this task using human interpreters is not viable, considering the high volume of content that is added daily on the Internet. In the context of Digital TV, the support for sign languages is generally limited to a window with a human sign language interpreter, which is displayed overlaying the video program. This solution has high operational costs for generation and production of the contents (cameras, studio, staff, among others), needs full-time human interpreters, which ends up restricting its use to a small portion of the programming. To address this question pragmatically, one of the most promising approaches today is the use of tools for machine translation of a spoken language into a SL.

Proportionately to the number of SL, there are also numerous parallel initiatives to build machine translation tools for these SLs, usually focused on the scope of a single language/country, some even competing with each other. Most of these text-to-sign machine translation tools, although conducted completely independently in their respective countries, have similarities in approach, scope, and architecture. In general, the basic functionalities are present in some form in most of them. Steps such as extraction of the text to be translated from audio and subtitles, generation of the sign language video, incorporation of the sign language videos into the original videos (e.g, on Digital TV), spelling and rendering of glosses by plugins and mobile applications, etc. There are also similarities in the structure and behavior of components, such as APIs and backends of communication, translation and control, etc.

The main points of variation are usually the specific mechanism of translation and the dictionary of signs of the language (visual representation of signs). For the latter and considering the use of avatars, the modeling process of visual represention is similar (e.g., a set of animations) and usually depends on the allocation of financial and human resources, regardless of the technology used.

To reduce this problem, the objective of this paper is to propose an open, comprehensive and extensible platform for *text-to-sign* translation in various usage scenarios and countries, including Digital TV. In the proposed platform, the common components share generic functionalities, including the creation and manipulation of the dictionaries. Only the translation mechanism and the

dictionary itself are interchangeable, being specific to each SL. To accelerate the development, we used the Suíte VLibras[1] as a basis.

Our motivation is the concentration of efforts and resources around an unique solution that can be able to provide cutting edge gains, such as the definition of patterns for the industry standard and greater functional flexibility for the common components, and also allow advances in the state-of-the-art, such as sharing techniques and heuristics among translation mechanisms.

A single standardized platform with centralized processing of multiple sign languages can also serve as a catalyst for more advanced translation services, such as incorporating text-to-text conversion. In this sense, available translation mechanisms between spoken languages can be integrated to allow Deaf in Brazil or Spain to understand, in Brazilian Sign Language (LIBRAS) or Spanish Sign Language (LSE), respectively, a text in English, for example.

Another contribution is to leverage the emergence of a common core rule-based translator that can be extended / adapted to meet new languages and regionalisms. Reducing the effort to make a new SL available may further enhance digital inclusion and accessibility, in technologies such as Digital TV, Web and Cinema, especially in the poorest countries.

The remainder of the paper is organized as follows. Section 2 lists some of the machine translation tools available in the scientific literature. Section 3 presents the proposal generic platform for machine translation of spoken language to sign language. Section 4 presents a prototype of the proposed platform as proof of concept. This prototype accepts input texts in any spoken language and translates into three target sign languages. Section 5 finally brings our conclusion and final remarks.

2 Machine Translation Platforms for Sign Languages

Machine translation systems for sign language are generally divided into three main classes: Rule-Based Machine Translation (RBMT), Statistical Machine Translation (SMT) and Example-Based Machine Translation (EBMT) [17]. One important challenges of such systems is to ensure that the content available to Deaf has the same consistency and quality of the original content, allowing the adequate understanding of the message.

Considering these systems may be a viable alternative to minimize the marginalization of Deaf, especially through digital inclusion, several researches have been developed around the world focusing on the development and offering of operational platforms for machine translation of spoken languages into SL[4][2].

[1] The **Suíte VLIBRAS** is the result of a partnership between – removed for blind review –, and consists of a set of tools (text, audio and video) for the Brazilian Sign Language (LIBRAS), making TVs, computers, mobile devices and Web platforms accessible to deaf. Currently, VLibras is used in several governmental and private sites, among them the main sites of the Brazilian government (brasil.gov.br), Chamber of Deputies (camara.leg.br) and the Federal Senate (senado.leg.br)). Further information can be obtained from http://www.vlibras.gov.br.

In Brazil there are at least four platforms available for machine translation of Brazilian Portuguese digital contents into LIBRAS: **Suíte VLibras**[7,8], **Hand-Talk**[3], **ProDeaf**[5] e **Rybená**[6].

The **Suíte VLibras** consists of a set of open source computational tools, responsible for machine translating digital content into Brazilian Portuguese for LIBRAS, making the information available on computers, TVs, mobile devices and Internet portals accessible to Deaf. The VLibras main components are:

- *VLibras-Plugin*: a browser extension that allows the translation of any selected text to LIBRAS;
- *VLibras-Mobile*: VLibras clients for mobile devices (both iOS and Android);
- *VLibras-Desktop*: is a Tool used to translate into sign language any marked text taken from applications running on personal computers;
- *VLibras-Video*: is a portal that allows translation to LIBRAS of audio tracks or subtitles associated with videos;
- *LibrasTV*: an adaption of VLibras for the Brazilian Digital TV system.

3 Open Signs: A Proposal of a Multilingual Machine Translation Platform

It is a consensus that machine translation does not match the quality of a human interpreter in capturing and transmitting all the nuances of a message. However, the use of glosses and animation can be a complementary and practical solution, especially when human interpreters are not avaliable or are not feasible.

In this sense, the main contribution of our work was the transformation of a complete platform of automatic translation from Brazilian Portuguese (written or spoken) to LIBRAS, called VLibras, into an extensible platform, called OpenSigns.

The new platform can be expanded with the addition of new text-to-gloss translators with support for other pairs of spoken languages and sign languages. In the restructuring of the platform, an additional step of automatic text-to-text translation was also included in order to extend the scope of each specific text-to-gloss translator to other input languages.

During our study, we identified that a number of features of the original platform (VLibras) were agnostic regarding input and output languages and possibly applicable to other contexts directly. Thus, among the technological tools already available in the generic platform (Open Signs), we can mention:

- **Plug-ins** for many popular browsers that allow texts on web pages to be captured, submitted to a remote text-to-gloss translator and the resulting glosses rendered by an avatar.
- **TV applications** for the most popular platforms that allow the presentation of sign language contexts available on Digital TV signal.
- **Mobile applications** for the two most popular platforms that allow the translation and rendering of signals from an input text, also using a remote text-to-gloss translator.

- **Desktop applications** for major operating systems that allow content from multiple sources on the user's computer to be translated and rendered offline.
- **Extraction mechanisms** of texts from audio and videos for later translation text-to-gloss.
- A **web portal** for on-demand text translation, performed by an internal text-to-gloss translator.
- A **web portal** for video translation resulting in a new video with a signal language window synchronized with the original audio.

An integrated set of tools like this for machine translation using avatars is not easy to build and we believe that few initiatives in the world have such reach and penetration, with a dictionary with more than 13,500 LIBRAS 3D modeled signs. With the effort of generalization practiced in this work, this framework is available to be extended and used in other countries and languages.

The main effort to include the treatment of a new sign language is the creation of the 3D sign language dictionary and the addition of the associated text-to-gloss translator. The text-to-gloss translation components have been carefully isolated on the new platform so they can be easily retrofitted and / or replaced.

In this sense, the focus of this research was to validate previously three aspects of the new platform:

- If the new text-to-text translation step, which converts any spoken language into the reference spoken language of the desired sign language, inserts too much noise into the quality of the generated gloss;
- If the process of incorporating new text-to-gloss translators is feasible and simplified;
- If the process of setting up a new text-to-gloss translator (for example, ASL) using the generic internal translator with morphological, semantic and syntactic treatment is feasible.

The experiments and comparison of the obtained results were concentrated in the result of the gloss obtained automatically with respect to the glosses produced by human interpreters. They considered results in previous works, including validated in real experiments done with users.

4 Proof of Concept: Text Translation in Any Language for LIBRAS, LSE or ASL

4.1 Prototype Implementation

To develop a proof of concept of the proposal platform, initially, we developed a translator prototype able to translate texts into any spoken language of source into three target SLs: LIBRAS, LSE and ASL.

The text-to-text pre-translation module was created using the Google Cloud Translation API[2], to convert texts in any spoken language into Portuguese, Spanish or English depending on the target sign language.

[2] This API is able to identify the input language of a sentence and translate it automatically into a target spoken language (www.google.com/translate).

Then, the text-to-gloss translation module was adapted to support the translation of sentences in Brazilian Portuguese (BP), English or Spanish for a sequence of glosses into LIBRAS, ASL or LSE respectively. The tokenization (i.e., the separation of words from each sentence) in English or Spanish languages was made specifically for each of them, taking into account their own structural characteristics.

We also adapted the process of generation of sentence syntax trees for English and Spanish new translation modules. Figure 1 bring one example of syntactic trees for the same sentence in BP, English and Spanish, respectively.

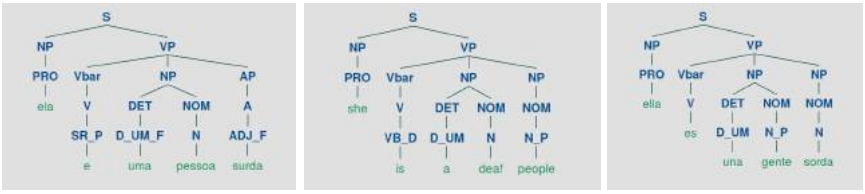

Figura 1. Example of a Sentence Syntactic Tree in BP, English and Spanish

We also have to make a mapping between the tags of the languages treated in the prototype and apply the syntactic description of the BP language. An excerpt from the crosstab that was created is illustrated in Figure 2.

Thus, before the generation of the syntactic tree, the proper labels of English and Spanish are replaced by their grammatical equivalents in BP, if any. Such a temporary artifice used in the prototype may have some impacts on the generation of the syntactic tree of some sentences but does not make the translation process unfeasible.

The text-to-gloss translation is based on a set of grammatical rules specific to each language treated in the prototype. Such rules are aimed at the adequacy of the morphosyntactic divergences between the spoken language and the associated target sign language.

All rules, whether morphological or syntactic, are modeled in XML files. Basically, each rule contains information from which grammar class it is intended for and the action should be taken whether the rule applies to the sentence. The application of syntactic rules implies the updating of the syntactic tree in order to keep it consistent with the modifications made. Below we have an example of rule applied in prepositions (P) of BP:

```
<rule name = "P"><!-- remove specific preposition -->
    <active>true</active>
    <count>1</count>
    <class>
        <title>P</title>
        <specific>x</specific>
        <action>remove</action>
    </class>
</rule>
```

where:

– *active* indicates that the rule is active, if its application is required;

– *count* is used for the next iteration with the sentence. In the case of BP prepositions, for example, only the current token will be evaluated. The next iteration should only advance one sentence token;
– *specific* is a specific action given to the need for translation into a target sign language. In the case presented, this action verifies whether the token is actually one of the prepositions of the spoken language;
– *action* is a generic action in case the outcome of the specific action is affirmative. The absence of a *specific* results in the execution of *action*. In the example, the prepositions are removed.

Grammatical Class	Portuguese (Aelius)	English (NLTK)	Spanish (Conll 2007)
PROPER NOUN	NPR	NNP	NP
PERSONAL PRONOUN	PRO	PRP	PP
POSSESSIVE PRONOUN	PRO$	PRO$	DP
INTERROGATIVE PRONOUN	-	-	PI
DEMONSTRATIVE PRONOUN	D	-	PD
PREPOSITION	P	IN	SP
VERB	VB	VB	V
MAIN VERB	-	-	VM
IMPERATIVE VERB	VB-I	-	-
PRESENT VERB	VB-P	VBP	-
PAST VERB	VB-D	VBD	-
CONDITIONAL FUTURE VERB	VB-R	-	-
DEFINITE ARTICLE	D	DT	DA
INDEFINITE ARTICLE	D-UM	DT	DI
DEMONSTRATIVE DETERMINE	DEM	-	DD
ADJECTIVE	ADJ	JJ	A
SUPERLATIVE ADJECTIVE	ADJ-S	JJS	-
ADVERB	ADV	RB	-
COORDINATING CONJUNCTION	CONJ	CC	CC
NUMERAL	NUM	CD	Z (digit) / DN (in words)

Figura 2. Grammatical tags mapping between the source spoken languages

In this other example of treatment of verbs in the past, *newprop* specifies that the new token tag will be after the rule is applied. In that case, the part of the tag representing the verb tense (-D) will be removed, since the action made in this type of verb for the translation to LIBRAS is the conversion of the verb to the infinitive and the addition of a new tuple to the sentence containing the verb tense of the verb treated.

```
<rule name = "VB-D"><!-- verb tense - past with advt-->
        <active>true</active>
      <count>1</count>
     <class>
            <title>VB-D</title>
              <specific>advt</specific>
             <action>change_vb</action>
           <newprop>VB</newprop>
     </class>
</rule>
```

The two examples presented are morphological rules, but the syntactic rules follow the same pattern.

The adaptations made from BP to LIBRAS also use auxiliary dictionaries and algorithms for treatments of special plurals. In the morphological adaptations to

English, auxiliary dictionaries are also used for the verification of some specific, as well as exclusive modules for verbal treatment and treatment of plurals, in both cases using algorithms based on WordNet[3]. In this first version of the prototype, in the translation from English to ASL and Spanish to LSE, only morphological adequacy is being done.

The post-processing step implemented in the *OpenSigns* prototype refines the translation in a specific way for each of the three SL. Some examples of steps performed in this step are: substitution of words or part of the sentence by a synonym, the substitution of numbers by numerals and identification of compound words, among others.

4.2 Experiments and Results

A set of tests was carried out to verify the feasibility of the proposal in the translation of sentences for LIBRAS, LSE and ASL.

The tests were performed using objective metrics WER (*Word Error Rate*) and BLEU (*Bilingual Evalution Understudy*) [14], which are generally used to evaluate machine translation strategies[15][17][11]. According to Melo, Matos e Dias [12], this type of computational test has the "purpose of evaluating machine translation systems with greater economy, speed and independence of languages than evaluations performed manually".

Initially, we performed a set of tests to evaluate the machine translation of sentences in English to LIBRAS. To perform this task, we used the same sentences of the corpus "Bosque" [10] used by Lima, Araújo e Oliveira [11] to evaluate the Suíte VLibras translation[4].

In the tests with our prototype, these 69 sentences were initially translated from BP into English by an English specialist. Then, the Open Signs prototype was used to machine translate these sentences in English for glosses in LIBRAS. Then, the WER and BLEU metrics, considering the precision in 1-grams (unigramas), 2-grams (bigrams), 3-grams (trigrams) and 4 grams, were recalculated for this sequence of glosses. The results can be seen in Table 1.

According to Table 1, the BLEU and WER values of VLibras were better than those of OpenSigns in all cases. This result was expected, since the sentences were translated using a single step of machine translation from BP to LIBRAS in VLibras. In the case of OpenSigns, on the other hand, the sentences were translated using two stages of translation (one from English to BP and the other from BP to LIBRAS), which explain the difference in the results.

However, we can observe that this difference of values was not so significant, considering that a new stage of translation was included. This difference was around 20% for all metrics. For the WER metric, VLibras obtained a value of

[3] https://wordnet.princeton.edu/wordnet/citing-wordnet/

[4] In this test, the authors randomly selected 69 sentences and two LS interpreters generated a sequence of glosses in LIBRAS for each one. Then the VLibras translator was used to automatically generate a sequence of glosses of these same sentences and the values of the WER and BLEU metrics were calculated for the two scenarios.

Tabela 1. BLEU and WER values for the 69 sentences of corpus Bosque

	VLibras [11]	Open Signs
BLEU 1-grams	73.50%	56.80%
2-grams	61.20%	39.00%
3-grams	51.20%	27.70%
4-grams	43.00%	20.30%
WER	31.70%	55.00%

33%, whereas OpenSigns had a value of 55%, an average difference of 22%. In the BLEU metric, the difference was also in the range of 20%, for all n-grams.

It is also important to consider that despite having slightly lower values in translation metrics, OpenSigns has a great positive difference on VLibras: the possibility of a deaf user translating a text in a foreign language (possibly unknown to him) into his own sign language (e.g, LIBRAS), increasing the scope of inclusion of these users, allowing them to access texts in other spoken languages.

In addition, the sentences in BP were also translated using a direct approach to gloss in LIBRAS, and WER and BLEU values were also calculated. Direct translation, as its name implies, involves the literal translation of each term of the sentence to a correspondent in gloss, i.e. without processing, interpretation or analysis of the context. With this, it is expected to contrast the translation made using VLibras, Open Signs and direct translation. Table 2 lists the BLEU and WER values for the three scenarios.

Tabela 2. BLEU and WER values for VLibras, OpenSigns and Direct Translation

	English-LIBRAS (OpenSigns)	BP-LIBRAS (VLibras)[11]	BP-LIBRAS (Direct Translation)
BLEU 1-grams	56.80%	73.50%	40.70%
2-grams	39.00%	61.20%	22.20%
3-grams	27.70%	51.20%	11.40%
4-grams	20.30%	43.00%	5.50%
WER	55.00%	31.70%	87.70%

According to Table 2, we can observe there was a reduction in BLEU values, and an increase in WER value, when the translation using the prototype is compared with the translation generated by VLibras. As mentioned before, we expected a worse result in OpenSigns due to the intermediate machine translation process text-to-text, which is an inherent bias that can be reflected in the final result of the translation. The reduction in BLEU values averaged 20% to 30%, which can in principle be considered an acceptable noise considering that there are two translation processes involved. However, it is part of our future roadmap to conduct an experiment with deaf users to verify the level of intelligibility of the translations obtained.

In any case, when we compare the machine translation of English to LIBRAS generated by the prototype with a direct translation strategy (from words in Portuguese for glosses in LIBRAS), we can observe that there was an improvement in the results of the BLEU and WER. This is an indication that the translation of sentences from English to LIBRAS using the proposed approach has the potential to produce better results than a direct translator of words to glosses. In other words, this result may point out that, even containing an intermediate stage of translation from English to BP, the noise generated in this process is not so high that it will not allow machine translation, since it had better results than a direct translation from BP words to LIBRAS glosses.

Continuing the validation of the approach, we carried out a second set of tests with the objective of evaluating the use of an additional translation stage between sign languages, rather than a stage of intermediate translation between spoken languages. For example, to translate English contents to LIBRAS, instead of translating from English to Portuguese, and then translating to LIBRAS, we performed two step of translations: translation from English into ASL glosses, followed by a translation from ASL to LIBRAS.

In this test, some English sentences (and their respective glosses in ASL) were randomly selected from the *American Sign Language University* (ASLU)[5] site. After the selection, a LIBRAS specialist with advanced knowledge in the English language, translated all the sentences to a sequence of LIBRAS glosses.

The sentences in English were then submitted to the prototype and translated into LIBRAS glosses. Then, the ASL glosses of these sentences were submitted to the prototype and translated into BP, and then to LIBRAS. The BLEU and WER values were generated for the two scenarios based on the reference translation produced by the LIBRAS specialist. The values of WER and BLEU obtained are shown in Table 3.

Tabela 3. BLEU and WER values for ASLU ASL sentences

	English-LIBRAS	ASL-LIBRAS
BLEU 1-grams	65.20%	47.80%
2-grams	42.60%	18.90%
3-grams	25.60%	0.00%
4-grams	14.20%	0.00%
WER	19.3%	28.0%

Analyzing the results, we can observe that the BLEU values are higher and the WER value is lower in the first scenario, where the translation was made directly from the sentences in LIBRAS. This result indicates that the translation of the sentence in a given spoken language directly to the target SL, can offer better results than translation from the gloss in another SL.

Afterwards, the sentences translated by the specialist were converted to a sequence of glosses in LIBRAS, where the VLibras and the prototype were again

[5] www.lifeprint.com/asl101/index/sign-language-phrases.htm

used to generate the sequence of glosses in LIBRAS from phrases and glosses randomly selected from the ASLU database[6]. With this, we can calculate the BLEU and WER values of the glosses in LIBRAS generated from the text in English and the glosses in ASL in order to analyze the best approach: direct translation of the sentence or translation from the gloss. Table 4 contains the percentage values of the two approaches.

Tabela 4. BLEU and WER values for the two approaches to translation

	Direct from English	Glosses in ASL
BLEU 1-grams	65.18%	47.80%
2-grams	42.58%	18.89%
3-grams	25.60%	0.00%
4-grams	14.18%	0.00%
WER	19.32%	28.02%

According to Table 4, we verified that the BLEU values are larger and the WER value is lower in the first approach, where the translation was performed directly from English to gloss in LIBRAS using the prototype. On the other hand, the second approach presented lower values in the BLEU and higher in the WER. In a first analysis, the direct translation of the sentence of a given language offered better result than from the gloss of another language.

5 Final Remarks

In this work, we present the results of a research whose objective is the development of a multilingual platform for "text-to-sign"machine translation, ie, a unique ecosystem that accepts several spoken languages as input and performs a machine translation for several output sign languages. The proposed platform is based on several common existing components, derivated from the **Suíte VLibras**, in which components supporting specific mechanisms of different sign languages have been added.

A prototype, based on an extension of **Suíte VLibras** was developed with the aim of verify that the basic concepts of the proposed platform are feasible. In this prototype, additional components have been implemented to support the translation of texts in any language for Libras and ASL.

In our conception, it is fundamental to stimulate the community of researchers and developers who work with translation support systems for sign language to collaborate. As we are distinct groups, in some cases with commercial interests and competing in the market for accessibility products, cooperation is only possible with the definition of standards for architecture and some system components. One of the components that is critical for the evolution of the results in the area is the dictionary. For us, the dictionary must be a resource

[6] http://www.lifeprint.com/asl101/index/sign-language-phrases.htm

shared by the different translation systems. This would imply in a more accelerated increase in the number of signs, quality and convergence in the use of signs. It is therefore vital to accelerate the definition and expansion of the sign languages themselves.

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Multisensory Devices: Lessons Learned from Experiences with Cerebral Palsy Towards its Use in TV Contexts

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Abstract. The evolution of user interfaces has improved the user experience, especially when considering its sensory dimension, which role is crucial for the effectiveness of assistive technologies that are used to increase, maintain or improve functional capabilities of users with disabilities. This study presents the potential of using multisensory tangible devices to promote the accessibility of children with Cerebral Palsy (CP) in television contexts, through the analysis of the results of a study that occurred in a game context. CP refers to a range of clinical syndromes characterized by motor disabilities and postural changes, that may or may not be associated with cognitive disabilities and speech disorders. Due to a restricted motor condition, the access to games and sports can be difficult for people with CP, as well as performing regular tasks in the television (TV) context, as turning on the TV to watch cartoons or use a remote control to play a videogame. Our goal is to offer an alternative to people with CP, based on the results of a study described in this paper using tangible multisensory devices that allowed the remote manipulation of a robotic ball. This experience was conducted in a clinical environment throughout an 8-week study with two 5-year-old children with CP. The observed improvements in play performance and positive achievements in the quality of the interaction between the user and the game, together with the immersive potential of the television device, allow us to discuss the potential of using tangible and multisensory devices in accessible TV scenarios.

Keywords: Assistive Technology, Cerebral Palsy, Television, Games, Human-computer Interaction

1 Introduction

Human-Computer Interaction (HCI) is related to the functionality, design and evaluation of computer systems in providing an effective and enjoyable user experience for individuals. Thus, the process of communication between the user and computer system

is taken into account to achieve these objectives [1]. Knowledge about the characteristics of users is necessary, as well as the environments where the systems will be used and which tasks are involved to achieve the goal of the activity. Therefore, in order to develop and to produce effective and efficient computational systems, human factors are extremely important [2][3][4].

Currently, computer systems are increasingly dedicated to providing users with more sophisticated sensory experiences. Therefore, user interfaces and, consequently, computing systems are becoming more ubiquitous in our physical world. This fact is observable due to the tangibility of the context in which sensations are experienced in everyday life, such as in playing, talking and listening[5].

According to the American with Disabilities Act, Assistive Technology is "any piece of equipment, product system, used to increase, maintain or improve functional capabilities of individuals with disability"[6][7][8]. Therefore, high-performance assistive devices can also be represented by hardware or software [9]. Several studies have been performed using Tangible User Interfaces (TUI) in Assistive Technology for rehabilitating people with physical disabilities [10]. These technological devices may offer disabled children enjoyable experiences in safe environments and may, for example, help and assist people with motor disabilities such as cerebral palsy.

Cerebral Palsy (CP) refers to a series of clinical syndromes characterized by motor disabilities and postural changes, that may or may not be associated with cognitive disabilities and speech disorders [11]. Children with special needs may demand more time to learn and perform some activities, which is also true in relation to playing and participating in games. The early years is hugely important in the growth and development of the individual, and a motor delay may result in a setback in occupational performance of a child, subsequently affecting play. Also, the difficulty in manipulating objects causes dependence on the performance of commonly routine tasks, such as turning on the TV, watching a cartoon or playing a videogame [12][13].

Television is one of the most advantageous entertainment media for kids. Since the TV is present in a considerable number of houses, this device can be seen as an important instrument to promote playing and for knowledge acquisition by children, since it can have an important role in helping them to better engage in games using consoles and watching children's shows [14][15]. Also, videogames are very attractive for children, becoming a way to increase the motivation and engagement and to provide a greater social interaction, therefore, promoting motor improvements to children with CP [16]. Regarding the development of video games, one important criteria to be taking into account is related to gameplay, which is closely associated to the game quality in the viewpoint of the players; thus, it's a pivotal element to be consider in a game situation.

Furthermore, over the last decade, we have followed a meaningful change in the TV ecosystem, that goes beyond the increase in the number of media content offered by many commercial players and Pay-TV operators. These changes encompass innovative ways to interact with the TV by the emerging of new technologies in the HCI field, making possible to control the TV using different User Interfaces (UI). Among these interfaces, are a variety of Graphical User Interfaces (GUI), Tangible User Interfaces

and Natural User Interfaces (NUI), such as gesture recognition (using cameras) and voice controllers.

The main objective of this paper is to show the potential of the use of tangible multisensory devices to promote accessibility for children with CP in TV scenarios, such as playing a video game or watching cartoons. To do that we will present the results of a multidisciplinary study involving professionals from occupational therapy and computing. The study was conducted in a clinical context throughout an 8-week study with two 5-year-old children with CP, in study case sessions. We intended to connect the needs of CP users with the gameplay of a robotic ball through the development of digital game for the children. The robotic ball is a device that allows remote control of its movement and color change functions [21]. The use of a robotic device allows manipulation of the ball remotely, which makes this feature helpful for people with disabilities. The analysis of the results was made based on gameplay criteria. In the next section, our main interest is to present theoretical background. After the game is presented, we discussed the results and the perspective of using tangible multisensory devices to promote the accessibility of children with CP in television contexts.

2 Theoretical Background

Tangible User Interfaces (TUIs) can be observed as physical manifestations of computing. This simple feature allows users to use their native senses to interact with computer-based systems. In the literature, we have found descriptions of the use of interactive technologies that explore multisensory qualities and allow people to participate using their senses. Urbanowicz [22] emphasizes the power of these interactive technologies as important tools, which have the ability to enhance individuals' perception. The same author also emphasizes that sensory systems have a crucial role in the life of all beings, from the moment they allow the perception the environment in which they live [22].

Simultaneously, computer systems provide sensory experiences to their users. Aside from the intrinsic attributes of the perception of shared environments, applications transcend the pixel barrier and make the user part of it. Ishii [5] refers to Tangible User Interfaces (TUIs) as a physical manifestation of computing. Conceptually, all digital information contained in these dynamic materials has a physical manifestation which one can directly interact with, creating an user-computer relationship. In this sense, there are Tangible Interfaces (TI) that are based on the concept of a tangible digital device, or touchable, that will ensure a realistic interaction between the user and the computer. The use of physical objects by TIs allows users to employ a wider range of actions and regain skills and knowledge, which are acquired in the form of data manipulation [23].

In addition, systems that include interaction with tangible interfaces have a software structure and a physical structure, which is represented by physical space and objects. Thus, these systems are embedded in real space and physically embodied. Applications can offer a framework of facilitation, prohibition or hindrance of actions at the moment

that directs user behavior, which can influence human behavior, patterns and emerging social interactions. This makes tangible interfaces actually facilitators [25].

The day-to-day life of every individual is filled with objects with functions, textures and shapes that determine specific ways to catch, carry, and throw, thereby building skills that can be recalled in other situations. With this perspective, the interaction between the individual and environment are key determinants in the production of meaning. This action is considered a prerequisite for perception. Thus, sensory input, such as recognition of the environment, begins to have meaning to the extent to which actions are performed and the space around the individual is explored [24].

Many are the studies related to the use of tangible user interfaces for motor improvements through digital games. Regarding the development of digital games, the concept of gameplay is important to note. Gameplay is related to the quality of the interaction during the game from the perspective of the user. In this sense, gameplay criteria may be related to the interfaces and development of the game. Some studies discuss the criteria for determining the quality of digital games [26][27]. Malone [28] notes that the game must present three characteristics: challenge (involving the presence of an explicit goal in the game), fantasy (presence of emotional appeal and metaphors with physical systems that the user already knows) and curiosity (presence of visual and auditory elements, humor and randomness). Barcelos [26] highlights attributes for gameplay:

- the main objective of the game is presented to the player from the beginning;
- the game should offer several levels of difficulty and allow different strategies to be used;
- the game's pace should take into account the user's level of fatigue and ensure the maintenance of well-being;
- the game difficulty level can be adjusted according to the player's skill;
- the player should be rewarded for achievements in a clear and immediate way;
- the controls should be clear, customizable and physically comfortable;
- their responsive actions should be immediate;
- the player should be able to customize the audio and the video settings for the game according to their needs.

This criterion mentioned above makes gameplay a crucial point to be considered in a development process of the game.

Regarding the use of digital games for children with CP, works that uses some kind of interaction resources to improve assistive technology have often been the focus for investigations (for example [9, 29, 30]). In all three studies, the authors put conditions to improve games in order to maintain the motivation of the players with respect thereto. Furthermore, it is emphasized that the interest of the subject at stake is an essential factor to be used in rehabilitation. The gameplay is therefore present in all studies, with a view that all studies show an interest in maintaining the quality of the user interaction with the games. In the first work, the author puts as attractiveness factor of the games the fact that the movements are assisted by computer [30]. The second puts the suggestions of the therapist and patients to improve the quality of the system and increase the

interest of the subject. This system is based on Microsoft Kinect [9]. The suggestions are related to the increased number of games offered by the system and the ability to play with another person, increasing social interaction. The third study uses guidelines as basic attributes for the development of digital games for CP users. The author states that the intention is to develop games in which players will maintain the high level of interest in the game. Four interactive games were produced. On those games, the players used the Wii Balance Board to navigate in the virtual environment [29].

3 Game Idea

Our proposal was to use multisensory devices to develop a game designed to promote the play in people with CP. In the conception phase of the project, we thought how could we develop games that can simulate real games that are common for children without Cerebral Palsy, but uncommon for children with the condition. So, we found the Sphero [21], a robotic ball which movements can be manipulated by many different devices. Using the Sphero as a tangible device we focus on games that use a ball as the main object of the game, such as football and bowling. The main idea was to make the users with CP have the thrill with the movement of the ball that they may have never had, like kicking or throwing a ball. One of the promising application areas of Sphero is the digital games. We have a lot of games using Sphero as Sphero Pet and Sphero Draw N' Drive from Orbotix Inc. [31]. The next step was to think how the user will be able to manipulate the Sphero. So, we came up with several ideas, such as a projector to project a scenario of the game (like a virtual crowd) to induce the fantasy property as suggested in [28] and different ways to control the ball. Some possibilities were tangible devices, which enables to interact with a digital content, like the Pull and click mouse and *switches* with different colors, mobile devices or natural interaction devices as Leap Motion (see fig. 1) [32]. These features could collaborate for the immerse of the user into the game.

For developing the proposed game, we used an user-centered design approach. This approach puts the disabled person as a center of the development of the project, shaping the adaptations of interfaces according to their needs. Thus, user interaction with the devices could be efficient and effective. The user-centered design relates to the production of a customized computer system, i.e. facing the demands of a single user. In this way, specific attributes that must be in games in way to get a high gameplay are easier to achieve. Concerning the production of a TA product, the prescription of a TA feature demands the following set of actions: (1) review the state of the client; (2) evaluation of devices being used; (3) evaluation of customer needs and the family; (4) prescription item; (5) development of the project; (6) user training; (7) monitoring of the use; (8) reviews changes in framework [10].

Fig. 2 shows part of the storyboard for the proposed soccer game. Sphero was used as the ball and it kept the integration with other interactive devices which were used to control Sphero.

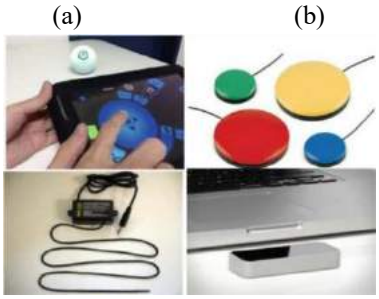

Fig. 1. Devices. In (a) Sphero, in (b) pressing buttons, in (c) pull and click mouse and in (d) leap motion

This feature highlights the flexibility of this work. Once the project uses a user-centered design, the devices were used in accordance with the user needs and capacities.

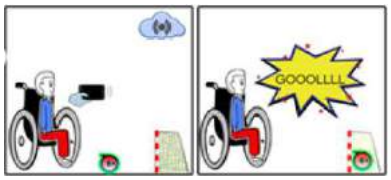

Fig. 2. Part of the Storyboard

4 Tests and Evaluation

Apart from the above considerations, the user experience required some special care in submitting the project to the Research Ethics Committee (CEP), since it includes experiments with human beings. The CEP is an interdisciplinary and independent organization that evaluates research involving human subjects in Brazil.

The sessions were conducted with two five years old children, Y and P. The first one has a diagnosis of quadriplegic spastic cerebral palsy. As a result of this condition, the child uses a wheelchair to move, which needs to be transported when necessary. The child does not have motor coordination in the upper limbs and, therefore, cannot hold or manipulate any objects. P has a diagnosis of spastic diplegic, a form of cerebral palsy. As a result of this condition, the child does not walk. The only way for her to move from one place to another in the house is crawling. Regarding the upper limbs, the child has good motor skills and can handle large and small objects with ease. First, an interview analyzing each participant was conducted in which the classification of the user's CP and others information were collected and a casual conversation with parents took place. The therapist's observations were also considered. Analysis of the user experience took the form of weekly sessions (16 in total), which always involved

two therapists and the child. These sessions were held in two academic school clinics: the physiotherapy and occupational therapy clinics.

Throughout the study, we conducted five assessment sessions to evaluate the participant's movement and play as well as functional skills, like eating. Assembling a complete profile for each child — knowing their demands and capabilities and assessing the performance and autonomy of their functional abilities — is important. To do this, 5 evaluation tools were used. Among these tools are the Gross Motor Classification System [33], The System Manual Ability Classification for children with cerebral palsy [36], The Pediatric Evaluation of Disability Inventory [34], The Ludic Model Protocol [13], The Gross Motor Function Measure [35]. Although we used all these instruments, in this article we only mention them. Further, since we believe that gameplay is an important thing to be taking into account, we will show the results of each child based in five of the eight heuristics pointed by Barcelos [26] that we mentioned previously. The results are organized in tables, which presents the concepts of each heuristic followed by questions related to them. The questions only permit "yes" or "no" as an answer.

In the current literature, there is an increasingly perceived tendency to develop games according to the need and the capacity of each person, in order to increase the interaction with the game and get better results. Thus, we created an immersive environment, in which children had motivation to play and a friendly environment to meet the specificities of each user.

5 Obtained Results

For a higher engagement of the child in the game some motivational factors were introduced, such as figures and songs of the children's favorite cartoons in the scenario. The Tables 1 and 2 show the results of Y and P after the analysis of the sessions, in what concerns gameplay.

The gameplay questionnaire was extremely important, since it offered insight into factors that determine a good relationship between the user and digital games. Users P and Y showed positive interaction with the game, which was fundamental to achieving the objectives of this study. In analyzing the results, we note that the motivational factor is extremely important in achieving the goal. One of the most important factor for promoting motivation concerns to the immersive capability of the system. Further, both users who participated in the games wanted to achieve the main objective at the time of play. The achievement of these objectives led to higher physical performance observed by the therapist, that was not reported by parents or seen in evaluations prior to the intervention. According to the therapist's observations, the fun and engagement shown by the children playing the games was clear. Moreover, the TUI were more effective to

Table 1. Results about gameplay of Y

Heuristics and related questions	Answers
H1: The main objective is presented at the beginning of the session.	
1-Did the user understand the objective of the game?	Yes
2-Did the user achieve the goal of the game in every session?	Yes
H2: The place should take into account the fatigue and maintenance of well-being.	
1-Did the user want to keep playing?	Yes
2-Did the Participant want to stop playing due to fatigue?	No
3-Did the user remained engaged with the game during the sessions?	Yes
H3: The controls should be clear, customizable and physically comfortable.	
1-Did the user be able to manipulate Sphero using the controls?	Yes
2-Did the user have difficulty manipulating the device?	Yes
3-Did the user use another device to further manipulation actions?	Yes
H4: The games difficulty level can be adjusted according to players skill level.	
1-Was the difficulty level of the game correctly matched with the user's abilities?	Yes
2-Did the users performance improve in the final sessions compared to the previous ones?	Yes
3-Was the game level ever modified to correspond to the user's skills?	No
H5: The player should be rewarded for achievements clearly and immediately.	
1-Did ball move after the Participant threw it?	Yes

Table 2. Results about gameplay of P

Heuristics and related questions	Answers
H1: The main objective is presented at the beginning of the session.	
1-Did the user understand the objective of the game?	Yes
2-Did the user achieve the goal of the game in every session?	Yes
H2: The place should take into account the fatigue and maintenance of well-being.	
1-Did the user want to keep playing?	Yes
2-Did the Participant want to stop playing due to fatigue?	No
3-Did the user remained engaged with the game during the sessions?	Yes
H3: The controls should be clear, customizable and physically comfortable.	
1-Did the user be able to manipulate Sphero using the controls?	Yes
2-Did the user have difficulty manipulating the device?	Yes
3 Did the user use another device to further manipulation actions?	Yes
H4: The games difficulty level can be adjusted according to players skill level.	
1- Was the difficulty level of the game correctly matched with the user's abilities?	Yes
2-Did the users performance improve in the final sessions compared to the previous ones?	Yes
3- Was the game level ever modified to correspond to the user's skills?	No
H5: The player should be rewarded for achievements clearly and immediately.	
1-Did the ball move after the Participant threw it?	Yes

achieve the goal of the game, since both children had difficulty in controlling the robotic ball by Leap Motion, which provides a natural interaction. Therefore, the main devices used for the control of the ball ware Pull and Click Mouse and the switches.

This study led to the conclusion that it is possible to make tangible digital games accessible to children with physical disabilities. Moreover, these technologies are capable of contributing to the promotion of playing for these children. Games provide stimuli for several human senses and even make physical improvements when children are engaged with the game. Therefore, tangible technologies, in particular the immediate feedback from the system (heuristic 5), are essential features to improving the whole experience.

6 Lessons Learned Towards the Potential of Using Multisensory Tangible Devices in TV contexts

One of our biggest challenges was to promote an immersive experience in games for children with PC. The use of multisensory TUI is one of the solutions we used to achieve it. Through this interface, user interaction is closely related to the immersion of the individual, making it an integral part of the game and thus an active participant regarding game interaction. So, designing the game interaction is also choosing the best stimuli for improving the gamer's performance in an immersive environment.

Concerning improvements by the children with CP, the possibility of the engagement with fun activities was crucial to foster motivation and to lead them to become the main actor of the game. In this work, we identify that if the fun activity, e.g. play or game activities, takes part of child's daily life, it can be possible to engage them in an immersive environment which can motivate the children to perform specific tasks related to this "fun environment".

Therefore, the existence of immersive environments is important to motivate children with CP to engage in simple tasks that are difficult for them in daily life. Among these tasks are simple activities, such as controlling the TV by turning it on, or increasing/decreasing the volume, changing the channel and playing a videogame. One of the main factors that lead the TV to be the most important device in home environments is the immersive potential, which contributes for the exploration of the feasibility for its use in game contexts. Since the television is found in a considerable number of houses, it is crucial to present the potential of using the TV as an immersive, multisensory and powerful device to be used for accessibility for children with CP in their daily life [38].

Currently the TV is present in a substantial number of houses being an important ludic and didactic equipment for children in domestic environments [14][37]. The interactive multisensory potential of the television must be observed taking in consideration the significant role that digital means have in motor, social, cognitive, emotional and linguistic development. Additionally, the television's current scenario is characterized by a clear evolution in the amount of digital content transmitted in a panorama in which many children spend much of their days in front of the TV [37][19].

Improvements in the TV scenario makes possible to dig deep to the power of influence of the TV, which can be translated in in the digitalization of the television signal

that turns possible the emergence of the interactive TV. Interactive TV may enable facilities, such as interface customization, multiple streams of audio and video and the arise of applications with manifold kinds of interactivity in a large range of services [38].

Nowadays, TV operators have invested in alternative user interfaces and multimodal means of interacting with TV, that go beyond the traditional interaction paradigms in order to take advantage of new features and to make a difference in their offer to the market [37]. Therefore, the industry leveraged a substantial number of interactive means that allow controlling these systems with different interfaces [17]. Also, different smart devices appear as complementary platforms for watching TV content through household or in mobility [18]. Taking this into account, it is possible to notice the huge multisensory trend in the future interactive systems, which aggregate multimodal interactions and explore one or more sensorial systems. Simultaneously, taking advantage of this multisensory profile, it is possible to foresee that the future interactive systems will be potentially used in the accessibility field to obtain motor, social, emotional and affective improvements.

Although it is possible to find many studies about the use of multisensory devices for motor rehabilitation of children with CP in using games [16], there is still a lack of studies that involve the accessibility of these children in the TV context. Taking into consideration that play is the most important task in a child's life and that TV can be a simple mean to achieve a daily scenario in which they can really enjoy playing, it is crucial to conduct studies in this direction. The current scenario includes several changes in the TV ecosystem, including the high diversity of contents and a plenty of support devices that allow unconventional ways of controlling television. Therefore, we can benefit from this context to promote play, at home, for people with CP.

Concerning the multisensory devices used in the present study and the trends of the industry to improve interactive solutions for controlling the TV, it is possible to notice that children with CP could benefit from this scenario by controlling the TV or even playing a videogame, at their houses. This has the potential to bring significant gains in their family daily lives. In this sense, one of the contributions of this work is to highlight the use of multisensory devices for accessibility in TV contexts. Since the use of the tangible devices was a success in promoting play in a rehabilitation scenario through the control of a robotic ball, we suggest the use of these devices as TV controllers, like in the game presented in this study. Therefore, we suggest a user-centered design approach to adjust to the needs of each child.

7 Final Considerations and future work

This work presented a tangible game idea for the promotion of play for children with CP, using a robotic ball which can be controlled remotely. To do that it was considered the demand and characteristics of the children through a detailed assessment, to provide the most suitable device to be used for each child. Tangible multisensory devices proved to be effective for the promotion of accessibility in a game environment for children with CP, thus, proving their feasibility in a game context. In addition, since

there are many available options of game consoles that can be connected to these devices, a game environment could be inbuilt in their houses for playing videogames. Since the television is a multisensory device, the use of tangible devices to promote play activities among children with CP must be highlighted. As future work, we plan to implement these kinds of tangible multisensory devices in a home environment in order to improve accessibility in TV contexts for children with CP. We also plan to propose recommendations concerning which are the most appropriate devices to be used accordingly the specific kind of CP for interact with the TV in their houses. The idea goes, thus, beyond the development of a game. In this context, the immersive potential of the iTV must be explored to improve the autonomy in simple and important tasks for children with cerebral palsy (such as for a typical child), just like turning on the TV for watching cartoons or participating in game contexts using videogames. Is important to highlight that, since the television device is present in most of the houses and has a crucial role in the daily life of a child, improvements on accessibility for children with CP could make a real difference in those children's' lives.

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Involving visually impaired viewers in the design of accessible solutions for audiovisual translation

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Abstract. Audiovisual translation is commonly related to the reproduction of an original audiovisual content in another language, for example using subtitling or dubbing. In addition, several contents can also be enhanced with more information with, for example, audio description (AD). In this framework, the emerging of new digital technologies and media accessibility solutions allow the development of innovative audiovisual translation techniques which can easily meet the needs and difficulties of different target groups, like visually impaired viewers.
Currently, the production methods of audiovisual translation are expensive and complex, involving several professionals and procedures. However, the current Television eco-system opens the way to enhance these techniques, leveraging the quantity of translated TV content for people with special needs.
This paper reports a study which results will be used to design two accessible solutions (collaborative/spontaneous audio description and automatic reading of subtitles) for audiovisual translation in an Interactive Television (iTV) context, aiming to support viewers with visual impairment. Based on two focus groups with these viewers we found that the proposed solutions are relevant for this audience, who revealed interest and receptiveness to use them.

Keywords: Accessibility; Interactive Television; Audiovisual translation; Visual Impairment; Audio description; Subtitling.

1 Introduction

Audiovisual translation is commonly used in the television context, especially to help the interpretation of foreign content, using techniques such as subtitling and dubbing. When the contents are in native language other techniques, like voice-over and description, also support a specific kind of audiovisual translation. In these techniques, the management of verbal and nonverbal components of the narrative are required [1], demanding human intervention.

The role of these techniques in the development of accessible TV contents is of major importance, because they enabling its access to people with special needs. In the specific case of viewers with visual impairment, they benefit from audio descrip-

tion and dubbing techniques. However, in Portugal, visual impaired viewers have only access to the AD of some series of RTP1 (the Portuguese public TV station). In contrast, the AD international scenario is very different: countries like the United Kingdom and United States of America have an AD television market much more regulated and developed. Concerning dubbing, Portugal is not a country with a tradition of this technique, contrarily to countries like Spain, France and Italy, so the television contents that are dubbed in Portuguese language are mostly animated movies and documentaries.

In this context, this paper describes the proposal of two new approaches for the creation of audiovisual translation techniques: (i) collaborative/spontaneous AD (ii) and automatic reading of subtitles, which are addressed to television contents in native language and non-native language, respectively. Regarding collaborative/spontaneous AD, this technique is supported on a co-participative approach that mainly takes advantage of the situations where viewers with and without visual impairment (e.g. relatives) are physical watching the same TV content. On the other hand, automatic reading of subtitles technique is based on a mechanical and automated approach with no human intervention. These two proposed techniques were evaluated within the context of two focus groups of visual impaired viewers using an assessment table and considering the current Portuguese TV environment.

In the next sections the proposed techniques are presented, alongside with the state of the art related to this field of research. After that, the methodology that was used to conduct the study is explained, pointing out the results obtained with the focus groups. The paper closes with the final comments and the work to be done in the next phase of this study.

2 Proposed Techniques

In this section the two new approaches for the creation of audiovisual translation techniques are presented.

Collaborative/spontaneous audio description is supported on a co-participative approach that takes advantage of the family relationships between viewers with and without visual impairment for the creation of audio descriptions. In a starting study related with this technique (previously performed by the authors of this paper) it was possible to find that volunteers were satisfied with the procedure used to create AD and visually impaired users felt that this type of AD assisted them [2]. On the other hand, automatic reading of subtitles is based on a mechanical and automated approach with no human intervention.

It is worth to say that as these new approaches demand a preprocessing phase, they are especially relevant for non-linear TV programs, for instance those available from the video-on-demand (VOD) service or the Catch-up TV service of Pay-TV providers.

2.1 Collaborative/spontaneous audio description

The concept for the collaborative and inclusive approach will be supported in a cross-platform solution (web and mobile) for iTV and will be sustained in the following workflow (**Fig. 1**): (1) recording of segments of spontaneous audio description to be carried out by the volunteers synchronously with the television content (taking advantage of frequent situations were visual impaired viewers are assisted by their relatives while watching TV); (2) uploading of the resulting audio file into an audio descriptions repository; (3) easy edition/elimination of unsuitable content and/or assembly of several volunteers' contributions to create a more complete audio description; (4) providing the audio description through an iTV application associated to same infrastructure that transmits the respective television program (usually a catch-up TV program or other non-linear one). It is also foreseen to provide the possibility of selecting the audio description by various criteria (e.g. name of the author or group of authors).

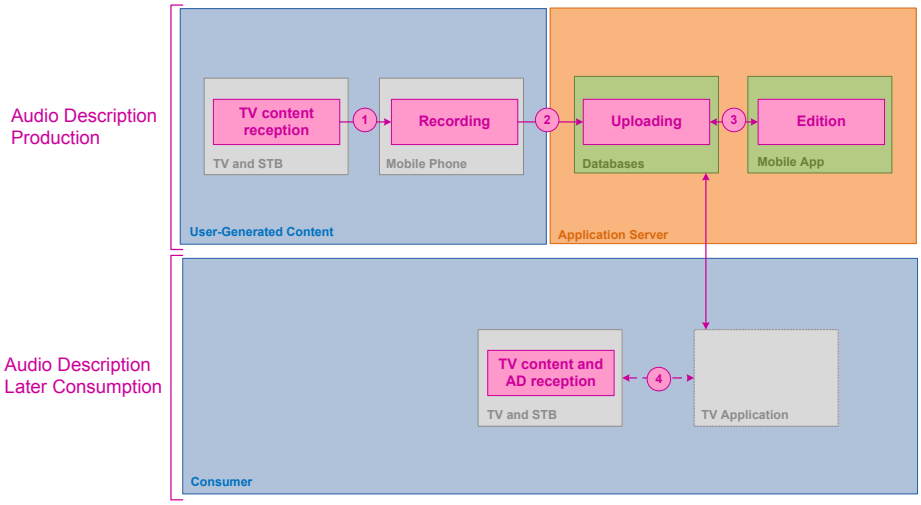

Fig. 1. Workflow of the collaborative/spontaneous audio description technique

2.2 Automatic reading of subtitles

The system approach that supports the proposed automatic reading of subtitles will be sustained in the following features (**Fig. 2**): (1) identification of the subtitles for each TV program using its subtitles file (e.g.: via a free online repository); (2) reading of the subtitles via a text-to-speech (TTS) to produce an audio stream; (3) synchronization with the television program that is being broadcasted (e.g.: via an interconnection with an existing TV infrastructure); and (4) providing the automatic reading through an iTV application associated to the same infrastructure that transmits the respective television program .

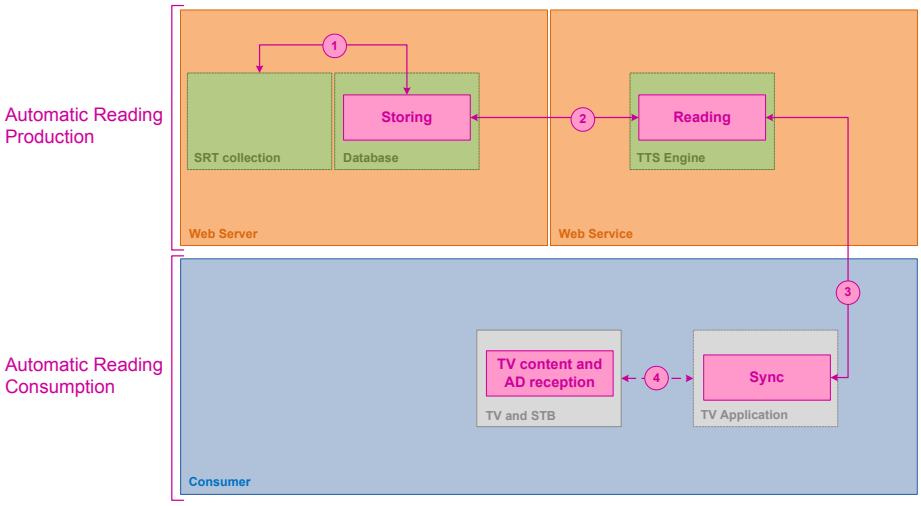

Fig. 2. Workflow of the automatic reading of subtitles technique

3 Related Work

The international scenario on the audio description is quite different from Portugal. For instance, in the UK the broadcasters have a legal obligation to provide at least 10% of its programming through audio description [3] and in USA, the local stations of the 60 zones of the country with greater use of Television are obliged to broadcast about 4 hours a week of programs with audio description [4].

However, the Portuguese academia being worried with this situation has performed significant efforts to counteract it. Neves [5] is a precursor of several projects that encourage the use of audio description in several domains. Oliveira et al. [6] has some work in the field of interactive television, suggesting an adapted system to visually impaired users supporting access to audio description. In Spain, the 'AudescMobile' mobile application was created allowing the access to AD of several types of audio-visual productions, using audio fingerprinting (analysis of a sound excerpt recorded by the application) [7]. In Brazil there are projects related to the promotion of audio description; for example Campos [8] suggests a mechanism based on semantic web application for the automatic creation of audio description for movies and Domingues et al. [9] proposes an automatic system to create audio descriptions. In the United States of America there is a free and experimental tool developed as part of an academic research that allows adding audio descriptions on YouTube videos [10]. The audio descriptions can only be created and accessed through the 'YouDescribe' web tool.

Concerning the volunteer model to provide inclusive services, there are several European initiatives that take advantage of it for the creation of audiobooks [11] [12] [13], audio description book illustrations [12] or audio newspapers [14] and for the supply of geographical information [15] and social initiatives [16].

In Europe there are also more extensive audiovisual translation projects, such as the 'HBB4ALL' [17] that aim to promote a wider availability of accessible media aids to all viewers with special needs (like audio description, subtitles and sign language). The project aims to make a cross-platform production and distribution of accessibility features more cost-efficient and more flexible and easier to use, benefiting users and also broadcasters and media producers.

In Portugal, there isn't a great tradition of dubbing; it is applied almost exclusively to documentaries and animation movies and series. In 1994 the first Portuguese language dubbing was held in the "The Lion King" Walt Disney movie, until then the animation movies were dubbed in Portuguese of Brazil [18]. Currently, in Portugal, cable channels like Discovery Channel, Disney Channel and Cartoon Network use dubbing on its television contents. However, despite these small advances in the Portuguese market, it is possible to verify that most foreign movies are usually broadcasted in the original language with the respective subtitles. Thus, Portugal is away from the amount of content dubbed in countries like Spain, France, Germany and Italy [19].

Regarding the automatic reading of subtitles systems for television, between 2002 e 2005, Germany [20] and Sweden [21] public television providers implemented a solution that automatically read the subtitles, but it has limitations inherent to the use of two boxes by the user in order to receive the reading sound through a secondary audio channel. Recently, in Sweden and Denmark were developed some prototypes in this field, in particular through complex solutions, which used OCR [22] and TTS [23] systems. Also in Sweden, Ljunglöf et al. [24] developed a prototype that does the automatic reading of subtitles of videos and television programs through a TTS engine using a computer. However, this solution was not specifically adapted to a television scenario nor allows the cohabitation of visually impaired users and sighted users. The media player "KMPlayer", since 2008, allows the automatic reading of subtitles that appear on the screen and are associated with a subtitle file [25].

4 Methodology

The researchers conducted two focus groups with visual impaired viewers in order to have inputs from this kind of audience regarding the two proposed audiovisual translation techniques (collaborative/spontaneous audio description and automatic reading of subtitles). A comparison table, which was previously applied in a focus group conducted by the researchers with experts in the audiovisual and TV subjects [26], was also used for this purpose. This table was composed by four techniques (the proposed ones and a respectively alternative technique to each one, namely traditional audio description and dubbing). It is worth to say that the four techniques were analyzed by the participants considering the Portuguese reality.

In the next sections, the used table is described, pointing out the compared audiovisual translation techniques as well the analysis parameters, and the focus groups are explained, identifying their participants and structure.

4.1 Comparison Table

The comparison table was prepared taking into account four translation audiovisual techniques: traditional audio description; collaborative/spontaneous audio description; dubbing and automatic reading of subtitles. In order to analyze these four techniques, three different parameters were established (Technical implementation - covers topics related to the resources that are needed to the technique pre-production; Production Team - covers topics related to the resources that are needed to the technique production; and User Consumption - covers topics related to the user consumption background), which are subdivided into sub parameters (detailed below).

Audiovisual Translation Techniques

- Traditional Audio description (T.A.D.): regarding professional audio description, the researchers explained this technique considering the Portuguese reality, showing a demonstration video. So, viewers with visual impairment can only follow some series of RTP1 (the Portuguese public TV station) with AD - about once a week. The AD is accessible through an outdated system - the medium wave of Antena1 (the Portuguese public Radio station). The TV program is broadcasted via the free to air TV network and the audio description is simultaneously broadcasted by radio. More recently, through the Digital Terrestrial Television (DTT), the RTP1 audio description is broadcasted in a secondary audio channel but this setup is still inconsistent [27].
- Collaborative/spontaneous audio description (C./S. A.D.): the researchers explained this technique to participants with a practical example, reproducing a sound file with a sample of this type of audio description. Besides that, details were given about the workflow (described above). The researchers gave the possibility to participants to ask questions about any doubts that arose during the explanation.
- Dubbing (D.): the researchers also demonstrate this technique showing a video. Dubbing consists of the of characters' voice replacement by another voice in a different language from the original and being performed by a professional in the area. This audiovisual translation technique involves the establishment of synchronization between what it is hear and the movements of the characters' mouth. Furthermore, it is also essential to take into account facial expressions and body movements. As mentioned before, there is not much dubbing in the Portuguese television market; however it appears to be a helpful alternative for viewers with visual impairment comparatively to subtitling. In spite of the scene context and environment are not narrated as in AD, the viewer can be aware of TV programs dialogues in their mother language.
- Automatic reading of subtitles (A.R.S.): this technique was explained to participants with a practical example, as it happened with the collaborative/spontaneous audio description. The workflow of this technique was also explained and participants could ask questions about its functioning and usage mode.

Analysis of Parameters

To compare the four audiovisual translation techniques, the researchers determined several parameters and sub-parameters. To fill in the table with the participants' opin-

ions, the moderator researcher asked them questions related with the sub-parameters. For example, in the first sub-parameter ('costs') of the 'Technical Implementation' parameter, the following question was asked: "Do you think costly technological resources are required to produce the technique?". The entire table is available in the following link: https://goo.gl/Uk2vYT in order to be possible consulted it in detail.

4.2 Focus Group

The comparison table was analyzed by two focus groups (**Fig. 3**). One of them was composed by twenty participants (FG-A) and the other was composed by six participants (FG-B). The researchers sent an invite to two delegations of a Portuguese association that represents visually impaired persons and the members who were willing to participate took place in the focus group session.

The participants of FG-A were between 20 and 75 years old and in the FG-B were between 35 and 68 years old. Most of the participants of FG-A had an occupation and all of them lived in a large Portugal city. On the other hand, in the FG-B, half of the participants had an occupation and everyone lived in small cities.

Each session lasted about 2 hours and followed the protocol suggested by Krueger and Casey [28]. The recording of the sessions was accepted by all participants. The protocol followed in the focus group is explained below.

- Stage 1: Brief introduction of the research project (10 minutes): presentation of the idea and motivation that guided the project and reporting of the results already obtained. This stage was supported by oral describing a set of powerpoint slides.
- Stage 2: Focus group purposes (20 minutes): explaining each of the techniques (traditional AD, collaborative/spontaneous AD, subtitle reading and dubbing); presentation of the parameters and sub-parameters that compounded the table. This stage was supported by demos (videos) of each technique and by the comparison table.
- Stage 3: Discussion of each technique (80 minutes): The table was filled in by the moderator while participants gave their answers to the asked questions.
- Stage 4: Closing activities (15 minutes): quick snack with some further discussion.

Fig. 3. One of the focus groups' sessions

5 Results and Discussion

The analyses of the focus group sessions revealed interesting findings, which are following presented according each audiovisual translation technique.

- Traditional Audio Description (T. A. D.)

It is worth to say that all participants of the two focus groups know the audio description concept but most of them do not use it because they do not know how to use it (FG-A: 13; FG-B: 4). The authors think this situation happens due to the poor dissemination of this technique and also because in Portugal there is only one TV channel (RTP1) that offers a very limited number of programs with audio description.

Regarding the technical implementation of traditional audio description, all participants of FG-A and FG-B think expensive technological resources and many technological devices are required, such as professional microphones, sound mixers, etc. The two focus groups participants know that the technique follows a rigorous elaboration method. Regarding the audio synchronization parameter, most of participants (FG-A: 15; FG-B: 4) could not answer the associated question, because do not have technical knowledge about the issue. The remaining participants (FG-A: 5; FG-B: 2) think there are no problems of synchronization.

Concerning the production team, all participants of both focus groups know there are costs in hiring experts, because only audiovisual professionals elaborate this technique. Some of the participants of FG-A (9) already had contact with these professionals (in theaters).

Considering the 'user consumption' parameter, most of the participants of FG-A (17) and FG-B (5) consider that professionals ADs are reliable due to the preproduction and production work, but sometimes there are AD's too descriptive and out of the important focus. The participants who use AD from RTP1 (FG-A: 7; FG-B: 2) consider that neither the analog nor the digital service are really accessible. These participants also reported that the RTP1 AD broadcasted via radio is not synchronized when programs are watched either via DTT or via a pay-TV solution. They report also that the RTP1 AD has no sound disturbance in its consumption and it has significant level of authenticity because descriptions are produced with natural voice. A negative point reported by the participants who use RTP1 AD is the fact that it does not cover foreign and subtitled content. Other described negative aspect is the poor offering of audio description contents in RTP1 channel.

- Collaborative/Spontaneous Audio Description (C./S. A. D.)

Regarding the technical implementation of collaborative/spontaneous audio description, all participants think there is no need for expensive technological resources or a great number of technological devices. However, some participants of FG-A (5) showed some doubts in the edition of the AD soundtrack and its synchronization.

In what concerns the 'production team' parameter, all participants of the two focus groups think this technique has no costs in hiring professionals.

Concerning the 'consumption' parameter, all participants of FG-A and FG-B agree that volunteers, especially blind's relatives can produce AD's as good as the professionals and think the technique has a high degree of accessibility. Some participants of FG-A (5) recognize that the synchronization of the AD and the program can be a problem, but as they do not have technical knowledge about IT solutions, they cannot provide examples of solutions. All participants of the two focus groups consider that AD can overlap over the program content because they can distinguish both. All participants also consider that the authenticity inherent to this technique is high. In the same way as traditional AD, all participants know that this technique does not cover foreign and subtitled content, but it covers the description of visual content in native language contents. All participants report that the collaborative/spontaneous AD can increase the offer of audio description in Portugal.

- Dubbing (D.)

Regarding the 'technical implementation' parameter, all participants know that dubbing requires expensive technological resources and many technological devices in the same way of traditional audio description. Besides that, all participants know that this technique is more complex than traditional audio description and there are no synchronization problems with it.

As regards the 'production team' parameter, all participants know that this technique is the most expensive one, because it requires a lot of professionals for replace characters' voice and is produced by audiovisual professionals with various skills.

Concerning the 'user consumption' parameter, all participants agree that dubbing has reliable voiceovers due to the extensive pre-production and production work. They also think the degree of accessibility can be higher, because there is no audio information when a program with dubbing starts in the Portuguese TV channels. All participants report that there are no synchronization problems, no sound disturbance in its consumption and no authenticity problems. All participants also know that this technique is addressed to non-native language content, enabling the understanding of TV content by people with visual impairment who do not understand a second language. In Portugal, dubbing does not cover the description of moments that are not perceptible by visually impaired users and its offering is limited in the Portuguese market; facts that are reported by all participants.

- Automatic Reading of Subtitles (A. R. S.)

Regarding the technical implementation this technique, most of participants of the two focus groups (FG-A: 14; FG-B: 4) mentioned there is no need for expensive technological resources and for a great number of technological devices. Most of participants are familiarized with TTS engines (FG-A: 17; FG-B: 5) and consider that they getting better and better. Like collaborative/spontaneous audio description, no participants give technical answers about the complexity and synchronization parameters, because they do not have technical knowledge about IT solutions.

In what concerns the 'production team' parameter, as all the creation process is automatic with no human intervention, all participants consider that its production is facilitated.

Lastly, concerning the 'user consumption' parameter, all participants agree that the reading quality depends on the TTS system quality. Similarly to collaborative/spontaneous audio description, all participants consider that this technique has a high degree of accessibility. All participants also agree that the level of sound disturbance is higher than collaborative/spontaneous audio description, because the user has to distinguish many characters' voices with only one TTS, inserting also an artificiality layer to the TV content. All participants know that with the automatic reading of subtitles, the foreign contents can be understood. However, it does not cover the description of moments that are not perceptible by visually impaired users. Most of the participants of the two focus groups (FG-A: 13; FG-B: 4) consider that this technique can start this type of offer in the Portuguese Television market.

From these results, researchers can verify that the two proposed techniques (collaborative/spontaneous audio description and automatic reading of subtitles) have several advantageous parameters in its favor and are very welcomed by viewers with visual impairment; however it is not possible to mention that one is better than the other. However, if an integration of both techniques in television ecosystem would be accomplished, TV viewers would benefit from greater accessibility to content.

Comparing the aforementioned results with those that were previously verified in a past focus group with experts, the researchers can recognize five major differences from the perspective of visually impaired viewers: i) they know what audio description is but do not know how to use and access it; ii) they think volunteers can produce AD as good as the professionals; iii) they do not consider that listen two overlapped different sounds in the program (the AD + the program soundtrack in C./S.A.D. and the automatic reading + the program soundtrack in A.R.S.) is a problem, since they can discriminate the two sounds; iv) they have difficulties in identifying solutions for the technical problems inherent to the proposed techniques. v) they stand out the recognized strengths and do not worry with the technical problems, because they think problems can be solved in a more or less simple way.

6 Conclusions and future work

The info-inclusion of people with disabilities is becoming a reality. However, it is necessary to study and develop more services and tools that allow all citizens to participate actively and autonomously in society. This problem is particularly critical in usage scenarios involving mass media like Television (TV), specially taking in consideration its audiovisual format (which involves image, sound and text) that are not perceptible by many of viewers with special needs, such as visually impaired persons.

The focus groups described in this paper, allowed us to find that the proposed audiovisual translation techniques are relevant for visually impaired viewers, who revealed interest and receptiveness to use them. Besides that, the researchers can confirm that the integration of the two proposed techniques (collaborative/spontaneous

audio description and automatic reading of subtitles) in the translation of TV contents could be a suited solution in terms of accessibility, because it covers both native and non-native contents.

From the presented results, we are now able to extend this research with an additional study about the technical challenges that brought up with the outlining of the two audiovisual techniques presented in this paper. This study was based on an integrative literature review, enabling the identification and definition of the technical framework inherent to the proposed models.

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Designing a video library for senior users of iTV

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Abstract. The adoption rate of technologies by older adults is dependent on several factors, such as the identified potential benefits in the users' perspective. Designing and creating technology-based products since their beginning with potential end users, will help to guarantee a high rate use of these type of solutions, as verified in literature. In the scope of +TV4E project, which aims to deliver information regarding public and social services to older people through an interactive television (iTV) platform, this study analyses the best approach to implement a video library. This functionality allows the user to access a list of produced videos in the last days, categorized as "seen" and "unseen". Therefore, this article explores the process carried out to define the best approach to present a video library. For this, the research team presented to a sample of 4 seniors, three video library proposals developed concerning the design guidelines for iTV applications for elderly, supported on literature review. The data collection was followed by a cognitive walkthrough and a focus group session. Aspects as using different combinations to present the layouts and ensure that participants were not influenced, allowed to obtain results free of bias.

Keywords: elderly, iTV; video library; design

1 Introduction

Nowadays almost all developed countries are facing an inversion of the ageing pyramid with an evident grow of the number of elderly population. This trend has become increasingly visible over the last decades, it can be explained by the decrease in the fertility rates and by the fact that people tend to live longer. This happens mainly due to better health care, living conditions and sanitation [1]. Currently, the older population (people with 60 years old or over) reached 962 million in 2017, which represents 13% of the total population and by 2030 this number is expected to grow up to 1.4 billion worldwide. This phenomenon presents new challenges in multiple aspects of societies such academic and governmental. One of the possible ways to fulfil the needs and expectations of the elderly is related with the possibilities that technological solutions have. However, in order for technological solutions to be useful they must consider the ageing characteristics during their development process.

Being informed is a vital pillar to participate in today's society, which are increasingly becoming more and more dependent on quick and easy information access. This fact has been supported and improved by the technological revolution over the last decades. Having the ability to obtain information provides individuals with the knowledge needed to support informed decisions [2]. This is even more important when people grow older and, as a result of the normal ageing process, their capacities to acquire and understand information are affected which implies direct consequences in their quality of life. One of the areas where Portuguese elderly (and even younger people), have difficulty to access and understand information is public services. Seniors are at a clear disadvantage when it comes to accessing this information since it is mostly scattered across various mediums such as the internet, which requires a certain level of digital literacy. The access to this type of information influences not only the quality of life of individuals but also of those who are close.

As a response to the identified needs of Portuguese seniors, a research team from University of Aveiro is developing the +TV4E project. This work aims to promote the info-inclusion of Portuguese seniors through the delivering of informative contents, supported by an interactive television (iTV) platform, by interleaving the normal broadcast with informative spots related to public and social services accordingly to the user's profile [3]. During the definition of functional and technical requirements of the iTV platform, it was observed that a video library would be an added value for the elderly. This component of the +TV4E platform will allow the consultation of video spots already visualized, as well as to access videos that were triggered to the user but that were not visualized.

Academic literature and the experience gained daily reveals the importance of a developing process concerning innovative responses for elderly population to be carried out with the participation of target users. Neglecting this development approach may cause consequences in the technology acceptance, and more important, the solutions developed may not have a positive consequence in peoples' life.

Thus, this paper aims to present and analyse the process to define the best development approach regarding a video library. This work started with the definition of three proposals, previously developed by the +TV4E team considering the guidelines when building television (TV) interfaces for the elderly. The data collection was carried out following a cognitive walkthrough method and, afterward, a focus group with all the participants.

Additionally to this introduction, the article is organized in the following parts: section 2 presenting a theoretical framework on the questions of answers to fulfil the informative seniors' needs and guidelines to follow when building TV interfaces for the elderly; section 3 which illustrates the methodological steps followed to define video library available in the +TV4E project; section 4, where the obtained results are presented and discussed in detail; and finally, section 5 presents some of the conclusions drawn from this study as well as tracks to future work in this field.

2 Theoretical Framework

Worldwide, populations are facing a serious increase in the number of older people. Although this is a very positive phenomenon, supported in several enhancements in many areas of society, at the same time a new set of problems and challenges arises. To have an idea of the abrupt modifications in this age group, the report of United Nations [4] reveals that in 2017, 13% of the global populations are people with 60 years old or above, which corresponds to 962 million people. This segment of population is growing at a rate of about 3 per cent per year. Projections indicate that in 2030 the population with 60 or more years will achieve 1.4 million, 2.1 billion in 2050 and could reach 3.1 million in 2100 [4]. This phenomenon is inevitable, concerning the fertility declines and the increase in life expectancy rises hampered by the expected decrease of global populations (of 51 countries) between 2017 and 2050 [4].

Specifically, Portuguese resident population projections confirms this tendency and is expected that, in 2080, the ageing pyramid approaches an inverted triangle shape [5]. Between 2015 and 2080, the number of people with 65 years and more will increase from 2.1 to 2.8 million. Associated with the increase of older people and decrease in the number of youth, it is expected that the age index more than double, increasing from 147 in 2015 to 317 elderly people per 100 young people in 2080 [5].

The "active ageing" concept, is one of the firsts contributions with a global impact, that recognized ageing population as an important phenomenon. This concept encourages older people to remain active by working longer and retiring later, through engaging in volunteer work after retirement, and by leading healthy and autonomous lives. "Active ageing", created by World Health Organization (WHO), is defined as the process of optimizing opportunities in three pillars: health, participation and security [6]. This will promote the elderly's quality of life, highly influenced by the ability to maintain their autonomy and independence.

One of the living areas that influence older people' quality of life is the access to information. This allows people to stay aware about their surrounding environment and consequently make decisions in a more supported manner [2]. In Portugal, despite information about social and public services being available in several service counters and online platforms, this information is sometimes shrouded in technical terms hard to decipher by most of the citizens. To make this process even more complex, especially to older people, access this type of information involves a pro-active behaviour by the user [7]. According to Silva and colleagues [2], information needs of the Portuguese elderly encompass: health care and Iconography's development for a seniors' iTV informative platform welfare services; social services; financial services: cultural, informal education and entertainment; security services; local authority services; and transport services.

Technological products can help seniors to have a higher quality of life levels, and one of the solutions with great potential to supports elderlies are interactive TV applications mainly due to the time that seniors spend in from of TV. In this context, an academic project is under development that aims to develop an iTV platform, specially designed for the elderly and based on simple interactions, that delivers information

about social and public services through brief video spots, without active search performed by the user. The video library is an important platform enhancement that strengthen the overall solution for elderlies. This extra feature, will provide the videos generated on the last five days, categorized as seen and unseen. The development of new innovative products should be conducted, since the beginning of the process, with inputs from potential end users that represent the target population [8].

An extensive study regarding guidelines to follow when building TV interfaces for the elderly has been conducted in the context of +TV4E project. This study focused on a literature review regarding the specific characteristics of the seniors that come from the ageing process, such as loss of hearing and visual acuity [9]. These need to be taken into account when developing software for seniors to guarantee good usability, however, since there is no sound in video library only recommendations regarding visual content need to be considered, specifically regarding text, icons and colours. These guidelines are following resumed, based on the study of Reis and colleagues [9].

Most notably, loss of vision in seniors causes them to have difficulties in focusing at short distances, distinguishing small details, discriminating chromatic differences and reading moving text. It also reduces their adaptability to lighting, makes them more susceptible to brightness and requires them to have more luminosity when reading for example. To counter these limitations there are several design recommendations to make visual content more suitable for the elderly. In general, the literature suggests that text in screens should be at least 40pts, the fonts with serifs, the italic or decorative elements should be avoided, text should be aligned to the left, the spacing between lines needs to guarantee fluidity and readability and there should be high contrast between the background and the text. When it comes to icons, they should be the combination of an image and text, never one without the other, be easily distinguishable and avoid the use of abstract concepts or graphical conventions associated with recent digital technologies. Lastly, the colours need to be chosen carefully to consider the limited colour spectrum of televisions and the seniors' needs. Concerning this, the development of the video library available on +TV4E platform will take into account all the orientations presented above and also the inputs gather from potential end users. So, in the coming section, the methodology used to select the preferred layout for the +TV4E platform is described in detail, going over the objectives of the study, the sample and the whole process.

3 Methodology

This study aims to access the preferences of older people concerning the best video layout that will be supported in the +TV4E platform. Thereafter will be described in detail the methodology followed, namely the objectives, sample and the process carried out.

3.1 Objectives

The present study was performed with the main objective of determining the best approach to implement a video library, which would serve as a component of the iTV

application being developed under the +TV4E project. The main purpose of this video library is to allow the users to visualize the informative videos provided by the platform in a different manner, that would be similar to an on-demand video service. In the library, the users are able to re-watch videos they had already seen and watch videos they reject or missed, therefore complementing their user experience and giving them some degree of control over the system. With this in mind, three layouts proposals were developed in order to be presented to the seniors for the sake of validating them and ultimately choosing the most suitable solution.

A state of the art review was carried out prior to the designing of the layouts in order to identify the current trends in iTV applications for seniors. All the layouts share several similarities, being the header displaying the name of the interface, as well as telling the user how to return to the TV broadcast or how to access the settings menu. Besides sharing the same header, all the layouts are based on video cards, although the information shown in the cards varies per layout. In the case of the interface proposed in this work, the lists only contain videos from the last five days and are sorted chronologically, having the newest videos shown first.

The first layout (Fig. 1) one of the examples of a horizontal navigation where the top lists shows unseen videos while the bottom list shows seen videos. It is also the simplest proposal since each card contains the least amount of information, in this case the title, and the duration of the video.

Fig. 1. Layout 1

Layout 2 (Fig. 2) was based on one of Netflix interfaces, this layout featured a horizontal navigation, similarly to layout 1, however it included a lot more information. In this layout, the users are presented with a lot more information, since the two video lists for seen and unseen videos are condensed to the bottom half of the layout, in order to include a section with details of the selected video. In this details section, it shows the title of the video, a small description based on the first paragraph of the news article, the duration of the video, the thumbnail and how long ago the video was created.

Fig. 2. Layout 2

Lastly, layout 3 (Fig. 3) is a variation of layout 1 where the navigation is done vertically instead of horizontally. In this proposal, each list only shows two cards on the screen, which leaves room to include more information, so the date of the video was also included and the font for the title is bigger.

Fig. 3. Layout 3

It is also important to mention that none of these layouts were refined to the point of them being considered final. Since the main goal of this study was to assess which of these navigation typologies, vertical or horizontal, was best suited for the project's target demographic and what kind of information was most relevant to be displayed.

3.2 Sample

The sample for this study which took part in the data collection moment consisted of four participants, 50% males and 50% females, all of them over 65 years old and were students at a Senior University of Curia. They were selected via convenience sampling

due to the difficulty of selecting a random sample. The participants were already familiar with the project, since they had already been involved in previous data gatherings, where other visual elements of the iTV platform were defined. Next the testing process will be described.

3.3 Process

In order to develop an interactive TV platform which is both attractive and adequate to the target demographic its essential to resort to a participative design process where the final users are consulted, thus helping in defining the final result.

Currently the ongoing process of participatory design in the context of +TV4E project is being carried out in two senior universities located in the district of Aveiro. These moments occur during the evaluation of key parts of the project. The data gathered in each of these moments is analysed and used to improve the current state of the iTV application. The results achieved are then presented in the next session. As stated above, developing a platform that is intuitive and easy to use is essential to ensure high levels of success among its users. At the moment, the video library is a hub where it is possible to access all the information provided by the application and it is also the only interface in the iTV application where the users are required to navigate. Therefore, it's important to guarantee that the navigation meets the users' needs and expectations.

Thus, since in the context of the +TV4E project the researchers want that all the elements of the platform are designed and tested alongside the end users, an experiment was conducted with a restricted number of participants to assess which of the three video library layouts was preferred. Each layout represents one way of presenting the information and the navigating between it.

Due to the limited size of the sample, the experiment was designed so that each one of the participants had the opportunity of navigating inside each one of the layouts so that the choice of the preferred layout was based on actual user experience and not solely based on expectations.

This experiment was divided in two parts, an individual cognitive walkthrough, which in turn was separated in three different moments, and a focus group with all the participants afterward.

Considering the demographic of the study, the researchers took care in using clear and concise language with all participants throughout the entire process, while also avoiding any technical terms that might confuse or demotivate the users.

The cognitive walkthrough would start with the investigator contextualizing the user about the experiment. To start the participant was informed about the results of the previous data gatherings since, as stated above, the participants took part in previous +TV4E studies and then contextualized regarding the experience that was going to take place. Subsequently, it was explained to the participant that he would be able to interact with three distinct layout proposals for the video library, where they could visualize videos they missed and videos they had seen previously, which would be later included in iTV application.

Additionally, each participant was informed that after testing the three interfaces he would be asked to wait in a room while the other participants finished their tests.

This last step was necessary, considering the goals and sample the team had to find an adequate test that would allow all users to experiment every layout in order to form an opinion about each one. However, due to the lack of multiple television sets it was not possible to run all the user tests in simultaneously. Thus, a specific approach was needed that would not allow the users to influence each other's opinions between tests, so after some deliberation, it was decided that users needed to remain isolated from each other while the individual test was ongoing.

Following the contextualization, the participants were informed that they could freely explore each of the three interface layouts, but also needed to perform some simple tasks while doing so. These tasks were designed with the goal of making the users explore the most important features in the video library, which are to watch seen and unseen videos. They consisted of changing between the two video lists, counting the number of videos in a list, watching a previously watched video and watching a specific video given its title.

So that the participants would not be confused when asked to view a video they had previously seen, the test began by showing them an informative video before proceeding to open the video library. Following this step, the participants went through each of the layouts while performing the tasks listed above.

To conclude the cognitive walkthrough phase, the participants were asked some short questions regarding their user experience, this helped in gathering the individual opinion of each participant before having them discuss their opinions during a focus group. The following questions were asked:

a) Which of the three options is most appealing to you? Can you explain why?
b) Was it easy to navigate between lists? In which option was it easier?
c) Do you have any suggestions that can help making this solution easier?

The steps above were repeated for every participant with the only difference being that the sequence of the presented layouts was shuffled to avoid the users from becoming biased by the order of the layouts. With this in mind four showing combinations were used which are as follows:

a) 1-2-3;
b) 2-1-3;
c) 3-2-1;
d) 2-3-1.

Following the cognitive walkthrough, all the participants were gathered in testing room to begin the focus group, as it can be seen in Fig**.** 4. The participants were then encouraged to share their opinions regarding their experiences. In the end, they were required to choose their preferred layout, which needed to be a group decision.

Fig. 4. Focus Group moment

In the next section, the results of this study are presented alongside with a discussion pertaining their implications in the final product.

4 Results and Discussion

The present study wielded both individual results for each participant and a group decision for the best overall interface layout. The individual results are synthetized in Table 1 and include all the suggestions, made by the users during testing (see Fig. 1, Fig. 2 and Fig. 3).

Table 1. Individual results for each layout

	Layout 1	Layout 2	Layout 3
Subject 1	The video cards are easy to distinguish since the title occupies less space	The selected video is not big enough. The lighter colours are not distinct.	The background colour cannot be distinguished from the cards.
Subject 2	The play symbol should be blinking to make it clear that it plays the video.	Headers should be bigger. The font should be changed or have a different colour.	Vertical navigation is better than horizontal. Having two cards per column is appropriate since they are bigger.
Subject 3	Liked it because it was simple and easy to navigate. Should have less cards shown on screen.	Has too much information. Should have less cards shown on screen.	Easy to understand which card is selected. Two cards per column makes it easy to read.

Subject 4	Duration of the video is important to keep. Intuitive navigation.	Too much information makes the layout confusing. Number of thumbnails is appropriate.	Prefers horizontal navigation.

Regarding each of the individual participants preferred layout, all participants with the exception of participant 2 choose layout 1 as their favourite.

Since most participants already chosen layout 1, the focus group results were very similar to the individual results. In the end, the majority of the participants preferred layout 1 due to it featuring a horizontal navigation and fewer interface elements. The participants justified this by saying they were already familiar with the horizontal navigation, therefore making it easier to use. The focus group participants also decided that the appropriate number of video cards per list should be three, in order to allow them to be bigger and thus easier to read.

5 Conclusions and Future Work

Developing technologies that cater to needs of seniors is paramount to promote their quality of life. The quality of life can be measured in terms of independence from their informal networks, such as, the informative dependence of their caregivers and dependence while doing day-to-day activities, such as shopping, eating and dressing.

In the end, this study was considered successful since the participants clearly understood the purpose of the tests and it was possible to get a clear decision between the all of them. The results were consistent and the fact that the layout showing order was different for each participant, further indicates that the chosen layout was the most appropriate.

Following the final choice of layout 1 and considering that the layouts were not finalized, the next step was refining it with the participant's suggestions. One of the main complains regarding layout 1 was the number of cards shown on screen, so the number of cards will be reduced to three per list. The background colour was also a problem for some users so the contrast between the cards and the background will be further increased to circumvent this problem from happening. The font Tiresias was well received by all the participants, although the title of each list should be increased to make them easier to read.

The improved version of layout 1 was integrated into +TV4E project iTV application and is being evaluated at the moment as part of another ongoing +TV4E study. This study is being carried out in a domestic environment with real context users and has the goal of testing the first iteration of the application as a whole.

However, there is still room for improvements when it comes to the video library. The team is already considering the inclusion of sound in the video library, specifically the addition of sounds when switching between cards and lists. This would provide the users with an auditory reinforcement to make it clear they changed between cards or lists and would also address one of the problems raised by some participants.

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Expert evaluation of a user interface for the unification of TV contents

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Abstract. The Ultra TV project is a partnership that connects the research field and the industry to bring innovation to the iTV domain. Among its goals is the development of an interactive TV ecosystem with the most advanced services, integrating different sources of content in a same (user) interface. This project comes in a period of great transformation regarding the consumption habits. This scenario is encouraged by an increase in the offer of On Demand services in parallel to the traditional TV operators offer. These changes combined are forcing users to change their interaction behaviors, since they have to switch between devices and applications to find the right content to watch. This paper presents the results of UltraTV project including an expert review of a user interface aiming to offer a unification of contents. Despite the challenges of introducing a disruptive interface, the results of the experts' review show the feasibility of the unification of linear and nonlinear contents in the same interface and provide insights for further stages of field trials with end users.

Keywords: Interactive Television, User Interface, Expert Evaluation

1 Introduction

The TV ecosystem has been witnessing fundamental changes in the way viewers get access to TV contents, increasingly supported by (Video) On Demand (VoD) services in addition to the traditional lineup of TV contents. This transformation on viewing habits is supported by recent solutions which allow to access the available contents anytime and anywhere [1][2]. These solutions include the use of mobile devices, working as secondary screens and, many times [1][3], as the primary displays for watching TV.

In addition it is possible to observe, mainly among the Z generation of consumers, a shift towards retrieving content in the cloud [4], specially movies and series that can be found in services like Netflix, YouTube or even Facebook. This current trend follows the original offer of the commercial TV media devices, such as Chromecast, Apple TV and Android TV, which have promoted the consumption of Over the Top (OTT)

content, contributing significantly to an increase in the amount of content viewed from Internet sources [5][6].

The services of traditional Pay-TV operators have been trying to adjust to the contemporary scenario. In order to grant its clients with access to linear contents at alternative schedules, Pay-TV operators have changed the pre-programed TV to become more flexible by introducing services like "catch-up TV" and "time-shift" [7].

The aforementioned framework leads to enormous changes in the TV offer. In parallel, the democratization of technology contributes to the improvement of users' digital literacy, increasing the challenges of commercial players that are trying to cope with new users' expectations by offering more engaging systems supported on new paradigms of User Interfaces (UI).

In this context, this paper presents a User Interface prototype of an advanced Interactive TV (iTV) service iteratively developed in the scope of the Ultra TV project. The UI proposes a disruptive approach based on the unification of contents from regular linear TV and OTT sources. The paper also reports on the methodology used in the expert evaluation process as well as the results obtained.

The paper is structured as follows. The next section (2) presents the state of the art concerning current viewing habits, trends in UI for iTV and regarding assessments in iTV context. Next (section 3), the TV Flow concept, translated into an UI and prototype development, is introduced as a grounding concept for a content unification approach underlying the referred project. Section 4 presents the evaluation goals and methodology used for the validation of the proposal. Finally, the last section (5) presents the most relevant considerations and suggestions for future work.

2 State of the Art

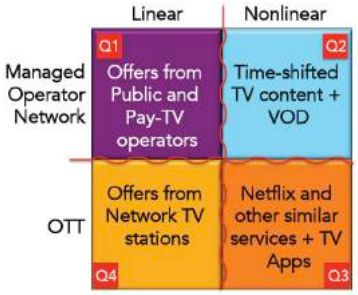
2.1 Viewing habits and taxonomy of iTV services

As previously mentioned, the current TV scenario is suffering profound changes, mostly caused by a transformation on consumers' habits. In order to adjust to this new context, the services supported by Pay-TV operators are adding new features to assure flexibility for clients regarding content availability and mobile access. At the same time, OTT players are offering a great diversity of online videos, which can even make harder to determine which content to watch. This scenario leads to the hybridization of the ways TV is viewed [8].

In order to clarify some concepts about the TV ecosystem, Abreu, et. al [1] presented a detailed taxonomy of ways of watching content on the TV set, which can clarify the existing Pay-TV and OTT services typology. They present a matrix with four quadrants (see Table 1). The four quadrants identify different ways of watching TV, although not completely apart from each other, since services found in one case can eventually be found on a neighbor quadrant. In the linear content column, the first quadrant is related to the dominant way of watch television offered by Pay-TV operators, supported by Managed Operated Networks (MON). Following the linear column, fourth quadrant refers to different approaches for linear contents made available online by Network TV

stations. The next column is related to nonlinear content which includes services offered mainly by MONs and the third quadrant encompasses nonlinear content delivered over the internet. These contents can be provided by OTT players, e.g., Netflix and TV broadcasters dedicated apps.

Table 1. Quadrants showing ways of watch TV content



2.2 Current trends on user interfaces for iTV

Regarding the iTV domain, some proposals have been trying to break the existing paradigms and go beyond the common textual menu based interface and the traditional TV controller. These new approaches are translated into different domains of the UI, including: i) innovative layouts that emphasize the dynamics of the navigation supported by transition effects, like the three-dimensional effect in Mur Vidéo[1] by Voo, the diagonal carrousel navigation of the smart TV LG webOS[2], the horizontal navigation with circular items, of Frog[3] interface by Wyplay, or the disruptive interfaces by Cisco, like the Infinite Video Platform[4], based on video masks; ii) content unification as provided by Android TV[5]; iii) multisensorial and multimodal trends, like gesture interaction (Samsung Smart TV[6]) or voice controlled interfaces supported by the Google Assistant of Android TV, and; iv) the integration of different devices to watch complementary information or to control the TV.

2.3 Evaluations in iTV context

The concept of User eXperience (UX) does not have a consensual definition in literature, since it relates with a broad range of applications in a diversity of interactive systems [9][10]. Also, due to the diversity of application scenarios, it is important to consider the type of system and functionality, as well as the technological context involved,

1 Voo Mur Vidéo - https://www.youtube.com/watch?v=dwLK2stDH0g
2 LG webOS 3.5 - https://www.youtube.com/watch?v=v5471kC8heE
3 Wyplay Frog - https://www.youtube.com/watch?v=cNSkoeDaGDY
4 Cisco Infinite Video Platform - https://www.youtube.com/watch?v=5LrVIablSJk&t=280s
5 Android TV - https://www.android.com/tv/
6 Samsung Smart TV - https://www.samsung.com/ph/smarttv

in order to adapt and validate specific UX evaluation methods to actual cases. Concerning the iTV field, the UX is considered a very precise domain as it must take into account environmental factors, such as social, temporal, personal and technological contexts. Furthermore, specific characteristics such as remote controls, set-top-boxes and other components of the environment must also be considered in a UX evaluation [11].

Regarding the UX process, the evaluation of a prototype by experts represents a crucial step towards the assessment of a product's usability and a quick mean to gather relevant suggestions. In this regard, two facts are important to highlight: i) the evaluation of the UI should be as early as possible in order to offer designers the chance of getting feedback for the redesign process [12]; ii) the selection of suitable evaluators considering their background, expertise and previous experience with similar systems [13]. After the definition of the experts, it is important to define methods and the tasks that will be applied [14].

Heuristic evaluation, cognitive walkthrough and guideline review are some of the most common methods for expert UX evaluation [14]. The heuristics consider a set of UI related principles. The experts evaluate the interfaces and make considerations about its features, identifying potential problems. A cognitive walkthrough methodology is similar to a heuristic evaluation but with an emphasis on a task scenario that evaluators need to perform in the UI. The experts must go through predefined steps and identify issues concerning the interface and navigation. Finally, a guideline review involves having an evaluator comparing an interface against a detailed set of guidelines.

3 Assessment of a UI for the unification of TV contents

3.1 Goals of the project

The Ultra TV project is the result of a partnership that connects the research field and the industry to bring innovation to the iTV domain. The main goal of the project is to develop an interactive TV ecosystem that supports the most innovative services while integrating audiovisual content in a unified way. This project is focused on facilitating the access to on demand content in an integrated UI approach, surpassing the linear and traditional organization of the channels lineup. The development of the project encompasses the design of new interaction models and user interfaces and the validation of its feasibility through field trials. These goals have been pursued in a UI proposal called TV Flow. Essentially, the TV Flow aims to promote a consistent and fluid UX while interacting with an engaging interface, providing access to profile-based recommended content from different content sources.

3.2 The UI and Prototype Development stages

The first tasks of this phase included defining the requirements and guidelines of the aimed solution. Then the firsts sketches and low fidelity mockups were tested internally among the team members. Based on user and task analysis, a medium-fidelity prototype was developed encompassing an exploratory UI supported by a grid-based navigation using the four directional keys on the remote control. In the prototype, the content is

structured in columns (organized by genres and sources) and rows (presenting content clusters tagged such as 'Keep watching', 'Trending', 'Popular', among others). The main column – the "Live" content – is centered by default (see Fig. 1). The closest columns ("Mix TV" on the left and "Mix Web" on the right) include content suggested to the user (based on his profile, considering the viewing habits, the time of the day and other factors). The left-hand side columns sort broadcast content by thematic categories and genres. The right-hand side columns display content from OTT players (e.g. YouTube, Facebook Videos, Netflix). The graphical layout of the UI is organized in two areas: The Header that displays the Menu button and settings information regarding the list of available categories, the active viewing mode and profile; and the Body, with a navigable grid. The presentation of the grid is available in two selectable viewing modes (see Fig. 1). The Wide viewing mode shows an overview of the grid with 5 full cards and half of a card on each side, while the Zoom-in mode shows a navigation focused on the selected item, presented on a larger scale, with a hint of half of each next card surrounding it.

Navigation through the cards is made using the vertical and horizontal axis, to match the D-pad of the remote control. When selected, the content is enlarged and pushed to the center of the screen (moving the entire grid) resting on the highlighted blue column with overlaid contextual information (see Fig. 2).

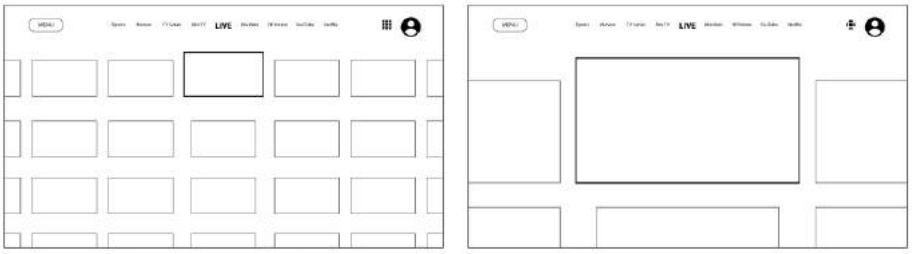


Fig. 1. The viewing modes wireframe. Wide mode (top left) and Zoom-in mode (top right);

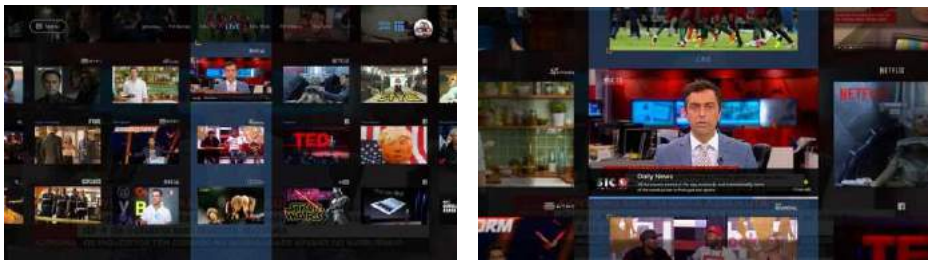


Fig. 2. The prototype viewing modes interface after navigating downwards on the "Live" content column. Wide mode (bottom left) and Zoom-in mode (bottom right).

After pressing 'OK' on the remote control, the content is displayed in full screen. Pressing the 'Menu' key invokes, on the bottom of the screen, an informative contextual

menu about the selected content (see Fig. 3). Using a 'tap & hold' command (pressing OK for a few seconds) a circular contextual menu appears on the screen (see Fig. 3), with options such as "Info" (comprising synopsis, more episodes and cross-content recommendations), "Favorite" (bookmarks the content saving it on a customized list), "Like" (refines the recommender system) and "Dislike" (removes that content from the grid and also refines the recommendation algorithm).

Fig. 3. Preliminary prototype contextual menus. Informative contextual menu (left) and circular contextual menu (right).

4 Experts Review

4.1 Evaluation goals

Early testing is crucial for the success of any system, as the development cycle highly benefits from those inputs both in terms of time and costs. It also gives the opportunity to promptly test design alternatives in low-fidelity prototypes, allowing the iterative refinement of the versions presented to evaluators. Experts review is an important asset during the entire process, as it gives access to the background experience of the evaluators (as developers, researchers and users) which represent a surplus value on both levels: to the development process and to the end-use solution. From this point on, the validation by experts of the sustainability of a UI prototype is described and discussed.

Since the tests with experts were essentially aimed to the first layout and navigation review to guide the design process further on, the evaluators' opinion about some specific issues was particularly relevant to the definition of the goals and procedures. The UI issues included:

- Grid based layout vs text menus;
- Fixed header vs auto hidden header;
- Two viewing modes vs one single mode;
- Several contents with smaller preview vs larger preview with fewer contents;
- Non-automatic vs automatic profile detection;
- Unification and cross-source recommendations (e.g. YouTube video as a complementary content to a linear TV show).

Beyond the UI assessment of the preliminary prototype, there were other addressed topics during the expert's review. Namely, whether if the unification of sources with

the inclusion of OTT players side-by-side with the TV lineup, arranged according to live and non-live genres, would be welcomed by the users.

4.2 Methodology

As referred, the user evaluation process of the Ultra TV project relies on a spiral model of iterative design, within a User-Centered Design approach, which includes early testing of low-fidelity mockups with the team members, medium-fidelity prototypes with experts and lab testing with end-users. These tests are conducted using versions of the UI with an increasing fidelity based on the feedback of previous assessments.

For the expert review, user and task analysis was converted into scenarios describing specific navigations paths for a cognitive walkthrough by the evaluators, using a storyboard on a semi-functional prototype. Also, a presentation and a video including transitions and animations of the menus embedded in the navigation were produced to clarify, to evaluators, the look & feel of the UI. Additionally, during a semi-structured interview, an exploratory overview of the prototype using a think aloud protocol was encouraged. This UI testing was mostly focused on a qualitative approach to gather insights about the navigation and graphical options and drive the next redesign. Therefore, the recommendation of using five experts mentioned by Nielsen [15] [16], since it allows the identification of 85% of the usability problems, was considered as the most suitable option for this qualitative test.

Two panels of experts were arranged according to strategic partnerships of the project and the evaluators' expertise. The age range of the experts was between 35 and 65 years old. The evaluation was held in three sessions (see Fig. 4), two in Chicago (USA) and another in Aveiro (Portugal). In this regard, Panel 1 comprised two experts from a University of Chicago that were selected based on their background as academics working and lecturing about Human Computer Interaction (HCI), human factors and UX research and also considering their previous work experience in a multinational telecommunication company, precisely in the iTV domain. Panel 2 included a group of three developers from a research lab of one of the main IPTV providers in Portugal, based in Aveiro. This company is a member of the consortium of the Ultra TV project, thus offering precise expertise in the field of iTV ecosystems development.

Fig. 4. Experts test set in Chicago (left) and in Aveiro (right).

The tests in Chicago took place on the11th of May 2017 and followed a protocol comprising a brief presentation of the project and an introduction to the interface concept and layout. The presentation was followed by a video with a demo of the navigation including animations and transitions to translate the look & feel of the interface. Then, each evaluator was invited to perform a cognitive walkthrough within predefined paths, using a semi-functional prototype, according to a storyboard. They were also encouraged to think aloud during the navigation. The tests were conducted individually (2 experts were involved), being finalized with a semi-structured interview to outline all the feedback and suggestions.

The expert review in Portugal took place on the 25th of May and followed the same protocol held in Chicago. However, in this case, the prototype was reviewed collectively by the three experts from Panel 2. This group did not have a prior deep knowledge of the prototype final look & feel.

5 Results

Considering the current viewing habits and industry UI trends, the experts' recommendations proved that an iTV user interface approach for content unification is a sustainable and timely proposal, although there are still some issues to be addressed.

The following results from the expert evaluation are presented accordingly to the topics addressed and presented in section 4.1.

Regarding the **grid navigation** (see Fig. 2), that holds the aggregation and unification of content and sources, experts made clear that this kind of approach could be limited by the quality of the available thumbnails and the availability of privileges to access the content' sources APIs. Another concern had to do with information overload and how to promptly lead the way to the right content for each user – *"Users are highly sophisticated experts because when it comes to media it's their media. […] our goal is to help them find their own media"* (Panel 1 - Expert 1). To such achievement, it will be crucial to mirror, in the UI, the mental model of the user, providing a comprehensive structure for content sorting and display, with the right amount of hierarchy and contrast – *"Everything is equally catching your eye and that means nothing is getting your eye"* (Panel 1 - Expert 1).

In what concerns **content sorting** (see Fig. 2), using a double categorization: thematic genres and sources in columns and viewing categories like 'Keep watching', 'Trending', 'Popular', etc. in rows proved to be confusing – *"I'm getting lost… See, integration is great… but as a user, I am getting lost in the sense that I am not clearly understanding the model of this… why some content is here or there."*, *"It is not too much but it needs to be consistent. Top is always keep watching, second is popular… And then stack for multiples of the same kind."*, *"If I want the details I bring it to the middle* [column] *and then I get the details (popular, trending, ...)"* (Panel 1 - Expert 1).

On the other hand, a discovery feature was also a relevant highlighted topic, since one of the mains goals of the project is to catch the attention of users that are detached from regular TV consumption and are more used to explore the Web for new content –

"A lot of TV viewers express boringness because of so many channels and they get to see always the same channels. A shuffle feature could be fun.", *"I always like interfaces that people can play with. If I had a function like 'surprise me', that would get me out of my normal pattern of consumption. A button that shuffles all the suggestions and brings something completely different. I would see myself playing with this"* (Panel 1 - Expert 2). A suggestion for approaching this **content browsing and discovery** was the use of the viewing modes (see Fig. 2) – *"I believe in random access – I would zoom-out to have more choices."* (Panel 1 - Expert 2); *"90% of TV consumption is in full-screen mode. But when you provide these two views you can use the Wide to have an idea of what is available before you chose something to get more of that"* (Panel 2 - Expert 3). The option of getting more related content could be accomplished by using an accordion menu to disclose hidden information, and extend the grid space whenever required by the user, taking advantage of a 3D stack of contents – *"If I want more of that I should be able to get it"* (Panel 1 - Expert 1).

Despite these insights, the **viewing modes** (see Fig. 2) were somehow controversial among experts – *"I would go with one of the modes only"*, *"Modes is never a good idea"* (Panel 1 - Expert 1); *"The value to me of the zoom-in and zoom-out mode is that sometimes I want serial access and sometimes I want random access. Zoom-in is for serial and zoom-out for random access. They are both valuable"* (Panel 1 - Expert 2); *"I wouldn't call it modes, I would call it views"*, *"We could use the Zoom-in view when we have identified a content we want to see and we want to get related content, and the Wide view when we don't know what we want to see yet"* (Panel 2 - Expert 3).

As for the **amount of content to be presented in each view**, besides the lack of contrast and hierarchy to clearly highlight the selected card, experts pointed the need to reduce the size of what is not selected – *"we had made this in the lab but failed. We always wanted to push too much content on the screen"*, *"In the wide mode, all the thumbnails are the same size, that doesn't make sense"*, *"Content is king. Why is all content the same size?"* (Panel 1 - Expert 1). While using the Zoom-in mode, space could be optimized by enlarging the selected item and reducing the size of the surrounding cards, making them work basically as hints for navigation – *"They will know that the content is there but you don't need to see what it is"* (Panel 1 - Expert 1).

Panel 2 – Expert 3 suggested a quick-change of modes/views using a tap & hold (long press) command, that, in a responsive context using mobile devices, could be translated into a pinch to zoom gesture. Conversely, he also noted that this kind of **interaction** is somehow familiar to advanced users but not to regular ones. Therefore, visual hints on screen would be needed. This same long press command was also suggested to be used as 'back to top' feature in the grid, because of the amount of content on display – *"Clearly we have a multidimensional grid and is not easy to reach the edges. If they exist at all!"*, *"We need a quick trick to get back to top"* (Panel 2 - Expert 4). This means that the set of keys in the remote, required to navigate and interact with the UI, must be revised and clearly defined to achieve consistency throughout all the sections of the interface. The synergy between soft buttons and remote keys should be handled with the TV remote in mind to reach a simple and intuitive solution for interaction – *"Too many buttons on the device confuse people … too few buttons limit people when they have to do a lot"* (Panel 1 - Expert 2).

Regarding the **header** (see Fig. 2), the UI displays a top menu with only one clickable item, the Menu (remote key), which gives access to a textual list of options (including Catch-up TV, Video on Demand, Favorite list) and settings (such as changing the view mode and the profile). This also proved to be confusing, mainly because the header seemed a clickable area, which would be difficult to reach using the directional keys on the remote control that are already being used to navigate through the cards. Users were misled because in the header, interactive items (Menu) were presented next to non-interactive ones (labels of genres and sources; active viewing mode; and active profile) – *"Users will think it is a clickable icon"*, *"Hide top menu. Not needed."* (Panel 1 - Expert 1).

Moreover, the Menu button was also used to activate the **footer contextual menu** (see Fig. 3) when in full screen mode. The experts mentioned that in this scenario the Menu button should be used to return to the TV Flow grid instead, as this grid seems to take the place of the traditional Menu, displaying profile-based recommendation – *"The TV Flow must be designed to give you all your content. The Menu becomes secondary, for sporadic use, mostly for settings"* (Panel 2 - Expert 3). Panel 2 - Expert 5 also suggested that, in full screen mode, the navigation key 'down' could be used to display the footer menu, and inversely the key 'up' could be used to hide it. This means that, according to Panel 2 - Expert 5, the vertical card navigation provided by the TV flow grid should not exist in the full screen mode.

As for the **circular contextual menu** (see Fig. 3), there were some reservations about using a dark translucent overlay as background – *"It is a football match and you have darkened the image for the contextual menu?!!"* (Panel 1 - Expert 1). On the other hand, the animation effects were considered highly suitable for this menu and, additionally, useful to provide visual hints across the interface about which keys to use for navigation and menu activation – *"The animations are great and really needed"*, *"Show some kind of animation in the beginning to explain. Or later if they don't use it."* (Panel 1 - Expert 1).

The **profiles**, including the family profile proposal, were well received by experts. The proposed solution also intended to integrate a 'smart' profile change, based on the analysis of the viewing habits. Concerning this feature, experts referred that – *"It works once you give people the authority to overwrite and warn users when you are going to automatically change – 'Hey we realize you are not ... do you want to change?'... If the user reacts the change is made, if not it dies off."* (Panel 1 - Expert 1).

Finally, Panel 1 - Expert 2 provided some suggestions regarding special **recommendations** by friends or affinity groups – "*Millennials depend on others to curate content for them", "If you recommend based on affinity groups (friends) that carries some weight versus if it is recommended by an algorithm I don't understand or brands, or other.*", "*You need to be transparent on who is recommending. How to inform if recommendations come from friends? You could use any kind of icon to identify that a certain recommendation comes from a friend.*" (Panel 1 - Expert 2).

6 Conclusions

The TV flow concept may be considered a different approach to find something to watch either from regular TV sources but also from players that typically are not available in a regular IPTV service, or at least not in an integrated way. With this aggregation and unification mindset, the UI under expert review intends to reconfigure the way people perceive and interact with the TV ecosystem. The assessment of the UI's navigation and look & feel was carried by 5 experts, completing a work package assigned in the Ultra TV roadmap. Experts were in agreement with some of the proposals, namely with the grid concept, the need to focus on the active content and to better highlight the selected content. Experts also expressed their positive feedback on the profiling features and the contextual menus. But some issues were not shared between experts. As an example, the viewing modes were not consensual with one referring to its disturbance and others valuing it as a customization and discovery feature. There was only one expert that clearly rejected the wide viewing mode, stating that he would only use the zoom-in mode. The other experts referred that they would shift between modes whenever they had a clear idea of what they wanted to watch (zoom-in) or, on the contrary, would be opened to explore the available options (wide mode). In this sense, the age factor was not decisive for the differences in opinions. The viewer's personality as being more settled and selective or more curious and opened to discover new content was identified as the main reason for this dissonance. However, this does not represent an incompatibility since the dual mode can be integrated but with less emphasis on the switching option. Finally, the unification of content, the main feature of this solution, got the unanimous approval. From these results, the UI may be adjusted in order to allow its integration in fully functional prototypes. In overall, the expert review proved to be a very important evaluation stage, since it allowed, based on their extensive experience, to identify the most relevant problems and most valuable solutions that can lead to better and more efficient later field trials with end users.

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La Televisión Digital Argentina a dos años del apagón. Retrocesos e incertidumbres

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Resumen. Durante 2017, la televisión digital terrestre en Argentina alcanza su octavo año de implementación, en el proceso de transición de la televisión analógica al de televisión digital terrestre (SATVD-T) hasta su definitivo apagón en el año 2019.
Desde su activación, el Estado Nacional hizo hincapié en la idea de que la comunicación es un derecho humano, y para garantizarlo puso en marcha una serie de políticas con el objetivo de posibilitar el acceso universal a la televisión de aire de modo gratuito para todos los habitantes de la República Argentina por vía de la TV Digital Abierta (TDA). Sin duda, es difícil separar dicho proceso de la aprobación de la Ley de Servicios de Comunicación Audiovisual, que marcó un cambio de paradigma.
Este artículo tiene como objetivo describir y analizar las decisiones tomadas por el nuevo gobierno argentino, que modifican estructuralmente el proceso de digitalización.

Palabras clave: televisión digital; Ley de Servicios de Comunicación Audiovisual; derechos humanos; comunicación.

1 Introducción

El 10 de diciembre de 2015, la asunción del candidato de la derecha Mauricio Macri a la Presidencia de la Nación conllevó dar cumplimiento a un conjunto de consignas tradicionales neoliberales: generar un significativo achicamiento de las competencias del Estado; transferir riquezas a las elites económicas más importantes del país mediante exenciones impositivas (agroexportadores); devaluación de la moneda para beneficiar a los poseedores de divisas; quita de subsidios a los servicios públicos de los sectores más desprotegidos, achicamiento de políticas sociales y, entre otras cosas, protección a los principales grupos monopólicos de la comunicación que durante la última década habían sido sometidos a un proceso de democratización mediante medidas de desmonopolización que naturalmente modificaban su posición de privilegio.

No había pasado un mes desde su asunción cuando el Presidente cambió por decreto la Ley de Servicios de Comunicación Audiovisual (LSCA), votada por amplia mayoría en octubre de 2009, considerada como una de las más democráticas construcciones ciudadanas y declarada constitucional por la Corte Suprema de Justicia de la Nación luego de haber sido judicializada por la empresa propietaria del diario *Clarín*. En materia de gestión de la norma, el decreto abolió la Autoridad Federal de Servicios de Comunicación Audiovisual (AFSCA) y creó el Ente Nacional de Comunicaciones (ENACOM). Disminuyó la representación de sectores en organismos de gestión; amplió las posibilidades de la concentración; habilitó la compraventa de licencias, con controles muy laxos y prácticamente servidos a las condiciones del mercado; quitó las garantías de acceso universal a los contenidos informativos de interés relevante, pero fundamentalmente modificó la órbita de los sistemas de cableoperadores, sobre la que la LSCA establecía obligaciones respecto de la composición, orden de las grillas de programación, la obligatoriedad del *must carry* y cuotas de pantalla. Esto hizo que los sistemas de cable dejen de ser considerados servicios de comunicación audiovisual y en consecuencia excluyó del conteo de licencias los más de 240 sistemas con los que cuenta la empresa Cablevisión (propiedad de Clarín).

Este fuerte apoyo hacia el sector más poderoso del espectro audiovisual por cable va de la mano de un proceso de desjerarquización del sistema de televisión digital terrestre y gratuito, a los efectos de permitir el protagonismo excluyente de las corporaciones (en particular Clarín) por encima del derecho de acceso.

De esta manera, el decreto modificatorio de la LSCA fue solo el punto de partida de un conjunto de ataques sistemáticos que alcanzó al universo de la comunicación audiovisual. En este artículo intentaremos describir aquello que se circunscribe a la televisión digital terrestre.

2 Disminución de la oferta de canales y contenidos

2.1 La salida de Telesur

En los primeros sesenta días del gobierno de Mauricio Macri se dieron claras señales de cambios en la política exterior del Estado. Por ejemplo, en el discurso de su primera reunión del Mercosur enfrentó explícitamente a los gobiernos populares de América Latina, en particular a Venezuela; además, fue el primer gobierno en mostrar públicamente su respeto por la nueva situación brasileña, en la que el vicepresidente Michel Temer tomó el poder temporalmente poco después de que se aprobara el *impeachment* contra Dilma Rousseff. Estos gestos ponen en diálogo las intenciones demostradas en las visitas del mandatario francés François Hollande en febrero o de Barack Obama en marzo, quienes fueron recibidos con todos los honores.

Pero el primer impacto visible sobre la televisión digital fue el anuncio del ministro de Medios y Contenidos Públicos, Hernán Lombardi, de que Argentina se retira del 16% de las acciones de Telesur, la compañía de televisión estatal que también integran los gobiernos de Venezuela, Cuba, Ecuador, Bolivia, Nicaragua y Uruguay, el canal de noticias con la agenda y la perspectiva de los intereses de América Latina

hacia el mundo y del que nuestro país formaba parte desde hacía más de diez años. La novedad implicó que Telesur dejó de emitirse en la plataforma estatal Televisión Digital Abierta (TDA).

En diálogo con José Cretaz, en el ciclo "Conversaciones" de la versión electrónica del diario *La Nación*, Hernán Lombardi justificó así la medida: "Es un símbolo de los tiempos que vivimos. Solo hay en la tv digital dos canales internacionales: Telesur y RT. Eso muestra una visión sesgada y ahora nos vamos a abrir al mundo de verdad y sin esa visión tan sesgada[1]".

La disposición no fue acompañada de otra que explicara qué significa "abrirse al mundo de verdad"; sin embargo, se observan algunas alternativas. En primer lugar, las nuevas relaciones carnales que se están desarrollando entre el presidente Barack Obama y Mauricio Macri trajeron al gigante Turner, respecto del cual desde el principio se especuló —y luego se concretó— que conseguiría la transmisión del fútbol argentino. Por otro lado, la empresa norteamericana Viacom Inc. concretó la compra del canal Telefé a Telefónica S. A. por un total de 345 millones de dólares. En concreto, un fuerte desembarco de medios norteamericanos en el negocio audiovisual argentino, con la adquisición del fútbol, uno de los contenidos más importantes, y la compra del canal de mayor audiencia.

En segundo lugar, se conoció una reunión poco difundida entre Carlos Slim (propietario del gigante de las telecomunicaciones América Móvil) y el presidente Macri, en la que el primero mostró su interés por incrementar su participación en el mercado argentino. En una nota publicada en el matutino *Página/12* el 14 de mayo de 2016 se lee: "Slim tiene intereses de controlar una parte de la Red Federal de Fibra Óptica que construyó el gobierno e incluso comprar capacidad de transmisión satelital de Arsat para poner esa infraestructura al servicio de su expansión en el país[2]" . Héctor Huici, secretario de Tecnología de la Información y las Comunicaciones, encargado de llevar adelante la gestión de la empresa satelital con inversiones privadas, dijo que la única unidad de Arsat que a primera vista no parece tan tentadora es la de la TDT. Por eso, Huici se refirió a ella como "la mochila de plomo". Sin embargo, la porción del espectro que ocupan los canales digitales de aire que van del 21 al 51 (de 512 a 698 MHz) sí es tentadora para brindar telefonía móvil.

Queda claro que si esto prospera se perderá espacio en el espectro radioeléctrico para servicios audiovisuales tanto públicos, privados como aquellos sin fines de lucro. En el año 2010, a las señales otorgadas un año antes a las universidades se les reasignó el espectro para telecomunicaciones. La reubicación sigue en deuda.

Este capítulo continúa abierto. El ingreso al país de capitales trasnacionales despierta tensiones con los poderosos locales, que frente a cada noticia le hacen saber su descontento al presidente.

[1] http://www.lanacion.com.ar/1822490-hernan-lombardi-cultura-nunca-puede-ser-propaganda
[2] https://www.pagina12.com.ar/diario/economia/2-299313-2016-05-14.html

2.2 Fútbol para... algunos

La LSCA había establecido en su articulado que "se garantiza el derecho al acceso universal —a través de los servicios de comunicación audiovisual— a los contenidos informativos de interés relevante y de acontecimientos deportivos, de encuentros futbolísticos u otro género o especialidad". En este marco se firmó en 2009 el contrato entre el Estado y la Asociación del Fútbol Argentino para la televisación de los partidos de Primera y Nacional B por el término de diez años y la creación del programa *Fútbol para Todos*. A partir de dicho acuerdo, se utilizaron los derechos de transmisión por canales de televisión digital abierta para garantizar el acceso libre y gratuito. Además de la televisación por distintas señales, también se liberaron los derechos para la emisión diferida de las imágenes y se transmitía vía *streemend* por el portal web y aplicaciones móviles.

En el mismo sentido, en febrero de 2013, el Estado Nacional creó DeporTV, una señal pública que considera al deporte como un derecho y que servía como pantalla para garantizar la transmisión no acordada con las señales privadas.

Sin embargo, en el nuevo modelo de distribución de canales y partidos, la cesión de los derechos de televisación de los principales encuentros deportivos (entre ellos, de los equipos más grandes) a los canales El Trece, Telefé y América no garantiza el acceso a los mismos, pues son señales de distribución en la Ciudad Autónoma de Buenos Aires y no se encuentran en el paquete de distribución nacional. Es decir, quienes viven en el territorio nacional, pero fuera de la CABA, pueden acceder "únicamente" mediante servicios pagos como el cable o el sistema satelital.

Por otro lado, y luego de que autoridades del Ejecutivo y de *Fútbol Para Todos* extremaron un conflicto por falta de pago de los derechos adquiridos —que llevó a una huelga de futbolistas de casi tres meses—, el Estado anunció el final de este último programa y la Asociación de Fútbol Argentino otorgó los derechos de transmisión del torneo que comienza en el mes de julio a la empresa Fox Turner (la sociedad de las empresas FSLA Holding L. L. C. —cadena Fox— y Turner Broadcasting System Latin America, Inc) a cambio de 4.200 millones de pesos. Esta política devuelve contenidos de interés general como el fútbol al sistema de *pay per view* a un costo de 20 dólares mensuales, que se transmitirá por los sistemas de cable o televisión satelital, pero no se emitirá por televisión digital abierta.

3 Desfinanciamiento de la infraestructura

3.1 Arsat

Sin duda uno de los íconos del desarrollo tecnológico de los últimos años fue el lanzamiento de los satélites geoestacionarios Arsat 1 y 2 con el objetivo de brindar servicios de TV, Internet y telefonía para el país y América Latina.

Creada en 2006 con el objetivo de ocupar y defender las posiciones orbitales asignadas a la Argentina por la Unión Internacional de Telecomunicaciones con satélites desarrollados en el país, la iniciativa —que en 2010 alcanzó rango de ley— fue reco-

nocida como una de las más importantes políticas de soberanía nacional e incluyó al país en la corta lista de naciones con desarrollo industrial satelital.

A partir de 2010, Arsat implementó la Red Federal de Fibra Óptica, con un tendido que alcanza los 58.000 km y que se encuentra en proceso de puesta en servicio, y la plataforma tecnológica del Sistema Argentino de Televisión Digital, que sirve de soporte del sistema y que además de ser desarrollado en el país, vendió servicios a otros de la región.

Esta política que jerarquizó al país se encontró con un nuevo impacto normativo. El gobierno suspendió la construcción del Arsat 3. El presidente de la compañía estatal, Rodrigo De Loredo, resolvió quitar fondos públicos y buscar la incorporación de fondos privados. Con la suspensión, trescientas personas fueron despedidas y el conjunto de trabajadores de la compañía denunció mediante un documento público que se detuvieron las obras para la instalación de nuevas antenas transmisoras (de 32 pendientes, solo se completaran 8), se frenaron las obras para las nuevas instalaciones domiciliarias, no se están pagando los servicios de instalación doméstico y se suspendió la distribución nacional de equipos receptores para los beneficiarios del Plan de Acceso Mi Tv Digital.

En relación con los contenidos, se quitó financiamiento publicitario a señales de prueba, lo cual las hizo caer, y se frenaron las tareas para incluir otros canales.

Finalmente, las autoridades de Cablevisión celebran la situación y ya planifican el uso del tendido de la Red Federal de Fibra Óptica para alcanzar con su servicio de televisión por cable aquellos rincones del territorio nacional donde la empresa aún no llega. Una vez más, financiamiento público para el beneficio de privados.

3.2 Interferencias

En los últimos meses y de manera imprevista, el sistema de recepción comenzó a llegar a los hogares con interferencias que hasta entonces y desde el inicio del servicio nunca se habían registrado. Las mismas se produjeron en momentos en los cuales contenidos importantes generaban competitividad a los sistemas de pago, como partidos de fútbol de la Selección nacional (que cuenta con derechos de la televisión pública) o del torneo local, así como programas políticos que denunciaban acciones del gobierno.

Si bien las especulaciones y definiciones técnicas apuntan a que la merma del servicio podría ser propiciada desde el interior de la empresa, ya que es posible modificar la calidad de las señales en la configuración de los transmisores —y esto podría generar degradación de la señal, pérdida de la calidad o, incluso, interferencias que produzcan que la señal no se puede visualizar correctamente—; en las audiencias públicas realizadas por la Defensoría del Público se efectuaron denuncias por problemas en la recepción de la TDT por fallas técnicas en la transmisión. Las mismas se registraron en el período de diciembre de 2015—abril de 2016 por la caída en la calidad de la señal de transmisión de partidos de fútbol de equipos grandes, por interferencia en la recepción de Telefé, o por la presencia del canal 13 en la señal 33, donde debe ubicarse Barricada TV, ganadora del concurso público para una señal de medios sin fines de lucro.

Por otro lado, en el contexto de las mismas audiencias se produjeron numerosas denuncias referidas a demoras en la entrega de decodificadores en el marco del Plan *Mi TV Digital* y la falta de antena transmisora terrestre, que postergan el plan de aplicación.

4 Despidos en el plantel profesional del sistema

Además de los trabajadores cesanteados en la empresa Arsat, a pocos días de cumplirse el 31 de marzo, y mediante un comunicado de prensa, la junta interna de la Asociación de Trabajadores del Estado (ATE) del ex-Ministerio de Planificación denunció que por decisión de la máxima autoridad del organismo, Hernán Lombardi, se optó por no renovar el contrato a todos los trabajadores monotributistas del Sistema Federal de Medios Públicos.

La medida alcanzó a 74 trabajadores que desempeñaban tareas de asistencia técnica, entre los que se encontraban diseñadores, comunicadores, desarrolladores web, fotógrafos, etc. La gran mayoría realizaba trabajos de comunicación para la promoción de la Televisión Digital Abierta, como también para actividades del Centro Cultural Néstor Kirchner, Tecnópolis, etc.

Por otro lado, 50 trabajadores administrativos que desarrollaban actividades técnicas de la infraestructura de la TDA como distribución de decodificadores, antenistas, etc., no están recibiendo sus salarios y se encuentran sin respuestas oficiales. Además, otros siete trabajadores fueron notificados de que no continuarán desempeñando sus funciones en los programas de Acua Mayor y Acua Federal. A su vez, denuncian que estos dos canales no tienen un presupuesto propio asignado para realizar programas nuevos, lo que no solo afecta a la política de empleo sino también de oferta de contenidos de calidad. DeporTV decidió no continuar con servicios informativos que daban trabajo a 120 trabajadores, a cambio de nuevas licitaciones públicas que tardan en llegar.

El Sindicato Argentino de Televisión (SATSAID) anunció que reclamará por los despidos, y en reunión plenaria del 11 de mayo de 2016 difundió un documento que plantea "Nuestro firme rechazo y llamado de alerta por los despidos en la propia actividad que no solo repudiamos sino a los que responderemos con todas las acciones y herramientas gremiales a disposición de nuestra organización sindical[3]".

Los despidos masivos no solo se producen en el sector público sino también en señales privadas como CN23, Crónica TV y 360TV, en algunos casos por establecer un modelo de negocios basado en la pauta oficial y en otros por la caída de la pauta privada como resultado de la crisis económica, con altos índices inflacionarios, caída del consumo, etc.

[3] http://www.satsaid.com.ar/satsaid/declaracion-del-consejo-directivo-nacional-y-el-plenario-de-secretarios-generales/

5 Falta de garantías para los medios sin fines de lucro

5.1 Licencias

Como se mencionó al principio de este artículo, más de 80 concursos para licenciatarios con y sin fines de lucro se desarrollaron durante 2015 para dar garantías de la inclusión fundamentalmente del último sector. De los mismos surgieron canales como el de Fundación UOCRA Para la Educación de los Trabajadores Constructores; Construir TV en Buenos Aires; la Asociación de Prensa de Tucumán o la Cooperativa de Trabajo Construcción y Progreso Limitada de Formosa.

Asimismo, los primeros tres canales "comunitarios" del país que ganaron dichos concursos fueron Barricada TV, Pares TV y Urbana TV, adjudicados en noviembre de 2015 y que, como plantea la normativa, *a posteriori* de su adjudicación deben entregar un plan técnico en 180 días.

Más allá de que este acto administrativo ya fue realizado, la señal 33 —adjudicada a Barricada TV y Urbana TV— está ocupada por Canal 13, perteneciente al Grupo Clarín. Luego de más de un año sin respuestas, las señales mencionadas fueron reubicadas en el canal 31, debieron pagar todos los costos de elaboración del plan técnico y están a la espera de una habilitación definitiva.

Otro caso es el de Antena Negra TV, que se encuentra emitiendo en señal digital y se vio obligada a apagar sus equipos y cumplir la orden judicial de entregarlos al ente regulador a partir de una denuncia penal por interferencias a otros emisores que prestan servicio de seguridad bancaria en el canal 20. En 2014, el Poder Ejecutivo aprobó el Plan Nacional de Servicios de Comunicación Audiovisual Digitales por medio del decreto 2456, ordenó la inmediata liberación de la frecuencia correspondiente a la señal 20 por parte de cualquier servicio que no sea radiodifusión, y la entregó para el exclusivo uso de Televisión Digital Terrestre Abierta (TDA). Actualmente, la empresa multinacional Prosegur ocupa la banda para transmisiones de seguridad, y la justicia lo consideró prioritario más allá de los fundamentos de la ley y los reclamos históricos.

Por otro lado, amparados en que la Ley de Servicios de Comunicación Audiovisual ya no tiene vigencia, los empresarios dueños de Supercanal S.A. le enviaron una carta documento al Canal ENTV Canal 5 de Viedma intimándolo a dejar de transmitir por el Canal 5 de aire debido a que la señal genera interferencias en el servicio que la firma brinda en las ciudades de Viedma y Patagones.

5.2 Fondos concursables

Sin duda, el Fondo de Fomento Concursable para Medios de Comunicación Audiovisual (FOMECA) se convirtió en una de las herramientas más importantes para hacer sustentables los proyectos de medios comunitarios y de comunidades originarias. Desde su creación se repartieron aproximadamente 30 millones de pesos a emisoras de radio y canales de televisión, para contenidos, fortalecimiento de la gestión, etc.

Desde la asunción del nuevo gobierno, el Estado está en mora con más de 150 organizaciones que ganaron los concursos del año 2015, lo cual pone en riesgo la continuidad de proyectos y contenidos. Tampoco se anunciaron las líneas del año 2016.

6 Conclusiones

Pasaron 16 meses desde el cambio de gobierno en Argentina. Sin embargo, el aluvión de políticas tendientes a beneficiar a las corporaciones mediáticas y la desaceleración del proceso de democratización de los medios resulta sorprendente. Un decreto que reemplaza una ley, despidos, desfinanciamiento, falta de garantías a medios pequeños de todos los sectores, cambios en el paradigma de la política internacional en materia de comunicación, etc.

Sin embargo, todos estos acelerados cambios muestran resonantes conflictos sociales, que devuelven a los sectores populares a la calle ya no para celebrar sino para reclamar por los retrocesos en materia de derechos y por los crecientes conflictos económicos.

El devenir es aún incierto, y la suerte del nuevo paradigma neoliberal auspicia el crecimiento del conflicto social; encuestas que muestran la caída de la aceptación pública y una innegable crisis de financiamiento luego de una nueva etapa de endeudamiento externo a los efectos de saldar una deuda con fondos especulativos.

La ley que fue derogada con el argumento de una necesidad urgente hasta contar con una nueva legislación, prorrogó hasta finales de 2017 la presentación de su primer borrador, y a más de un año de trabajo en la nueva norma legal, muchos sectores siguen reclamando ser convocados a opinar sobre ella.

En medio de todo esto, un proceso de digitalización de la televisión que venía creciendo a pasos agigantados, con claro protagonismo en la región, y que hoy padece los ataques del mismo Estado que debe desarrollarlo para garantizar el derecho humano de acceso a una comunicación pluralista y al servicio de las necesidades sociales.

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TV Concierge: A Proposal for an Interactive TV Recommendation System Based on Viewing Context

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Abstract. With the continuous growth of channels and content available in a typical interactive TV service, viewers have become increasingly frustrated, struggling to select which programs to watch. Content recommendation systems have been pointed out as a possible tool to mitigate this problem, especially when applied to on-demand content. However, in linear content, its success has been limited, either due to the specificities of this type of content, or due to the little integration with normal consumption behaviors. Despite that, recommendation algorithms have undergone a set of enhancements in order to improve their effectiveness, particularly when applied to the world of linear content. These improvements have been focused on the use of the visualization context as the dominant factor for the suggestions to be proposed to the viewer. Also, the area of user experience (UX) evaluation, in interactive TV, has been subject of ongoing research, extending beyond the traditional usability evaluation, pursuing other dimensions of analysis such as identification, emotion, stimulation and aesthetics, as well as distinct moments of evaluation. This paper presents the proposal for the development of a recommendation system, based on the viewing context, and a methodology for evaluating the way this system influences the UX of the viewers.

Keywords: TV, UX Evaluation, Recommendations, Visualization Context

1 Introduction

In the last decades, the quantity and quality of the content available in a typical living room has increased considerably. Television, the main distributer of this content had, concurrently, a clear evolution. Not only have the number of available channels improved significantly, particularly on paid TV platforms and in more developed countries, but also, as a result of digitalization and interactivity, a number of additional features have appeared, granting a considerable increase on the available content. These new functionalities include, for example, video on demand (VOD), automated catch-up TV, and digital video recorder (DVR), and can be classified in a taxonomy that distinguishes between linear content, i.e., traditional television, transmitted in diffusion mode and nonlinear content, which include services that provide movies and television programs by request [1].

All this increase on content and functionality can add up really quick, resulting in a much wider choice for the end users. Accompanying this, there is also a progressive complexification on the interaction modes. In one hand, the amount of content is so great that the viewer has difficulty in selecting a proper program to see, attaining a so called "Paradox of Choice" [2, 3]. On the other hand, the tools that could help him in this task are of limited practical use, partly because of the physical limitations of the equipment itself (the user is too far away from the screen to be able to discern very detailed elements) and also because he interacts through a remote control with limited interaction features, which are not always adapted to the new interactive TV services [4].

This paper will focus on a proposal to develop and evaluate the user experience of an interactive TV application that aims to mitigate this paradox of choice, by artificially reducing the quantity of content presented at each moment to the user, through the use of personalization and, at the same time, building a minimalist user interface that further limits the number of interactions needed. In this way, in Sect. 2 we address a set of recently researched recommendation algorithms and techniques that rely on the TV consumption context and can be applied to linear TV content. In Sect. 3 we present our approach to the development of the correspondent interactive TV application and some of the mockups already designed. Next, on Sect. 4 we describe our user experience evaluation methodology and how we envisage executing it. Finally, in Sect. 5 the paper is wrapped up with the exposition of the results we expect to achieve in the upcoming months and some brief conclusions.

2 Personalization and recommendations in linear TV

In order to mitigate the nuisances caused by the content proliferation, for instance the situation where the user expends more time looking for content to watch than actually watching content [5], several proposals have been made, most of them focusing on the use of recommendation and personalization systems, in order to facilitate the discovery of interesting content to watch [6]. These systems have achieved effective success in on-demand video subscription platforms such as Netflix and the traditional VOD platforms of the various pay-TV operators, where there is a significant control over the offer of content to recommend and where the user is already predisposed to a more advanced level of interaction, namely with a greater propensity to assign scores to the viewed content. However, in linear content, recommendations are still not an effective tool [6] and end up being just another functionality, lost among many others and far from being a solution that truly contributes to an effective mitigation of the problem [7].

Some particularities of linear content add greater complexity in creating an effective recommendation systems, namely the content catalog being in constant change and the content being available only for a short time due to the TV channels programming being characterized by its constant renewal [6]. A recommendation system, that only has access to the linear channels programming, can only recommend, at any moment, the

programs that these channels are broadcasting or programs that will start in the upcoming minutes. Even systems that have access to a catch-up TV catalog, need to deal with the fact that fresh content is entering the collection all the time, since the system is constantly recording new programs and, similarly, removing older ones [1]. In contrast, VOD recommendation systems do not need to take these factors into account, as their catalogs have much slower turnover cycles.

Another characteristic of linear TV consumption that should be emphasized is that it normally follows a very regular pattern [6]. Contrary to a VOD system where the viewer usually wants to find a new movie to watch, when watching TV the consumer has habits associated with certain times of the day and follows specific recurring programs on a small number of available channels [5]. This regularity together with other contextual aspects of TV watching was also identified by other authors [3, 8, 9], who take them as the basis for proposing new approaches in recommending linear television content.

In [3], the authors looked for a better understanding of the contextual aspects involved in TV and video consumption on a domestic environment through the execution of two ethnographic studies. In the first, which involved 12 households, they observed how the household structure determines the viewing situations and the relations between the amount of attention, type of content and viewing behavior – planned, routine, or spontaneous. They also observed the different ways in which people discover new content. In a second, multi-method study, comprising 7 families with children, typical situations of visualization and their contextual aspects were assessed. After combining the results of both studies, they recognized seven viewing situations: weekend mornings; when the children are sleeping; family quality time; relaxing after school; a free moment: men and sports; and lazy afternoons. In each case they identified the contextual aspects: mood; content; viewers; time; content delivery time (linear or on-demand); and viewing mode (attention level associated with consumption). With the results of these studies they make several proposals for recommendation system, algorithms and user interface designs that could take into account these contextual aspects. Unfortunately, some of these contextual aspects are not easily assessed in an automated way, mood and viewing mode for instance, and cannot be used as-is in a non-intrusive solution.

Other authors found out that linear TV consumption patterns are strongly conditioned by time context and channel preferences [6]. In this sense, they propose that one way to go beyond the state of the art on the current recommendation systems for linear content is to explore and integrate this visualization context (time) in the user consumption modeling. Through empirical evaluation with a broad set of linear TV data, they demonstrate a significant improvement in the quality of the recommendations when the time context is taken into account. This usage of time context can be improved with the addition of implicit feedback, taken from consumer data analysis, and taking into account not only the linear TV services, but also the catalog of catch-up TV available today from most operators. Comparing this approach with current algorithms it has been shown it can be superior to these in accuracy, while maintaining good levels of diversity and serendipity [9].

In addition to the temporal context, an attractive idea, that has been shown to provide considerable precision gains in the recommendations, is the usage of a sequential context [8], which takes into account the last viewed program at the time of the recommendation to influence it.

An important aspect of TV consumption is that it is often shared by several different users, whose tastes can vary widely. Typical recommendation systems do not handle this situation very well, since visualization data is typically collected and modeled at the device level, aggregating all users and obscuring their individual tastes. The ideal contextual information would be for the system to know in each moment who is watching and their level of attention. That level of information is hard to attain today, without the introduction of additional hardware in the living room. A further layer of additional contextual information, that can be obtained automatically, must still be devised to mitigate this issue.

3 Prototype Design

With new recommendation algorithms, that take into account diversified contextual aspects of TV consumption, that are more focused on linear content problems, we have the foundations to the most important backend component of the TV Concierge system. However, the introduction of these features cannot be dissociated from the way the viewer can access it. It is important to note that, although there is a significant research specifically regarding interfaces to interactive TV recommendations systems, some authors report that many users preferred to have few or no interactions with the system [10]. Nevertheless, current implementations rely mainly on solutions where the recommendation is only realized after some kind of user activity [11, 12], sometimes forcing the response to a series of questions before any recommendation can be made.

This mismatch between the user expectations and the way the features are implemented shows that the relationship between the viewer and the TV goes far beyond the user interface, covering a set of other dimensions in what can be called, generally, the user experience (UX). In the ISO 9241-210 standard, UX is considered as the "person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service" [13]. In the notes associated with this definition, this standardization body stresses that UX includes all the emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviors and achievements associated with the user, whether they occur before, during or after use.

In "The Paradox of Choice: Why More Is Less" [2], the psychologist Barry Schwartz, explains why a lot of choices can be detrimental to people's psychological and emotional well-being. It explains how a culture that grows with an infinite availability of constantly evolving options can also foster deep dissatisfaction, which can lead to paralysis in decision making and, in some cases, depression. It also describes the difficulty of choosing a program to view when there are so many available, and that in this sense the (traditional) recommendations systems still make the situation worse, since they always propose something new, never seen.

Combining these insights, our prototype design took an approach that tries to minimize the number of interactions the user needs to perform with the system. Simultaneously we aim to bring the recommendations to the upfront of the platform – in this respect the system will not just wait for the user to ask for some recommendation but will preemptively suggest them. This will start from the very beginning, i.e., when the user turns on its Set-top Box (STB) it will be presented with the program that makes sense to play at the time it is turning the box on, rather than with the last channel tuned in the previous night. In addition, making use of the time-shifting capabilities of modern TV platforms, the suggested program will start from the beginning. For instance, if a potential viewer, who usually watches the TV newscast when he gets home about 8:00pm, turns on the STB around this time, the recommendation system will automatically start playing the newscast that the viewer usually sees and not a spurious channel, kept from the last usage session. This use case is illustrated in left side of **Fig. 1**.

Fig. 1. Mockup for the automatic program suggestion

It is also intended that when a program finishes and whenever the system has a high degree of confidence, it will automatically start playing the next suggestion, without any intervention from the viewer. This situation is illustrated in right side of **Fig. 1** – at the end of the newscast the system suggested an episode from a series and began its reproduction automatically, from the beginning.

Fig. 2. Mockup of the system allowing the selection of the following suggestion

When the system does not have a sufficient degree of confidence, it will select a reduced number of proposals for the viewer. In this case, the playback will still start automatically, but the viewer will get, for a few seconds, the opportunity to choose

another program to watch, a concept that is visible in **Fig. 2**, mimicking a typical binge-watching scenario [14], which is somewhat the brand mark of the current video-on-demand systems from the internet.

It is also possible that the system has no suggestion to propose at a certain time, for example when no pattern has been identified, in this case the system needs to propose a new program. Our approach for this situation is that the system will suggest a new release (e.g. a new season of a TV series) between a limited set of the most watched channels on that STB. The idea behind this methodology is that, usually, if a series that a viewer normally watches has ended, a new one will be released to take its timeslot, and the system will offer that. If that does not happen, some other channel that the viewer also watches will have something starting to promote. We already know that the user likes the channel, so there is a higher probability that it also likes a new show from that channel. This is the purpose of the interface shown in right side of **Fig. 2** – in this case we opted for the binge-watching interface for the user to have an opportunity to actually select the new program.

Although the interactive application will start automatically when the STB is turned on, and will keep providing suggestions and playing content in an automated way, this does not mean that the user relinquish all the control of his STB. The user can, at any moment, use his interactive TV system as usual and TV Concierge will disappear. It can be summoned again by the standard means of the interactive platform, for instance with a menu item or from a dedicated button in the remote, but it will also restart offering suggestions automatically if it detects that a program the viewer is watching just ended or upon detection of what we call a "mindless zapping", that is, when the user starts zapping in a pattern that appears to be just hunting for something to watch.

4 UX Evaluation

As stated in the introduction, one of the key aims of the TV Concierge project is to evaluate the way that an interactive TV recommendation system, based on the viewing context as described in the previous section, influences the UX of its viewers. To achieve this objective, we will address several dimensions of the UX, namely: usability, aesthetic, emotional, stimulation and identification, through the use of a methodology based on a framework that uses previously endorsed and validated tools [15], and is highly aligned with some previous similar evaluations [16, 17].

In our context of evaluation, the usability dimension can be understood "as being a general quality of the appropriateness to a purpose of any particular artefact" [18]. The aesthetics dimension portrays how visually pleasing or beautiful something is perceived. The emotion dimension portrays the emotional response to the outcome of the interaction with the product or service. The stimulation dimension describes the way a product addresses the human necessity for innovative and interesting functions, interactions and content. Finally, the identification dimension indicates how a certain product allows the user to identify himself with it, by using or owning a specific product the user can reach a chosen self-presentation [16].

This framework proposes different tools for each of the distinct UX dimensions. Thus, for the usability/pragmatic dimension, the System Usability Scale (SUS) [18] will be used. This is a questionnaire with 10 items on a five point Likert scale, which presents a final result in a range between 0 and 100. For this dimension, we will also use Pragmatic Quality (QP) component of the AttrakDiff questionnaire [19, 20]. Each of the AttrakDiff components have a value between -3 and 3 and represents an average of 7 items on a semantic differential scale of bipolar adjectives. For the aesthetics dimension, we will use the AttrakDiff Attractiveness component.

For the emotional dimension, the pictorial assessment tool Self-Assessment Manikin (SAM) [21] will be considered in its 3 indicators: pleasure, arousal, and dominance. This non-verbal tool measures the results for each of the indicators in a scale from 1 to 9. For the stimulation and identification dimensions, the corresponding AttrakDiff Hedonic Quality (HQ-S and HQ-I) components will be used.

To better understand the model that we intended to use for the operationalization of the research project, it is important to point out that the UX does not happen in a single instant, in reality it happens in a set of distinct and conjugated moments. Thus, even before the user comes into contact with a new product or service he already has the experience of using other solutions, similar or not. When he receives information about a new system, it creates a set of expectations and a mental model of how it will work, in what Roto et al. call of anticipated UX [22]. In the first experience with the system and with every additional interaction, there are moments of what these authors call momentary UX, i.e. UX experienced, sometimes viscerally, during use. After a usage session and reflecting on it, the user achieves the called episodic UX that recovers the memory of the sensations and emotions he had during that previous use. Over time and after several periods of use (interleaved by times of non-use), a cumulative UX is reached where the various individual experiences merge to create a whole experience, which may be the most important. As Roto et al. refer, the importance of a negative reaction during a specific use can be diminished by successive subsequent uses and the problematic use can be, in the end, remembered differently. Each of these different UX moments will be carefully studied using different tools. To address the anticipated UX, we intend to use semi-structured interviews, which will be carried out with a limited set of experts and end users. For the evaluation of the momentary UX, the ideal methodology would be direct observation, in order to capture the behaviors in the precise moment they occur. However, since the normal usage will occur in a residential environment by a large number of viewers simultaneously, this would be impractical. The alternative that this research intends to implement is the well-timed use of in-app questions, which will be presented to the viewer directly on the TV, in a way similar to the one depicted in **Fig. 3**. The use of this approach will also allow for the evaluation of the suggestions system since the experienced results are easily transformable in simple questions, with very direct response from the viewer, and can be very tuned to the respective functionalities.

The assessment of the episodic UX will be realized carried out shortly after the installation of the prototype and will be performed in an internet application using the three instruments previously mentioned SUS, SAM and AtrakDiff, instructing the

viewer that he should respond by recalling the most recent prototype usage. The evaluation of the cumulative UX, which will use the same three instruments, will be applied in the same way, three months of installation along with a semi-structured interview.

Fig. 3. Mockup of an in-app question being made directly on the TV

The data collected by these instruments will be analyzed using statistical methods. A set of analytics, obtained from the data that will be collected automatically by the interactive TV platform, will serve as a control and as a potential triangulation of the information collected in the questionnaires.

5 Expected Results and Conclusion

With the insights obtained through the data analysis, we expect to achieve a rich understanding of the influence that a recommendation system, based on the viewing context, has on the UX of the viewers. Furthermore, we will also assess the relation between the reduction of the number of content options offered to the viewer and their respective UX. As already mentioned, the excessive content can become a source of frustration for the viewer. Following this reasoning, we expect that reducing the number of options will lessen this frustration [2]. We also intend to evaluate the usage of in-app questions, directly on the interactive TV interface, in the UX evaluation context. This inquiring model has a set of advantages, since it enables a real contiguity between the moment of UX and the moment of the evaluation and allows an automatic data collection. However, it interferes directly in the interaction flow which in itself will change the perceived UX.

As we have seen in this paper, the enormous growth in content available in most pay-TV platforms has the potential for creating a "Paradox of Choice" in the viewer. Taking advantage of new developments in recommendation algorithms, based on the viewing context and much more tailored to linear content, we propose to implement a preemptive interactive TV application that will act upon these recommendations and actually plays automatically the content, minimizing the viewer interactions and decisions. Our ongoing project also aims to evaluate how such system affect the UX of its viewers, giving us the understanding of their potential in the linear content context.

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Audiences and Content

The Development of Media Affordances in the Audiovisual Design*

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Abstract. The Audiovisual Design is a communication model, represented by a methodology of analysis and development of content that mixes audiovisual elements with interaction software and digital interfaces. This essay introduces the concept of media affordances in the Audiovisual Design as a contribution to the understanding and planning of actions taken by a person during the production and enjoyment of sound and video using the contemporary set of media. The model represents the intersection between Human-Computer Interaction Studies and Audience Studies, required to the development of contemporary audiovisual and sound content. The present text introduces the definitions of Audiovisual Design and outlines the concept of affordances, characteristics of mediatic tools required to the individual to perform an assigned role, or step from one to another. This involves processes of learning and assimilating the available affordances in different contexts. It is highlighted herein the importance of the audiovisual producer to be able to understand and predict how the Audience, in different levels of engagement or inertia, will react to the tools made available by the content and the technologies through which they are distributed.

Keywords: Audiovisual Design, Human-Computer Interaction, Audience Studies, Affordances

1 Introduction

The communicational-methodological model of the Audiovisual Design (AD) reunites methods and concepts from two traditionally isolated fields that share similar approaches: The Human-Computer Interaction, from the Computer Sciences, and the Audience Studies, from Communication Sciences. To give a brief description, the AD

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shows two practical features: 1) To analyse the audiovisual content produced with tools from both HCI and Audience Studies altogether; 2) To predict user interactions and propose innovative applications of those tools in the development of audiovisual creations. The model's main characteristic is the planning of the interaction – or the interactivity – simultaneously with the creation and production of the audio and/or video features, which occurs based upon four *Lines of Design* that configure and shape the creative process: the Individuals, the Motivations, the Experience and the Content [1].

The integration of those elements (the interactive tools and the content itself) has altered the creation and production processes. The design and development of audiovisual content, including applications that make use of video, is swiftly changing in response to the technological convergence. Individually, HCI and Audience Studies do not contemplate such changes. The design of interactive computational systems initially focused on problem solving, tasks and functions; later, its reach was slowly broadened to incorporated other perspectives, such as novel possibilities, significances and emotions; and now the person's behaviour is also contemplated. For instance, the passive enjoyment gains relevance when the final object of the interactive system is an audiovisual content.

The same phenomenon is observable through the audiovisual consumption's perspective, once the software usage has become as relevant as the quality of the movies, TV series, online videos and sound content. All digital media for accessing content show a similar characteristic: interaction through software. The spectator's experience mixes an active posture (navigation and search for information) with moments of passive fruition (the visualisation of the content) in tasks such as accessing the digital TV schedule guide, searching for a title in applications as Netflix, or recommending a video or audio content through social media. In other words, the simple act of choosing and watching a video show may require the individual to assume different roles, with higher or lower levels of interaction and participation. Consequently, a revision of the theories and methods supporting the content development becomes necessary, especially in the HCI field, in which the notion of 'users' has a limited part by not contemplating their total immersion in the different media, especially the audiovisual ones.

To adequately respond to this new scenario of audiovisual content production and fruition, in which audio, video and software are integrated in a single product, the AD attributes five roles to be assumed by the individuals: The Audience, the Synthesiser, the Modifier, the Player and the Producer [1]. The uses of the available resources afforded in each performed role vary in degrees of engagement and inertia.

To distinguish the set of actions – or interactions – made possible by the varied technologies, in different moments of the audiovisual consumption is a key element to understand alterations in the level of actions related to the storytelling or the content – which, subsequently, may cause the individual to step from one role to another. In this essay, we are introducing the concept of *affordances* in the AD model. In short, the word affordance '… is used to refer to an attribute of an object that allow people to know how to use it' [2]. Thus, the DA considers that a person, to alternate between roles, must understand the set of available actions, which are those expected by the Producer they will assume or avoid, and how they can subvert the medium to their own

advantage or according to their own welfares. It is an essential concept in the convergence between theories and methods from HCI and the Audience Studies, where software becomes central to the content enjoyment, whether through digital TV, internet or on-demand services of audio and video.

The article has the following structure: the AD model is presented in section two; section three holds the conceptualization of affordance and its pertinence to media studies, while section four presents elements regarding the learning of affordances. Section five closes this essay by presenting some conclusions regarding the application of the model, and the features that require further investigation.

2 The Design Audiovisual Communication Model

The communication process can be defined with the use of theoretical and conceptual models, to describe communicative acts and the flow of information among people and the present and acting technologies in the communication [3]. Recently, new models have been suggested, aiming to understand how the notion of individuality – and the communities created around the generalisation of the concept – impact in the media and in the content creation. Jenkins, Ford and Green [4] proposed three simple models to describe different current communication scenarios: from one communicator to multiple recipients, the Broadcast; the online communication in which the person has the initiative of searching the content, as Stickiness; and Spreadable, when the content reaches the audience through the actions of persons, mostly using digital tools. The authors describe the communication processes connected to the exchange of information and to the varied modes of media consumption.

However, Jenkins et al. [4] did not contemplate the technical-creative process of the audiovisual production, where the subjectiveness of the storytelling links to the objectiveness of the interaction requirement. Interface problems, or bad user experiences, may compromise the entire audiovisual product. Some of those elements can be approached by the technological learning and the identification of possibilities of use of the communication interfaces. In contrast, these matters are broadly studied by HCI. While the audiovisual fruition has been hitherto considered a simple process with no requirements for technological mastery, the software development rests upon the capability of use by persons, that is, the potentialities of action regarding the perception one holds towards the object or the technology when interacting with it [5].

In contemporaneity, the increased presence of technology in different daily situations (mediatisation) profoundly transforms the media ecosystem. Besides the emergence of new technologies, the complementarity between existing means is extended, and they combine themselves in different communication processes [6]. Such transformations have some impact in people's lives by bringing new possibilities of use and interaction, through the properties of each technology individually and the convergences among those technologies. The AD contributes to understand these arrangements, pointing that the separate affordances of a technology applied in the production and distribution of content, as well as the competencies required to its use, are essential to the existence of multiple roles an individual (or user) can assume.

2.1 The Audiovisual Design

From the context outlined above, previous studies [1] identified the need of a theoretical and methodological model to integrate the software development and the audiovisual content creation. The Audiovisual Design results from the intersection of HCI and Audience Studies disciplines. It is represented by a graphic workflow that allows the recognition of the dynamic flow of the audiovisual production considering a variety of scenarios and roles performed by individuals (Figure 1) [1].

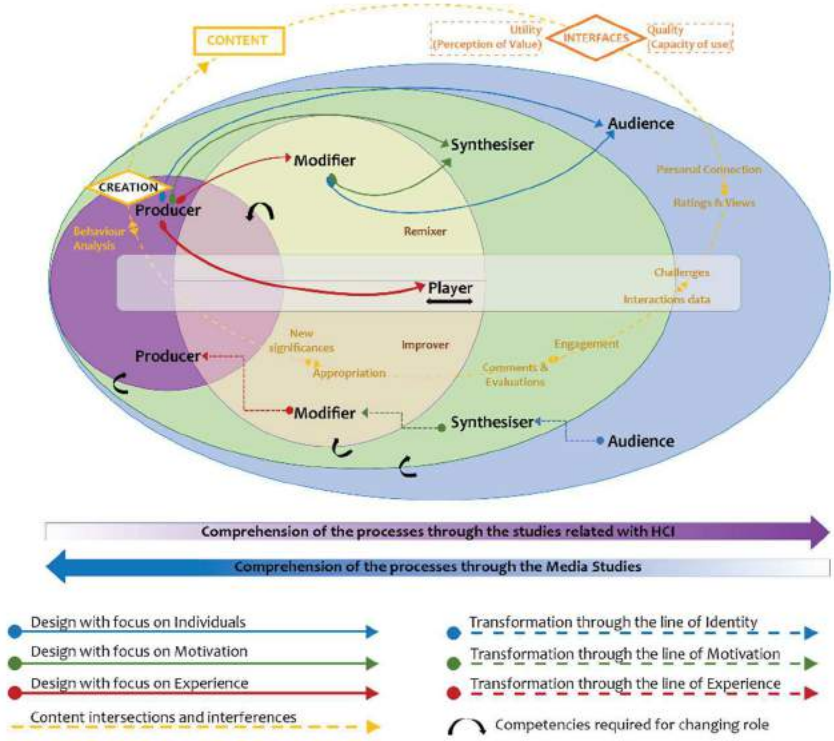

Fig. 1. Processual flow for Audiovisual Design [1]

Although dominant in software development processes, the user typically is an abstract individual commonly identified by archetypes. Instead, in the AD model, one person can perform different roles in different moments: Audience, Synthesiser, Modifier, Player and Producer.

Audience: this is the base for all roles an individual can assume; it denotates low level or absence of interaction during media consumption. It is the passive behaviour associated to the Broadcast model, approaching the digital interfaces through the selection of channels, search and playing of content, subscription to a feed or channel, etc. Hence those people are identified in groups by audience ratings or data about the access

to a given content, enabling only a collective vision of their preferences. The relationship of the individuals with the content occurs in the level of the personal taste and remains relatively private.

Synthesiser: the term has been presented by Jenkins *et al.* [4]. The individuals present competencies to compile, classify, comment, recommend and share the content they like, usually to construct a digital 'identity', a staged profile in a social network. The Synthesiser's role considers the notion of engagement, the emotional link that allows people to express something about themselves using the content to which they relate.

Modifier: it is a smaller part among the Synthesisers, with further competencies and abilities. They master software to manipulate and recreate content to which they identify themselves, thus amplifying the notion of engagement to that of appropriation. They can be divided into two main groups, although it may be possible to point others: The Improvers, that is, those who appropriate the content to change something they don't like; and Remixers; those who create new content from the original one.

Producer: a person or group of people who creates original content (even if inspired by other media content), who can be autonomous and independent or collaborators in great media corporations. Although every Producer is a Synthesiser (they hold among their competencies the content distribution), the competencies of the Modifier only apply when the industrially-crafted content is an adaptation to another, existing one. For this reason, the superposition of both roles is only partially represented in the figure.

Player: This role superposes all other because it refers to the individuals who completely use the tools available for and in each level, so we may call them Audience-Player, Synthesiser-Player, and so on. Their actions, especially those not foreseen in the design of the audiovisual product, shall feed the Producer in future developments. In other words, they can perceive and learn affordances not foreseen to their level. Players pursue challenging content that makes them, even if individually, think and perform an action. One may identify them (not restrictively) with the 'early adopters' or 'early users', that is, those who will assume the risk of using a new technology and, thus, contribute to its development. The AD model tries to predict every user behaviour, but it would a very restricted approach if it did not consider the unpredicted uses.

Finally, the two arrows in the inferior part of the graphic represent axis of comprehension of the process considering the Audience Studies and considering the HCI Study field. In the first case (represented by the blue arrow), it refers to the relationship of people with the content, that is, the objectives, intentions and meanings implied in (and derived from) the enjoyment of the audiovisual programme. Diverse intellectual traditions are usually combined in such an approach, for instance the Cultural Studies, Semiology and Ethnography. It is emphasised how discourses are interpreted and incorporated by people, which may lead to a comprehension of the creative process itself. In other words, through the Audience Studies one starts with a general context to try and understand the Producer's motivations – whether economic, cultural or ideological – and so point out his or her intentions. The main advantage in analysing the process of the audiovisual creation using this perspective is to come to acknowledge sociocultural concerns in a given local or historical context, plus how such concerns exert influence (or even determine) the choices made by the Producer. The data collected from the

observation of the relationship of the public with programme output are then feedbacked to the audiovisual industry's production chain, apart from becoming the basis for the creation of policies designed to cultural development.

Nonetheless, even if the content (format, theme and storytelling) is the foundation of the creative process of an audiovisual product, to consider the interactions performed by the audience through different interfaces requires the Producer to also contemplate the processes and the technical and technological courses that will lead to the content.

HCI presents the methods and processes that help composing such perspective. The fruition process is divided into steps, planned in accordance to the possible engagement the individual will demonstrate regarding the enjoyment of the programme and the motivation to contribute to the richness of content. This field of studies enables the planning and the comprehension of the production process of an audiovisual piece by looking at all the elements parallel to the content, usually sprang from the technologies employed for the enjoyment. That is how the concept of *affordances* becomes necessary. Starting from the production sphere and continuing in the direction of the most passive audience, the HCI axis (purple arrow) allows to underline different demands for a product, by considering its format and technology employed and the more active or less active utilisation the individuals will do of the possibilities offered in a technological context. For example, a programme that includes a complex interactional system, to be developed for the parcel of audience showing a major engagement level, should require a detailed planning based upon: problem identification, creation of scenarios, survey with selected people, analysis of gathered data, continuous and self-fed planning (incorporating the feedback coming from the surveys and the first uses) of usage methodologies, directly applied to the development of the audiovisual product. The phase of problem identification is also the phase of documentation of *affordances* of each technological support in which the content would be available. Hence the scenarios should be created considering the different levels of activity (from the most active to the most passive) and the selecting of technologies (including in the production sphere) that would impact in how the content is perceived by each person.

Thus, the encounter of both theoretical fields helps to explain the platforms of work and of circulation, the themes and the possible spread of the audience in each environment and platform delimited by the Producer. On its turn, the act of delimitation is informed by the data arisen from the creation process (HCI axis) and the data referring social and cultural uses and appropriations (Audience Studies).

3 Affordances

As shown by the description of the AD workflow, how the designer or producer aim their production to reach the different levels of AD-assigned roles, and how they are related among themselves, rely upon the content, technics and interfaces that fulfil the objectives individually defined by each person. Those objectives correspond directly to the way people get involved with a production (privately or publicly, passively or actively, as spectator or as co-producer). This requires the individuals to bare a 'set of

competencies' adequate to the technological affordances made available by the audio-visual product and its interfaces.

Such conclusion comes from a discussion common to HCI studies, that observes the better technology learning methods and the perception of resources available in or offered by digital technologies. It is a practicality that good designs, whichever of products, interfaces or systems, must be intuitive, with reduced mental load to the user [7; 8], inside the technological and intellectual limits and the story's aims. Thus, it is pursued a fast, automatic comprehension of the resources in each interaction artefact or device. Inside HCI, this discussion is centred around the concept of '*affordance*'.

The term comes from the ecological psychology, and was proposed by James Gibson [9; 10] to explain the possibilities of action offered by an environment to a given actor. The author developed a theory of perception applied to every animal, including human beings. According to him, animals can perceive how much they can use of and interact with the environment. The available signals that can be recognised by the animals are called 'affordances'. Hence Gibson came to conclude that affordances are physical properties of the environment, meaning they can be objectively measured and studied, as well as the information available for perception. 'The central question for the theory of affordances is not whether they exist and are real but whether information is available in ambient light for perceiving them' [10]. The affordances do not automatically present themselves to the actors, but must be uncovered through perception and learning. This process '...may require much exploration, patience, and time' [11, p.17].

Norman [7] expanded this line of thought to the design, to explain how important is to keep the products with a simple and intuitive design to use and learning. The author agrees that affordance is a characteristic of the object, and it rests upon the person to notice it to interact with (or to adequately use). However, to Norman (as well as to Gibson) the affordance does not depend on the personal perception to exist, it remains latent until it is necessary in a context. According to Norman, an essential part of the intuitive design refers to the perception. It is not enough a good design be rational and logical. Excellent and intuitive designs are those that allow one to see, directly and correctly, what is possible to do with the designed thing.

Other authors, however, noticed that the good and correct use of complex systems required more than the mere existence of *interaction triggers*. Affordance is then, when one considers human interaction, a relative feature of the environment dependent on the person's perception, which includes previous knowledge, social insertion, cultural aspects, etc. Thus, the affordances may vary circumstantially from person to person, being *real* (those accorded to the environment), *false* (erroneous indications of possibilities of interaction) and *perceived* (assimilated by the person) [7].

From the role of Norman's affordances in supporting the user during an interaction, Hartson [12] proposed a classification into four types, reflecting the users' processes and the type of actions undertook when performing a task. Norman's *perceived affordance* thus becomes a *cognitive affordance*, helping users with their cognitive actions to identify the tool's features (recognising what it is and what it is for). The *real affordance* turns into the *physical affordance*, aiding users in their physical actions (e.g., pushing, pressing, rolling, etc.). Then we have the *sensory affordance* playing an important role in the design and evaluation of the interaction, to assist the users with

their sensorial actions (such as to see and feel). The fourth type, the *functional affordance*, relates the use to the utility (how the action enabled a given result).

These four types of affordances can me mapped back to Norman's action model: the act of passing from an intention of interaction – or identification of opportunity – to the planning of a sequence of actions requires *cognitive* and *sensory affordances*. *Physical* and *sensory affordances* are related to the execution of this sequence of actions: the *sensory affordances* are associated with the perception of the state of the world, while *cognitive affordances* are necessary to interpret the perception.

3.1 Media affordances

In a wide perspective inside the AD, first the Producer must develop the *functional affordances* to incite the individuals' interest and call the attention to the programme. How the other AD-assigned roles evaluate the content – whether it deserves audience, synthetisation or improvement – rely on the adequate awareness of value, including subjective elements related to informational value or potential entertainment, and available resources of participation, interaction or sharing. Now, in a narrower perspective, the analysis of the content and of the interaction are directly linked to the individual's level of activity. The alternation of roles depends on the correct perception of *physical affordances*, which are associated to the environment and can be:

1. physical, composed by technologies used for content fruition, e.g. the remote control, mouse, virtual keyboards, computer screens or TV sets. This environment is relevant because it conceals or reveals the *physical affordances*, also impacting on the *sensory* and *cognitive affordances*. Depending on the context, some affordances may not be noticed, otherwise they may prevent action (E.g. an interactive TV show that requires a user subscription and the activity is too complex to be done with the remote control, demanding – in an ideal scenario – the use of a keyboard connected to the TV set).
2. of interactional graphic interfaces, such as interactive TV menus or the 'share buttons' in on-demand video systems. This has always been a paramount subject to the development of interactive TV, since the deficiency in digital culture (the impossibility of perception of *physical affordances*, consequently eliminating the *cognitive* and *sensory* ones) derail the use of complex interaction interfaces by people without the technological and relational knowledge of internet [13].
3. symbolic narrative, where *physical affordances* are subtler, and *cognitive* and *sensory affordances* rely not only on technology and interfaces, but also on the comprehension of narrative elements. As example, the cues and cliff-hangers from a character in a drama serial, aiming at the action of one AD-assigned role, or the call to action of a host in a programme, asking for the action of Synthesisers. In this case, the *physical affordances* can be the voice, a song, an image compounding a scene, or a set of actualities that stimulates curiosity (that is, a *cognitive affordance*).

As for the *sensory affordances*, they present two important functions. First, the mediation and link between the *physical* and *cognitive affordances*, which are necessary to identify its goal and associate it to a possible outcome. Second, the perception of the

elements that describe the affordances, which can be visual, sonorous or tactile. Putting these three affordances together is central to the different degrees of action, inherent to each role the individual performs.

Affordances determine the level of interaction within a given workpiece, analysable in accordance with the *axis of comprehension*. Through the HCI axis, the level of engagement and action facing a technology diminishes in each role, inclining to inertia[1] in the Audience role – e.g. when the person only watches TV comfortably, almost without any taking action towards the technology. However, following this scale, the inertia can be total in moments of total distraction, when the viewer does not pay attention to the programme and use the TV set as an environmental sound or company [14]. Therefore, the design of the audiovisual product starts from a whole participation (creation/production) to a continuous reduction of actions. As the line advances, the strategic functions of the HCI resources drop, while the relevance of Audience Studies increases.

On the other hand, the axis of comprehension through Audience Studies involves the increasing engagement and action with the technology, as the individual develops a more active attitude as the roles advance. This is to say that this line starts at the inert Audience posture to a higher activity level in every role. The peak of engagement or action is the creative and productive act performed by the Modifier or the Producer. The same occurs when one tries to understand the narrative complexity and the production process domain. While the Audience role does not require abilities and competencies related to production, the roles with greater activity entail complex actions facing technologies and markets. In this case, the peak of activity is represented by the Players role, who use the most of each resource available to each role they are connected to.

Affordances, as approached in the design of the audiovisual product, are responsible for the calls to action or to inertia, so they form the triggers for activity or relaxation. Therefore, we may have Triggers of Action (ToA) and Triggers of Inertia (ToI), which must be considered and included in each phase of the design of a production. The ToA can be composed by elements of visual signalling, storytelling motivation, narrative curiosity, voice or call for action from a character, desire for more information, game challenges or scavenger hunts, etc. They are subject to a coherent and combined use of the four types of *affordances*, since comprehension issues related to any affordance, even if partial, can compromise the experience. On the other hand, ToI normally are present in central points of the story, requiring the Audience role to present a high level of attentiveness. In this case, the perception of ToI may be unconscious, thus not demanding any *functional affordance*. In other cases of increasing inertia (e.g., when the Modifier changes their role to the Synthesiser), the difference of action and of reach of action are conscious to the individual.

Analysing the axis of comprehension through Audience Studies, one may note that the first ToA are already present in the Audience role, allowing the change into the Synthesiser role. To understand the functioning and reach of the action of sharing represents an initial competency of this role. The *functional affordances* are more relevant

[1] In this essay, the word 'inertia' differs from the concept of passivity, broadly discussed in the Communication Theories. While the second refers to how people introject the content, the former refers to the perception and action in response to triggers and related affordances.

in this scenario, since they enable the decision-making process related to the value and the outcomes of the interaction. Yet, to move from the roles of Producer, Modifier or Synthesiser to the role of Audience requires ToI, which can be a process more difficult to design.

Finally, it is important to highlight that, to the AD, the comprehension of the available interaction resources goes through the Hartson's four types of affordances [12]. The meanings, especially of *physical affordances*, must be introjected by the individuals. The complexity showed in the production and in the enjoyment of contemporary audiovisual works, inherent to the spreadable communication model mentioned above, rises as many persons perform the five AD-assigned roles, simultaneously or in alternated moments. As a result, the roles with greater action level must help the development of perception by the roles of greater inertia.

Besides, the *folksonomy* – the moral economy that drives a great deal of actions and can be considered a motivation for acting in roles of greater action level – also discuss the expansion of meanings among people integrating the same network. The circularity of production, providing that the Producer appropriates and replicates contributions by fans that are, on their turn, Synthesisers or Modifiers, is an important and efficient key especially from the second level on (Synthesisers). The outcome of such appropriation improves the entire chain of the audiovisual production, with a design adequate to all roles; including the Audience, that although shows the lesser contribution to the improvement, benefits from the different product generations or versions.

4 Learning the affordances

The initial conceptualisation of affordances presumed learning as unnecessary [9]. By looking at an object one should be able to promptly and mechanically know how to use it. According to Kaptelinin [8], this is the main reason why the term rapidly disseminated amongst HCI designers and planners. Such understanding still valid for the Audience role, given that the action of watching TV or enjoying an audiovisual workpiece, for example, does not rely on complex technological abilities or competencies. The presence of *physical affordances* is limited, being representative for the AD only when the Audience is changing role to Synthesiser, or when the Audience-Player role makes use of interactive tools.

Facing the new communicational affordances originated in the contemporary media ecosystem, it is natural to individuals that they show new competencies (new sets of abilities, knowledge, capacities and behaviours) or that they develop those culturally and psychologically rooted. Abilities are acquired and developed from the intention of the individual to act or react to a situation, thus shaping his or her behaviour during the action in which he or she is engaged.

The learning also takes place through the action of the Producer, who uses the AD to create strategies for the individuals to acquire knowledge and abilities that shall support the intentions and competencies necessary to alternate between roles. Included or not in the Producer's strategy, other learning scenario is the relationship among people, who use formal or personal channels to exchange knowledge and experiences about the

fulfilment of phases and processes inherent to the mediatic product. Consequently, the *functional*, *cognitive* and *sensory affordances* may be referred to in terms of interaction contexts, since the exchange of information between people improves the overall comprehension.

The assemblage of a media environment that explores the learning through the support itself – for example, the audiovisual media – is part of its own development. For instance, the first cinema in the beginning of the 20th Century had 'lecturers' and 'explicators' during the screening, to introduce the then new media affordances to the public – so far little used to the new format. In today's movies, trailers and teasers tangled with marketing actions afford people to acquire knowledge and capacities to the moment when the movie is brought into fruition.

About the learning and use of software, resources such as visual presentation and tour over the validation environment are common, aiming to introduce the set of phases and process of use, using both native resources and advanced devices such as cameras, microphones and sensors. The relationship between audiovisual media and computational software can be illustrated by digital games that supply the person with presentation or introductory sections, test of resources and the exploration of the technical and conceptual environment simultaneously, allowing the individual to establish aptness levels to expand their enjoyment and trigger the alternation of roles.

The affordances of a complex interactive audiovisual product must presumably be adaptable to be intuitively learned by the targeted public, and harmonic to the narrative's general universe. This relation is understood under two scenarios, 'Design *in use* and *for use*', considering that the Producer offers an environment with designed affordances. Even so, the exploration of the environment falls upon the individual, who may fully or partially comply with it, or even aggregate new meanings. In extreme situations, the individual can notice affordances that were not planned by the Producer, making the enjoyment of the audiovisual product even more complex. Concerning the Player, the constant quest for novelties encourages the creation of new affordances – thus increasing the storytelling power. Subsequently, learning the affordances (especially the *cognitive* ones) is important for a good experience in each role took by the individual.

The learning process can also be developed through conceptual approaches – e.g. Media Literacy – which propose the teaching of social, economic, technical and cultural aspects of media usage, to expand the competencies of access, analysis and creation of content. As an example, we may cite HCI methods currently applied for technological teaching and learning within Public Health-related disciplines. The teaching of skills to conform with the media affordances can be parametrised in measures taken to enable mediated medical interventions, as well as ongoing researches that promote content for people with special needs.

To conclude, the complex nature of the relationships between affordances and individual can be addressed through the contributions to the interaction design by the theory of activity[2], which considers each element via the encounter of distinct levels: Artefact

[2] The notion of affordance is not really developed by the activity theory, but this approximation is important for the AD, to understand the complexity of possible actions within each role.

> Tool > User interface *Versus* User < Worked < Human Being [15]. That is, the Producer constructs an artefact, with a set of affordances to the individuals, but they construct their connection to the media in accordance to their human factors (motivations, experiences), and conduct the action to attain objectives and activities. This way, the *in-use design* can differ from the scenario predicted by the *for-use design.*

5 Conclusion

This essay has introduced the concept of affordances in the Audiovisual Design methodology. The term is central and necessary for the comprehension of the actions the individuals can take when they occupy each role assigned by the AD. It is also important for planning the audiovisual product, both in terms of production – when the affordances become a tool of action or inertia – and in terms of engagement innate to the Synthesiser and Modifier roles. The affordances can be understood as characteristics of an object that can be perceived in its integrity, or that must be complemented by the individual's perception. This analysis is not central to the AD, since the model focuses on the triggers for alternating roles: a reduction to a level of greater inertia, or a progression to roles of greater activity and engagement.

The contemporary media ecosystem, by converging different media in the same environment, dominated by digital technology, brings within it a new demand for interaction, resulting in the rise of new affordances, related to the use of interfaces and computers. Therefore, the field of studies of HCI contributes with the analysis of situations in which the media consumption takes place, providing methodologies to underline and explain which are the new affordances and how the audiovisual production must be organised around them. Therefore, it becomes possible to predict, during the design of the programmes, content and the interaction interfaces, actions to be taken by individuals. The problem-solution chain of HCI allows the advent of a complex use of different media and platforms, by indicating the potential features of each content-distribution channel.

Future works shall focus on how the Producers must address to unpredicted uses and appropriation of the technology and content, which is already suggested by the theory of activity and the contrast between the *design for use* and *design in use*. Such study will help to further develop the behaviours and competencies related to the Player: the role responsible for taking the most extreme actions when consuming the audiovisual product. Also, future investigations must apply these theories into concrete productions and analysis of actual content, especially to show how competencies are acquired by individuals, and how media affordances can be transformed into real, viable tools.

Although the AD methodology considers the currently available technologies, we must keep an open plan to incorporate new social and technological dynamics that can modify the proposed workflow. We also understand that economic restrictions can render inviable the complete application of this methodology in its full version in every audiovisual production. Nonetheless, the Audiovisual Design remains a valid methodological set since it allows to contemplate every phase of the design process as an iso-

lated process. Also, it adds elements to the debate about the formation of the professionals who will produce this type of content, demonstrating the need for a revision of scholar curricula, especially in careers of audiovisual production, which currently does not contemplate disciplines important to the producer of content for interactive systems.

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Television consumption in the extreme points of Brazil: a macro-social overview of the scenarios under study

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Abstract. This paper presents a macro-social overview of the media ecosystem in Brazil, specifically about the digital television and internet penetration in urban and rural areas of two strategic points of the territory. For that, we related contextual data of a national research conducted by the Brazilian federal government (PNAD 2014) with four large processes that characterize the TV digitalization in the country. Taking into account that the objective of our research is to map the current consumption practices of Brazilian young people, the quantitative data analysed were fundamental to build the "information system" of the research and to guide the qualitative field research that is in progress. This is in line with the authors who recommend that, even in strictly qualitative research, such as the one we are performing, the data constructed in the field need to be permanently combined with macro-social data about the phenomenon under study.
Keywords. Communication, Digital TV, Contextual data, Brazil.

1 Introduction and "open system of information" of the research

Taking into consideration the complex scenarios of television consumption today and the existence of new *communicative configurations* [1], produced by the media digitalization process, [2] makes recommendations for the development of reception studies that deal with the "complexity of interactions with the screens." Among these, the author argues for an articulation between different lines of investigation that come from the academia, market data and governmental statistical studies.

In a similar direction, [3] recommends that, as we begin an investigation, we set up an "open system of information", i.e. an initial framework of information needed for understanding a given reality under investigation. This system refers to both a characterization of the empirical reality we intend to observe in a qualitative way and to a contextualization of the topic under investigation in a given field of knowledge. [4] argues that, even in strictly qualitative research, such as ethnographic studies, the analyses constructed based on observation need to be permanently combined with macro-social data (historical, economic, demographical, social data) about the scenario and/or phenomenon under study, to understand it across time and space.

Therefore, following the authors recommendations regarding the appropriation of official statistical data and the establishment of a previous macro social overview of

the scenario under study, we have been working to structure our "open system of information" taking into account the scope of our doctoral research, which aims to identify and characterize the TV consumption practices of Brazilian young people (from 15 to 24 years old), based on a qualitative study in two strategic regions of Brazil, specifically in rural areas located in the countryside of the state of Pará (PA), Northern Region, and the state of Rio Grande do Sul (RS), Southern Region. The capital cities of these states are, respectively, Belém and Porto Alegre.

In this paper, we shall present the results obtained based on one of the steps undertaken to build that system: a macro-social overview of the scenario under study based on the description of quantitative data from the 2014 Brazilian National Household Sample Survey [5], which were related with the movements that, according to our understanding, characterize the process of a (re)configuration[1] of television consumption in Brazil.

This exercise, in addition to putting in perspective the scenario of ownership of technology and internet access in Brazil, enables us to observe, in a comparative way, the data related to the states of Pará and of Rio Grande do Sul, thus it has been key to the outline of research goals and to guide the qualitative field research that is in progress. According to [2], the contact with these data is still rare in reception ethnographies and, when used, provides the study "a better view of the country and of society", thus enabling us to "better understand its interactions with the screens".

This text was structured in two axes besides this introductory text. These axes explore: (i) the aspects about the Brazil's TV market, in which we detail the penetration of TV and internet in Brazil based on contextual data from IBGE; and (ii) our initial findings, arisen from the relation between contextual data and the dynamics that characterize the digitalization process in Brazil.

2 Aspects about the media ecosystem in Brazil

In the current scenario of the much-celebrated *media convergence* [6], naturally the "boundaries" between the technological devices and the forms of production, availability and fruition of audiovisual content are "blurred" and become, at a first glance, apparently complicated. There is, from our perspective, a kind of confusion in relation to the new technological possibilities of screening, interaction and consumption of television content available on the market. Though convergent, all of these technological features and, in their turn, the communicative interactions shaped in the contexts of production and of consumption present unique differences.

These singularities might be considered as we strategically think about the production of content, especially when we investigate the way people relate and appropriate different technological features of interactivity and possibilities of fruition of content based on multiple connected screens available on the market.

[1] We graphically highlight the word configuration using the prefix "(re)" because, although we recognize that there are considerable changes in the way TV is produced and "watched", we know that, for younger generations, the habit of watching TV may have started in a scenario of multi-screen and on demand content offer and consumption, what differs from the experience of previous generations, in which "TV established itself as the 'epicentre of audiovisual'" [7].

In the Brazilian System of Land Digital Television (ISDB-T), for instance, in addition to the digitalization and the resulting improvement of image and sound quality of the television sets, the following actions are planned: (i) expanding the broadcasting bands considering the greatest number of spectrums available in the digital technology; (ii) including interactivity features based on Ginga[2] middleware, via remote control; (iii) circulating content of the television listings on mobile and portable devices based on the broadcast band *One-seg*[3], among other possibilities.

The potentialities of the "new Brazilian TV" have enabled new consumption practices beyond the audience of a continuous flow made up of the current listings of the TV channels in the country, in line with the phenomenon of "demassification" pointed out by [8]. Nevertheless, the implementation of the Brazilian system has taken timid steps that are limited to improving image quality and, this way, it is a technology that is not widely known by the population at large. On the other hand, a considerable part of Brazilians has already experienced new forms of media consumption, either on Video on Demand (VoD) as *YouTube* and *Netflix*, or through interactions with the audience of a given show on social media simultaneously with the screening of contents from the flow, including that of free-to-air (FTA) TV.

As previously detailed by [9], based on a literature review, we have identified at least four large processes, which have contributed to a reconfiguration of television consumption in Brazil: (1) the implementation of the ISDB-T, which is a result of a set of governmental policies aimed to bridge the digital divide in the Brazilian population; (2) the digitalization of subscription TV services, which now offers different forms of availability and consumption of their content (own digital converters and also own Video on Demand platform); (3) the selling of Smart TV models by big manufacturers from the audiovisual industry; (4) the growing number of VoD services for watching content of different genres and formats (many of which are television types) on multiple screens.

As we can see, the identified processes reveal new possibilities of TV content availability and offer (live or time-shifted), which is one of the most important founding elements of the "television experience"[4]. In addition, the internet access rises as one of the main elements of the (re)configuration of television consumption. In that sense, we start the description of our scenarios by showing the data related to internet availability and the most frequently used devices and connection conditions (dial-up, fixed or mobile broadband). After that, we shall analyse the data related to the presence of television in Brazil and in the regions/states within the study.

For that, we summarized the data in Table 1:

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[2] Middleware developed by Brazil that enables the interactivity applications available in ISDB-T.

[3] It is a service of land transmission of sound and image to mobile devices according to the Japanese model of digital TV adopted in Brazil.

[4] We understand, based on [10, 11] that it is not limited to characterize the content produced and screened traditionally on TV sets, but to the *"mediacidad"* (mediacy) of this medium and to a space of negotiation and mutual recognition of pace, forms of telling stories, etc. It is about a load of meaning established in the everyday and ritualized experience of contact, as viewers, with a specific grammar of TV content. The research focus, however, is not to analyse the "television experience" based on the use of second screens [12, 13] or multi-tasking practices while watching TV [14, 15, 16], but to observe different associations of the components which outline the contemporary "television experience" (kind of content: genre/format and live, time-shifted or on demand; providers: broadcast or online platforms; multiple screens, synchronized or not).

Table 1. Percentage of media penetration in Brazil (type of device, type of internet connection, type of TV signal and type of TV set available) [5]

Data/Location	Brazil			Northern Region					Southern Region				
Types of devices for internet access	Total (%)	Urban (%)	Rural (%)	Total (%)	Urban (%)	Rural (%)	PA (%)	Belém (%)	Total (%)	Urban (%)	Rural (%)	RS (%)	POA (%)
Absolute number of municipalities (1000 units)	36 814	35 074	1 740	2 202	2 073	128	936	400	5 981	5 559	421	2 403	1 035
Desktop computer	76.6	77.6	56.7	50.5	50.9	43.9	40.6	48.0	83.2	84.0	72.6	79.8	80.3
Desktop computer only	17.4	*	*	7.0	*	*	4.4	4.0	23.6	*	*	23.6	19.4
Tablet	21.9	*	*	12.0	*	*	10.2	12.5	21.1	*	*	20.8	25.1
Tablet only	0.5	*	*	0.2	*	*	0.1	0.1	0.5	*	*	0.6	0.5
Mobile phone	80.4	80.9	71.9	92.5	93.0	84,4	95.3	95.8	73.7	74.9	58.0	73.1	77.2
Mobile phone only	21.0	*	*	47.6	*	*	57.4	50.1	15.1	*	*	18.5	17.9
Tablet and mobile phone	82.4	*	*	93.0	*	*	95.6	96.0	76.2	*	*	76.1	80.3
Tablet or mobile phone only	23.1	*	*	49.3	*	*	59.3	52.0	16.6	*	*	20.0	19.6
Connected TV	4.9	*	*	1.6	*	*	*	*	6.1	*	*	*	*
Types of connection	Total (%)	Urban (%)	Rural (%)	Total (%)	Urban (%)	Rural (%)	PA (%)	Belém (%)	Total (%)	Urban (%)	Rural (%)	RS (%)	POA (%)
Absolute number of municipalities (1000 units)	36 814	35 074	1 740	2 202	2 073	128	936	400	5 981	5 559	421	2 403	1 035
Dial-up internet access	2.8	*	*	3.30	*	*	*	2.8	2.8	*	*	*	*
Dial-up internet access only	0.80	*	*	0.7	*	*	*	1.0	1.0	*	*	*	*
Fixed broadband internet access	71.9	73.0	49.0	42.5	43.1	32.1	32.4	76.8	76.8	77.9	77.9	69.8	71.1
Fixed broadband internet access only	35.7	*	*	14.6	*	*	9.6	47.1	47.1	*	*	40.4	35.3
Mobile broadband internet access	62.8	62.8	62.9	84.2	84.8	75.4	89.9	51.1	51.1	51.5	51.5	58.3	62.6
Mobile broadband internet access only	26.3	*	*	55.0	*	*	65.9	21.4	21.4	*	*	28.6	26.5
Fixed and mobile broadband internet connection	35.5	*	*	27.4	*	*	22.7	28.9	28.9	*	*	29.0	35.2
Types of TV signal reception/ TV sets	Total (%)	Urban (%)	Rural (%)	Total (%)	Urban (%)	Rural (%)	PA (%)	Belém (%)	Total (%)	Urban (%)	Rural (%)	RS (%)	POA (%)
Absolute number of municipalities (1000 units)	65 122	56 489	8 633	406	3 647	959	2 107	632	10 056	8 675	1 381	4 005	1 516
TV subscription service (pay TV)	32.1	35.9	7.5	19.8	23.4	6.0	14.7	22.1	32.5	35.9	11.2	35,9	48.0
TV subscription service only (pay TV)	7.4	*	*	3.9	*	*	3.0	2.8	6.4	*	*	7.3	7.5
Digital signal of free-to-air TV	39.8	43.5	15.7	32.1	37.3	12.6	26.4	48.6	41.5	45.2	18.3	43.5	60.8
Digital signal of free-to-air TV only	11.7	*	*	12.8	*	*	12.1	27.2	11.3	*	*	11.3	19.5
Parabolic antenna signal	38.0	31.8	78.5	43.7	34.0	80.8	43.2	8.4	40.7	35.5	73.5	34.0	12.5
Parabolic antenna signal only	22.6	*	*	30.7	*	*	32.3	2.2	22.6	*	*	17.5	2.4
CRT tube TV and flat screen TV set	22.1	24.0	9.4	14.8	16.8	7.3	*	*	28.7	30.5	17.0	*	*
Flat screen TV set only	33.6	35.8	19.5	32.0	34.5	22.5	*	*	30.3	32.2	18.5	*	*
CRT tube TV set only	44.3	40.2	71.1	53.2	48.7	70.2	*	*	41.0	37.3	64.5	*	*

2.1 Contextualizing internet access within the scope of the research

According to the data from the 2014 National Household Sample Survey (PNAD) [5], detailed in Table 1, 54.9% of permanent[5] private Brazilian households have internet access, which corresponds to almost 60% of the population. By comparing the regions studied in our doctoral research, we have observed that while 58.3% of the households in the Southern Region have internet access, only 44.6% of the homes in the Northern Region count on such access. With respect to population, however, the Southern Region has 10.5 million people with no internet access at home, while in the North there are around 9 million people in this situation[6].

We should observe that, of the almost 120 million connected Brazilians – 18.4 million in the South and 8.1 million in the North, according to [5] –, over four million have no income or have an income of one quarter of a minimum wage.

In the case of PA, household internet access (41.3%) is lower than the average in the Northern Region (44.6%). By contrast, in the Metropolitan Area of Belém the percentage of connection reaches the threshold found in the Southeastern Region, showing 62.9% of connected households. It is noteworthy that in the context of the Northern Region, Pará ranks 6th place among the seven states with the lowest number of households with internet access, only ahead of the state of Tocantins (TO), which has just 37.3% of connected households.

In RS, internet access is a reality for almost 60% of the households, corresponding to 65.3% of dwellers, according to Table 1. As in PA, the Metropolitan Area displays a higher level of access when compared to the rest of the state, showing 67.5% of households and 72.8% of the population being online. The Metropolitan Area of Porto Alegre, by the way, is the most connected area in the Southern Region and, in Brazil, it is only second to the Metropolitan Area of São Paulo, which has 71.3% of households with access.

Comparing the household access data for the states of Pará and Rio Grande do Sul, the difference is 17.7% more connected homes in RS and around 21.1% more dwellers included. When we compare the realities of the Metropolitan Areas, the percentage gap between the connected populations drops to 5.9%, as Belém shows 66.9% while Porto Alegre has 72.8% of their dwellers with internet access.

The most frequently used means to access the internet are the mobile phone and the desktop computer, which are present in 80.4% and 76.6% of the Brazilian households respectively. Tablet is the third most frequently used means of access to the internet, present in 21.9% of the Brazilian homes.

In the Northern Region the mobile phone reaches rates above the national average, even in rural areas. While in the South internet access by mobile phone is a reality for 73.7% of the households – 74.9% in urban areas and 58% in rural ones –, in the North 92.5% of homes are connected to the internet on their mobile phones – 93% in the cities and 84.4% in the countryside. Differences become even sharper as we compare

[5] According to the categorization by [5], the households may be: own and already paid for, own and being paid for, rented, granted or "other" (which does not fit irregular occupation).

[6] The total populations of the Southern and Northern Regions – considering the numbers of [5] – are, respectively, 29,036,620 and 17,232,190, so the percentage of digitally excluded individuals corresponds to approximately 36.2% in the South and 52.6% in the North. It is worth mentioning that, according to [17], the population estimate is: 29,422,507 (South), and 17,659,399 (North).

the access percentages in PA and in the Metropolitan Area of Belém to those reached in RS and in the Metropolitan Area of Porto Alegre. In PA and in the Metropolitan Area of Belém, connection percentages by mobile phone in households are, respectively, 95.3% and 95.8%. In the Southern Region, the percentage of this type of connection is lower than the national average, in both RS (73.1%) and in the Metropolitan Area of Porto Alegre (77.2%).

Differently from the data from [18], internet access made from a desktop computer is a reality, according to [5], for 76.6% of Brazilian homes and, of this total, 77.6% are located in cities, while 56.7% are in the rural areas of Brazil. In the Southern Region, internet access from a desktop computer is even more frequent, as it is present in 83.2% of the households — 84% in the cities and 72.6% in rural areas — and in 79.8% of Rio Grande do Sul's homes and 80.3% of the homes in the state capital city. When we turn to the data about the Northern Region, the national average drops more than 20%. Internet access from a desktop computer happens in little more than half of the region's households, 50.9% in the urban areas and 43.9% in rural ones. In PA, these shares are even lower: 40.6% in the state and 48% in the Metropolitan Area of Belém.

Considering the data presented in Table 1, we can observe that, in the Southern Region, the use of different means of internet access is more balanced than in the Northern Region. Mobile phone, for example, a technology that lower income population can afford, stands out as the only connection device in 47.6% of the Northern homes, which corresponds to almost half of the population in the region (49.1%). In PA and in the Metropolitan Area of Belém, these percentages reach 57.4% and 50.1% respectively. Meanwhile, in the Southern portion, 15.1% of the households use the mobile phone as the only means of connection to the internet.

Nationwide, the type of connection that is most frequently used is fixed broadband (71.9%), followed by mobile broadband, used in 62.8% of the households. As we compare the households located in urban canters with those from rural areas, this reality is very different. On the one hand, 73% of urban homes have internet access by fixed broadband and 62.8% use mobile broadband. On the other hand, in rural areas a majority of households (62.9%) use a mobile type of connection, while just 49% have fixed broadband.

When we compare the Northern and the Southern Regions, connection types also vary to a great extent. In the Northern Region, household access is mostly related to mobile internet (present in 84.2% of Northern homes, being 84.8% in urban areas and 75.4% in rural ones) and not to fixed broadband access (found in 42.5% of the households in the region, being 43.1% in urban areas and 32.1% in rural ones). By contrast, the most common type of connection in the South is fixed broadband, present in 76.8% of households (being 77.9% in urban and 62.2% in rural areas), followed by mobile broadband, available in 51.1% of the homes in the region (51.5% in urban and 46.2% in rural areas).

As we analyse the data in the Brazilian states and in their Metropolitan Areas, the types of connection follow the same pattern of internet access found in the regional contexts. In PA and in the Metropolitan Area of Belém, the most common household internet connection type is mobile, present in almost 90% of the homes in both cases, while only 32.4% and 43.7% of the households in the state and in the Metropolitan Area have fixed broadband respectively. In RS and in the Metropolitan Area of Porto

Alegre, the main internet access type is fixed broadband (69.8% in the state and 71.1% in the Metropolitan Area), while mobile access reaches 58.3% in the state and 62.6% in the Metropolitan Area.

This remarkable difference justifies the percentage of 35.5% of Brazilian municipalities that have both fixed and mobile broadband. That means that significantly less than half of the Brazilians (only 35.1%) have both types of internet access at home, which makes a lot of difference when we think about the new possibilities of watching TV. In the Northern Region and in PA, the percentage of inhabitants that have both types of connection at home is 26.9% and 21.7%, while in the South and in RS this percentage is a little over 28% in both cases. As we compare the two Metropolitan Areas, the realities are closer, as 33.2% in the Metropolitan Area of Belém and 34.7% in the Metropolitan Area of Porto Alegre have both mobile and fixed broadband.

However, when we take into account the data of households that have internet only through mobile broadband within the scope of the study, the Northern and the Southern Regions distance themselves again. It is noteworthy that more than one fourth of Brazilian connected households, which corresponds to 27.6% of the population, have mobile connection only. In the Northern Region, the percentage of people who have this type of access only goes up by 56.6%, being 67.8% in PA and 56.1% in Belém. In the South, the percentage is just 22% of its dwellers, being 30.1% in RS and 27.9% in the Metropolitan Area of Porto Alegre.

2.2 Contextualizing TV ownership within the scope of the research

In relation to technology access in Brazilian households, it is noteworthy that only 39.8% of the homes in the nation receive FTA digital TV signal (ISDB-T), as [5].

Considering the reception of the digital signal in urban and rural areas separately, the access shares account for 43.5% and 15.7% of Brazilian households respectively, according to the categorization by region in Table 1. That means that not even in the Brazilian urban centres the digital TV signal reaches half or more households.

In the Northern Region, the percentage of digital signal reception is lower than the Brazilian average in all cases, except for the Metropolitan Area of Belém, where the digital signal is a reality in 48.6% of the households. In PA, for instance, only 26.4% of the households have digital reception, being second to the state of Tocantins only, where 18.1% of the households have such signal reception. In RS, however, the digital signal reaches 43.5% of the homes and 60.8% in the Metropolitan Area of Porto Alegre, revealing an access condition that is completely different from the Northern Region — in fact, the condition in the Metropolitan Area of Porto Alegre is a leading position in terms of digitalization in Brazil[7].

Although the realities of access in the extreme points of the Brazilian territory are very diverse, it is interesting to notice that, as we analyse the rural areas in the Northern and Southern Regions, the shares of digital TV coverage reach, respectively,

[7] In the Federal District 62.6% of households have digital TV, so Brasília (Brazil's capital city) may have a percentage that is higher than São Paulo and Porto Alegre, but the data available by the 2014 PNAD do not consider any Metropolitan Area in that district.

12.6% and 18.3% of the homes. These data reveal to what extent the process of digital TV implementation in Brazil is concentrated in its capital cities, which makes realities of access that are completely different become similar and present common difficulties, characteristic of the extreme points of the territory.

Another piece of data that brings these extreme points together is the percentage of rural households that have just CRT tube TV sets in the North and in the South of Brazil, which accounts for 70.2% of the Northern homes and 64.5% of the Southern ones. The difference between these shares is very small when compared to that of households that have both analog and more modern flat screens, being 14.8% in the Northern Region and 28.7% in the Southern Region.

To make this comparison between the regions more complex, it is interesting to highlight that, in the case of households that have flat screen TVs only, the Northern Region is slightly ahead of the Southern Region in terms of having access to up-to-date devices. While in the Northern Region 32% of the households have flat screen TVs, 22.5% in rural areas, in the Southern Region the percentage is 30.3%, 18.5% in the rural areas. We can also see how close the percentages of households that receive TV signal by parabolic antenna are. While in the Northern Region the percentage is 43.7%, in the Southern Region it is 40.7%. The data are also similar when we observe the urban and rural areas separately, being 34% in the cities in the Northern Region and 35.5% in the Southern Region, and 80.8% in the rural areas in the North and 73.5% in the South.

Yet when we observe the number of households that receive the TV signal from a parabolic antenna only — likely due to the fact that they are located in places without coverage of some free-to-air TV channels — the Northern Region is again at a disadvantage, with 32.3% of PA households only watching TV from a parabolic antenna, while in RS this is a reality for 17.5% of the homes only. In terms of population, this means that more than 33% of Pará citizens today, despite the ongoing digitalization process in Brazil, do not have access to open free-to-air TV signal in their homes.

Finally, the percentage of households with pay TV is noteworthy in Brazil, reaching around 32%. Between the Northern and the Southern Regions, the difference in access is significant, being 32.5% in the South, above the Brazilian average, and 19.8% in the North. In the Brazilian states and in the Metropolitan Areas studied, the difference between these shares increases, being 35.9% in RS and 48% in Porto Alegre, and 14.7% in PA and 22.1% in Belém.

3 First findings based on the contextual data

We believe that the contextual data on the access to the internet and to technology devices, above all TV sets, in Brazilian households and in the regions that make up the scope of the study, are essential to guide the qualitative and comparative investigation that we intend to undertake in the our doctoral research dissertation. From this "bird's eye view" of the realities that are analysed based on the quantitative data from the research reported herein, it is already possible to verify clear signs of a process of (re)configuration of television consumption.

In addition to the significant expansion of internet access in the North and in the South of Brazil, the profile of ownership and use of technological goods has become more diversified among Brazilians, even in the extreme points of the national territory and among the poorer layers. However, an initial analysis points out a concentration of these types of access in urban centres, especially in more developed regions, which work as "pathways" for the offering and consumption of media and cultural products.

It is undeniable that a considerable part of Brazilians experience today practices of media consumption that are completely different from those of a decade ago, above all in relation to television reception, which is no longer limited to a single environment. Unlike years ago, the choices for watching and consuming these content are so many that they do not even require a TV set and do not need to happen in the living room at all. The present is all about a convergence of media supports and, as a consequence, of new dynamics in the context of *communicative mediations of culture*, especially in relation to the *technicity, rituality and sociability* [19].

Combining and relating those contextual data with the four processes that have contributed to a reconfiguration of the scenario of television consumption among Brazilians, we have analysed data that have helped us characterize the goals of this study. With reference to the first process, related to the digitalization of the Brazilian free-to-air TV, it is noteworthy that only 39.8% of the households receive the free-to-air digital TV signal. Digitalization, as observed above, is still concentrated in urban centres, especially in the Metropolitan Regions. When we observe the percentage of households with digital TV in rural areas, we find a very low reach in both the Northern and the Southern Region, accounting for 12.6% and 18.3% of the homes respectively. Moreover, in face of the scenario of media convergence, it is surprising that in the rural areas in the North and in the South are not included in the coverage of the free-to-air TV. This happens because 80.8% of the households in the Northern Region located in the countryside and 73.5% in the Southern Region use parabolic TV to receive the free-to-air TV signal, since not all TV channels have full coverage in the national territory.

In relation to the second process that has been identified, concerning the digitalization of pay TV, it is important to stress that the access to segmented television listings does not even reach half of the Brazilian population, being present in only 32.1% of the households. And, as seen above, the access percentages in the Northern Region are much lower than in the Southern Region.

On the access to TV sets that enable internet connection, this is a reality of only 4.9% of the Brazilian households, which corresponds to just over 5 million people, a number that is smaller than the total population of Pará, for example. Furthermore, for both processes 3 and 4, it is fundamental to bear in mind that, even though internet access may be growing in Brazil, around 71.9% of the national households have fixed broadband internet, but not necessarily the bandwidth is 2Mbps or larger [20]. This means that, of the total number of connected households, not all of them necessarily meet the minimum connectivity requirements to watch television content from VoD services.

With the analyses of the contextual data, it was also possible to base an exploratory field research performed in rural areas of Cametá (Pará) and Tavares (Rio Grande do Sul), between September and October 2016. As reported by [9] the groups of young people that were interviewed in both cities perform a kind of management of

the available screens (in both connected and offline conditions), which is a practice that tends to frame their interaction flows. In the places we have been – where there is less availability of internet access, especially in the rural areas of Cametá –, the practices are less frequent than for those with unlimited connection. However, it does not determine the way young people include these content in their daily practices, neither does it exclude them from today's media ecosystem or new consumption scenarios, announced by [1, 21, 22].

Taking into account that the main objective of our research is to map the current consumption practices of Brazilian young people as an attempt to outline typologies based on the "interaction flows" built by them, the contextual data presented in this text were fundamental to give us an overview, in a comparative way, of the multiple offerings scenario that we can find in rural areas of Pará and Rio Grande do Sul and to build the "information system" of the research, as recommended by [2, 4].

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El futuro de la TV IPTV integrada con la Inteligencia Artificial en la Gestión Socio-Sanitaria Integrada. "Disease Management"

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Resumen. Estamos de lleno en la tercera gran revolución de la humanidad, La Revolución Tecnológica, iniciada con el cambio de la tecnología analógica, mecánica y electrónica, a la tecnología digital encaminada hacia la singularidad, con cambios radicales provocados por la computación y las TIC y donde la materia prima es la información transformada en datos, bien sean estos estructurados como no estructurados. En medicina estamos yendo hacia la singularidad y el futuro de la medicina radica en la integración multidisciplinar con la genética y la biología molecular, la ingeniería biomédica (biotecnología), la inteligencia artificial, la robótica, y la nanotecnología.

Los pacientes con enfermedades crónicas, su manejo (gestión de procesos) y su tratamiento integral (atención sociosanitaria) representa uno de los principales retos actuales para los sistemas sanitarios de cualquier país. El avance en la gestión de las enfermedades crónicas y en la gestión de los pacientes pluripatológicos (pacientes con dos o más patologías crónicas), precisa de un cambio de paradigma de nuestros conceptos habituales de gestión de pacientes agudos dentro de los Sistemas Nacionales de Salud (SNS), y de que los marcos conceptuales actuales se transformen, de modo que, de manera integral, los ciudadanos, su entorno y sus necesidades sociosanitarias sean el centro real del sistema sanitario.

Actualmente con el gran desarrollo de los biosensores y de la computación ubicua (inteligencia ambiental) podemos transferir datos biológicos (ECG, Sat 02, Presión Arterial, Frecuencia Cardíaca, Temperatura…) y realizar diagnósticos a distancia mediante la uHealth y nuestra plataforma de uHealth, SiestaCare basada en los nuevos sistemas de TV digital por Internet (IPTV), siendo esta una herramienta clave en los nuevos modelos de gestión sanitaria integrada y en los procesos de atención socio-sanitaria y cuidado de las personas con dependencia. SiestaCare, nos permite ofrecer un conjunto de aplicaciones destinadas a los pacientes, y a los profesionales del sector socio-sanitario. A través de la interfaz intuitiva, se puede acceder a los distintos servicios de uHealth que van desde la

atención médica con Video-consultas, e-Chequeo y hospitalización en el hogar, hasta servicios de tele-educación para la salud, y sesiones clínicas entre profesionales con videoponencias, o emisión en 3D por videostreaming, lo que permite dibujar un escenario real de hospital sin barreras. En este escenario, el paciente está rodeado de sensores autónomos (básculas, tensiómetros, resgistradores de ECG, y otros dispositivos que pueden ser implantados en la piel o en tejidos, pasando por sensores ambientales de temperatura, humedad, posición, etc. que formando redes ad hoc, ya sean BAN (Body Area Network), PAN (Personal Área Network) y/o HAN (Home Área Network), adquieren y transmiten toda la información de interés. Además, la plataforma no está únicamente orientada al paciente, y los médicos, farmacéuticos y demás actores implicados en el cuidado de la salud pueden actuar en sinergia, mejorando la calidad asistencial y la eficiencia del Sistema Sanitario, que son los principales retos al que se enfrenta la medicina actual y del futuro inmediato.

Estamos de lleno en la tercera gran revolución de la humanidad, La Revolución Tecnológica, iniciada con el cambio de la tecnología analógica, mecánica y electrónica, a la tecnología digital encaminada hacia la singularidad, con cambios radicales provocados por la computación y las TIC y donde la materia prima es la información transformada en datos, bien sean estos estructurados como no estructurados. En medicina estamos yendo hacia la singularidad y el futuro de la medicina radica en la integración multidisciplinar con la genética y la biología molecular, la ingeniería biomédica (biotecnología), la inteligencia artificial, la robótica, y la nanotecnología.

Los pacientes con enfermedades crónicas, su manejo (gestión de procesos) y su tratamiento integral (atención sociosanitaria) representa uno de los principales retos actuales para los sistemas sanitarios de cualquier país [1, 5, 7, 10, 12, 13, 18, 21, 24, 25, 26, 28, 30, 35, 36, 40]. El avance en la gestión de las enfermedades crónicas y en la gestión de los pacientes pluripatológicos (pacientes con dos o más patologías crónicas), precisa de un cambio de paradigma de nuestros conceptos habituales de gestión de pacientes agudos dentro de los Sistemas Nacionales de Salud (SNS), y de que los marcos conceptuales actuales se transformen, de modo que de manera integral, los ciudadanos, su entorno y sus necesidades sociosanitarias sean el centro real del sistema sanitario [2, 3), 4), 6, 8, 9, 14, 20, 23].

Los modelos existentes de gestión de pacientes con enfermedades crónicas que requieren de procesos y cuidados híbridos, no solo sanitarios sino también sociales (procesos sociosanitarios) son pocos y muy jóvenes en su planteamiento derivando todos ellos del inicial *Modelo de Cuidado Crónico* (CCM), desarrollado por Ed Wagner y colaboradores en el *MacColl Institute for Healthcare Innovation* de Seattle (EE.UU.), para mejorar la gestión de enfermedades crónicas dentro de los sistemas de proveedores integrados, como el *Group Health Cooperative and Lovelace Health System* norteamericano [46]. Este *Modelo de Cuidado Crónico* (CCM), reconoce que la gestión de enfermedades crónicas es el resultado de las interacciones de tres áreas superpuestas:

1) la comunidad o país como grupo, con sus políticas sanitarias, su modelo sanitario y sus múltiples recursos públicos y privados;
2) el sistema sanitario, con sus organizaciones financiadoras y proveedoras y los sistemas de seguros públicos y privados;
3) la práctica clínica o asistencia sanitaria, primaria y especializada, identificando aquellos elementos esenciales interdependientes que deben interactuar de manera no solo eficaz y efectiva, sino también de manera eficiente, para alcanzar un cuidado óptimo de aquellos pacientes con enfermedades crónicas.

El propósito último de este modelo es ubicar a los pacientes de manera activa y bien informados como elemento central de un sistema que cuenta con un equipo dinámico de profesionales con los conocimientos y experiencia precisos (Figura 1).

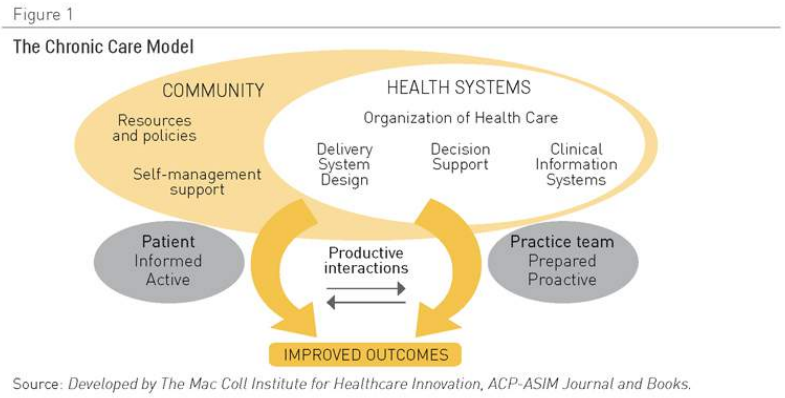

Fig. 1. Modelo de Cuidado Crónico. Fuente: *MacColl Institute for Healthcare Innovation*, ACP-ASIM *Journal and Books.*

Este modelo fue el primer sistema ampliamente divulgado y el que sirvió de base para todos los posteriores modelos como el posterior *Modelo de Cuidado Crónico Extendido* (ECCM), empleado y planteado por el Gobierno de la Columbia Británica de Canadá, que recalca la importancia y relevancia del contexto comunitario, al igual que la importancia de la prevención y promoción sanitaria (Figura 2), hasta llegar a crear el Marco del *Cuidado Innovador para Enfermedades Crónicas* (ICCC), de la Organización Mundial de la Salud (OMS) que en el fondo son solo variantes del modelo original de Wagner, y que recalcan por un lado la gran importancia y la urgente necesidad del compromiso en el proyecto, de la parte no solo sanitaria, sino también de la parte social, de una forma integrada (clave para este proyecto), y por otro lado la necesidad de potenciar a nivel político y cultural la promoción de la salud y la prevención de las enfermedades, junto con la necesidad de optimizar el uso de los recursos existentes, realizando una gestión integral con eficacia, efectividad y eficiencia, mediante la formulación de políticas sociosanitarias integradas [11, 17, 22, 29, 33] (Figura 3).

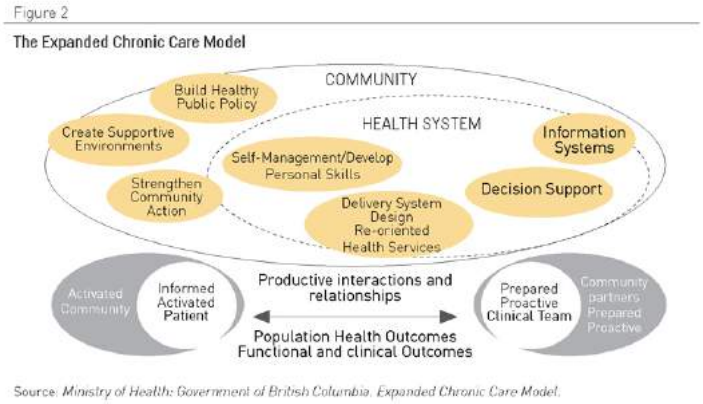

Fig. 2. *Modelo de Cuidado Crónico Extendido* (ECCM)**.** Fuente: Ministerio de Salud, Gobierno de la Columbia Británica.

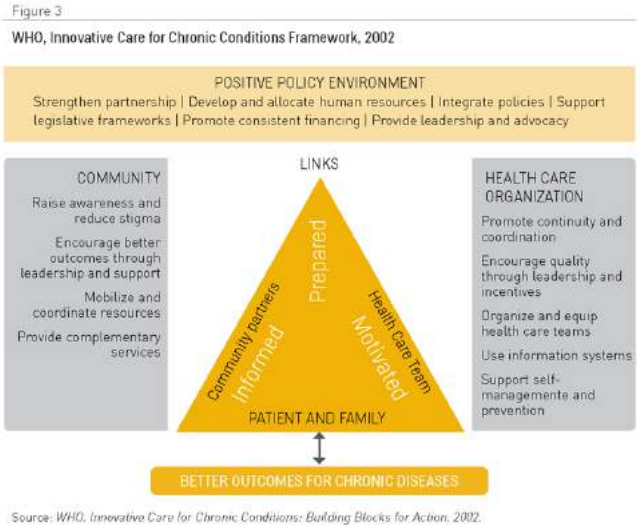

Fig. 3. OMS, Marco de Cuidado Innovador para Afecciones Crónicas, 2002. Fuente: OMS, Cuidado Innovador para Afecciones Crónicas: Construcción de Bloques de Acción. 2002

Este *Cuidado Innovador para Enfermedades Crónicas* de la OMS (ICCC) realiza varias contribuciones claves complementarias al *Modelo de Cuidado Crónico* (CCM):

- A nivel de macrogestión, resalta la necesidad de la existencia de una política sociosanitaria unitaria y fuerte que pueda reconducir los servicios sociosanitarios y orientarlos hacia las necesidades reales de los pacientes con patologías

crónicas, siendo este un elemento primario clave del modelo con una dirección fuerte, y con colaboración tanto interterritorial como intersectorial, que aporte al modelo una integración real de políticas, la sostenibilidad financiera y el aporte de unos recursos humanos preparados y cualificados.

- A nivel de mesogestión, la atención en este modelo sigue estando centrada como el de Wagner, en el papel activo de los agentes comunitarios, eso sí recalcando la gran importancia de la integración y la coordinación de los servicios sociosanitarios.
- A nivel de microgestión, la interacción establecida y existente dentro del *Modelo de Cuidado Crónico* (CCM) entre los profesionales sanitarios y los pacientes (interacción binaria), se amplía haciendo partícipe a la comunidad y sustituyendo el término de "activado" en referencia a los pacientes por el nuevo término de paciente "motivado y preparado" (Tabla 1).

Tabla 1. Elementos clave del modelo ICC

Table 1
Key elements of the ICCC model

KEY ELEMENTS OF THE ICCC MODEL
Evidence-based decision-making
Population health focus
Focus on prevention
Emphasis on quality of care and systemic quality
Flexibility/adaptability
Integration as the hard and fractal core of the model

Los pacientes con múltiples patologías crónicas, pacientes pluripatológicos, o aquellas personas con necesidades prolongadas no solo sanitarias sino también sociales, con algún déficit funcional que le impida realizar de una manera normal y adecuada las actividades cotidianas, transformándose en personas totalmente dependientes, son los pacientes que consumen el mayor volumen de recursos sanitarios de un país, por lo que la creación de nuevos modelos de gestión válidos para el manejo de este tipo de ciudadanos sigue siendo un reto a nivel nacional [31, 38, 39, 42]. En el momento histórico que vivimos, la organización de la atención sanitaria y sociosanitaria, encaminada hacia la gestión, el manejo y el tratamiento de estos pacientes pluripatológicos es totalmente inapropiada, siendo necesario potenciar y fomentar el trabajo de equipos multidisciplinares (profesionales sanitarios y profesionales de los servicios sociales actuando de manera simultánea y de manera sinérgica y coordinada) de manera que se pueda llegar a garantizar una atención sociosanitaria de manera integral y con equidad, que proporcione una continuidad de los cuidados a largo plazo junto con una mejora de la calidad asistencial, un uso más racional de los recursos tanto humanos como estructurales y financieros empleados (eficiencia) y que aporten una mejora de la calidad de vida tanto de los pacientes como de su entorno familiar, todo ello de acuerdo a unos criterios previamente definidos en las respectivas Leyes de Sanidad de los diferentes SNS [15, 16, 32, 41, 43, 44, 45].

Para lograr esta finalidad se requiere, ya de una manera inicial, de una clasificación para realizar el primer paso que es definir los criterios de identificación de aquellas personas que son susceptibles de inclusión en la necesidad de cuidados sociosanitarios integrados, respondiendo a la preguntas de ¿Qué pacientes son subsidiarios de una atención sociosanitaria integral? y a la pregunta de ¿Qué tipo de necesidades de cuidados tanto personales como sanitarios necesita dicha persona, dependiendo de su entorno familiar y estado socioeconómico?. Una estratificación basada en la descripción de la pirámide de Kaiser Permanente podría facilitar la clasificación de dichos pacientes en tres niveles de intervención, de acuerdo con su nivel de complejidad. El conjunto de pacientes que se sitúa en la parte superior de la pirámide, aunque representan sólo entre el 3% y el 5% de los casos, son los más complejos y los que consumen la porción más elevada de los recursos sociosanitarios, por lo que es necesario asignar a estas personas unos planes de cuidados integrales diseñados "ad hoc", para poder reducir de esa manera el uso innecesario de recursos especializados, y en especial para evitar ingresos hospitalarios (Figura 4).

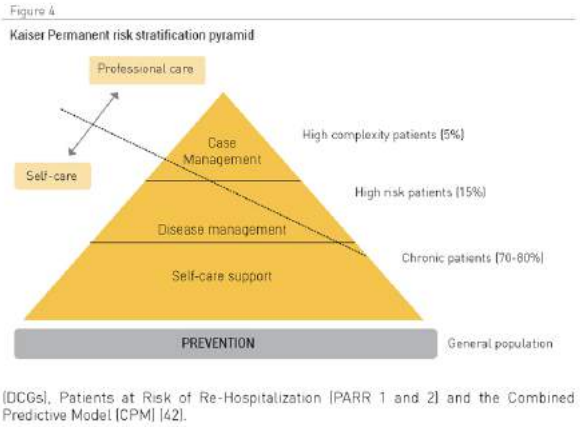

Fig. 4. Pirámide de estratificación de riesgos de Kaiser Permanente

Esta estratificación de riesgos conocida como la Pirámide de **Kaiser Permanente,** fue desarrollada por Kaiser Permanente en los Estados Unidos, para clasificar a los pacientes en tres categorías de niveles de intervención, dependiendo de su nivel de complejidad y, de acuerdo con la probabilidad de que sufran un deterioro de su salud [31, 34].

Esta clasificación de los pacientes en categorías ubica en un nivel cero a los miembros sanos de la población para los que la prevención y el diagnóstico temprano de la enfermedad son las prioridades. En el primer nivel, donde las personas tienen algún tipo de enfermedad crónica, que no tienen grados de dependencia el interés se orienta prácticamente al autocuidado, la administración apropiada de medicamentos y la educación en aspectos sanitarios, con pocas necesidades de apoyo sociosanitario, representando este nivel aproximadamente entre el 70-80% de los pacientes crónicos. En

un segundo nivel se sitúan los pacientes crónicos de alto riesgo, que ya precisan de una gestión más directa de la enfermedad y más apoyos sociosanitarios, representando el 15% de los pacientes. En el tercer nivel, se ubican los pacientes identificados como complejos (del 3% al 5% del total) y a los que se les asignan planes de cuidado guiados por lo que denominan proyectos de gestión de caso diseñados para reducir el uso inadecuado de servicios especialistas y evitar ingresos hospitalarios [14, 27].

Este modelo de Kaiser Permanente ha inspirado enfoques adicionales, como el *Modelo de Cuidado Guiado*, donde el personal de enfermería de cuidados primarios previamente entrenado y cualificado y en coordinación con un equipo médico se ocupa de la valoración, evaluación, planificación, cuidado, seguimiento y supervisión de aquellos pacientes crónicos complejos identificados por medio de modelos de predicción previamente realizados.

Algunos sistemas sanitarios públicos europeos, entre los que destaca el Servicio Sanitario Nacional de Reino Unido, el National Health Services (NHS), han tratado de aplicar el modelo Kaiser en sus contextos. Otros, siguen el modelo de predicción, mediante el uso de un amplio número de métodos tales como el *Modelo Ajustado Clínico de Predicción de Grupos, el Grupo de Coste Diagnóstico* (DCGs), *Pacientes con Riesgo de Reingreso Hospitalario* (PARR 1 y PARR 2) y el *Modelo de Predicción Combinado* (CPM) y (ACGs-PM). Independientemente de cual sea el modelo elegido, lo que sí está claro es que se necesitan modelos específicamente diseñados para mejorar la gestión de las enfermedades crónicas y de los pacientes pluripatológicos, ya que no existen pautas clínicas prácticas que aborden las afecciones múltiples, o que estén diseñadas para permitir a los profesionales de la asistencia tanto primaria como especializada considerar las circunstancias individuales y preferencias de los pacientes con enfermedades crónicas múltiples, mediante una integración multidisciplinar con profesionales del entorno sanitario, y profesionales del entorno de los cuidados sociales [12, 18].

Aparte de los modelos de gestión también es necesario crear estándares de calidad para estos servicios sociosanitarios destinados a estos pacientes con patologías crónicas múltiples, particularmente en relación con la coordinación del cuidado, la educación de pacientes y cuidadores, la capacitación en el apoyo al autocuidado tomando en consideración las preferencias y circunstancias individuales siendo necesario incorporar herramientas de mejora de los procesos sociosanitarios con la ayuda de nuevas herramientas tecnológicas, como la e-health, m-health, u-health, que requieren de plataformas potentes que soporten un análisis y gestión de grandes cantidades de datos (Big Data y la inteligencia ambiental (AmI), así como a través del desarrollo de servicios más allá de los límites del sistema sanitario actual [19, 37, 47].

Con esta finalidad se necesitan Sistemas de Información, que nos aporten datos tanto del paciente como de los aspectos sanitarios, que podemos obtener directamente de la explotación del Conjunto Mínimo Básico de Datos (CMBD), como información adicional de los aspectos sociales y socioeconómicos más relevantes y que nos facilite a los gestores la toma de decisiones.

Este Sistema de Información Sociosanitario (SISS), nos va a permitir, por un lado valorar los criterios de inclusión a las diferentes ofertas de la cartera de servicios sociosanitaria que exista en el momento, y por otro lado a crear y poder compartir una

historia sociosanitaria integrada (HSSI), a la obtención de un CMBD específico sociosanitario (CMBDSS), y a la obtención de sistemas de ajuste de riesgos que nos permitan conocer el coste de los procesos sociosanitarios para poder realizar tanto benchmarking de eficiencia y calidad y a poder asignar recursos en función de los costes obtenidos en los diferentes procesos de la cartera de servicios sociosanitarios establecidos.

Estos Sistemas de Información (SISS) nos van a permitir como gestores:

1) registrar a los pacientes y asignarles un código identificativo;
2) facilitar el seguimiento del proceso sociosanitario con una metodología ABQ, (activity based quality) enfocada a la calidad asistencial, conociendo por una parte como se realizan los procesos asistenciales sociosanitarios (activity based Management, ABM) y por otra cual es el coste de cada proceso (activity based costing, ABC) y todo ello tomando como eje del proceso el paciente con necesidades sociosanitarias que haya sido definida como persona susceptible de inclusión;
3) poder realizar un seguimiento mediante un cuadro de mando de todo el proceso;
4) finalmente realizar una evaluación y benchmarking disponiendo de una información sociosanitaria integrada (sanitaria y social) que esté disponible en una historia sociosanitaria integrada (HSSI), que sea interoperable y accesible tanto desde la parcela de lo social como desde la parcela sanitaria.

A nivel de los Sistemas Sanitarios, el Ministerio de Salud cuenta con sistemas de información, y suele tener un catálogo de referencia de Servicios Sociales junto a una base de datos de beneficiarios y usuarios de los servicios, pero para conseguir un método efectivo para la planificación, la eficiencia y el análisis es necesario complementarlos con:

- Una Historia Social Única (HSU)
- Una clasificación de pacientes según su etiología y necesidades: GRASS
- Un CMBD específico social (CMBDS).
- Un sistema de ajuste de riesgos a través de un Conjunto Agregado de Atención Social (CAAS) que nos permitan conocer el coste de los procesos sociales para poder realizar tanto comparaciones (benchmarking) de eficiencia y calidad como asignar recursos en función de los costes obtenidos en los diferentes procesos del catálogo de servicios sociales.
- Unas Guías Integradas de Atención Social (GIAS) para la estandarización de los procesos.
- Modelo de Asignación de Costes a los Procesos de Atención Social (MACPAS).
- Herramienta para la Evaluación de Resultados en Atención Social (HERAS)

Todo este marco de referencia de modelos, herramientas y metodologías es el que denominamos MIGRAS: Modelo Integral de Gestión y Resultados en Atención Social. El modelo MIGRAS sigue el patrón iniciado en sanidad, que ha originado pro-

ductos como los GRD (Grupos Relacionados por el Diagnóstico), los ACG (Grupos Clínicos Ajustados) y otros similares; busca aspectos comunes en los usuarios de los servicios sociales que posibiliten el establecimiento de clasificaciones que permitan agrupar los procesos de atención, dotarlos de indicadores y poder comparar su desempeño y la efectividad de sus resultados. Además, uno de los provechos esperados es disponer de información y herramientas para pronosticar las necesidades futuras.

Este conjunto de sistemas y herramientas nos va a permitir:

- Registrar a los usuarios de servicios sociales de manera unívoca y tener una visión integral de los servicios que utilizan ellos y su entorno familiar o de convivencia.
- Facilitar el seguimiento del proceso social con una metodología ABQ, (Activity Based Quality) enfocada a la calidad asistencial, conociendo por una parte como se realizan los procesos atención social (Activity Based Management, ABM) y por otra cual es el coste de cada proceso (Activity Based Costing, ABC).
- Poder hacer un seguimiento mediante un cuadro de mando de todo el proceso.
- Realizar una evaluación de la efectividad de las acciones sociales disponiendo de una información social integrada.

MIGRAS quiere satisfacer los siguientes objetivos globales:

1) Desarrollar un modelo integral de clasificación y agrupación por necesidad y consumo de atención social.
2) Extender una cultura de balance y control analítico en la asignación de recursos humanos, materiales y económicos y en el ajuste de riesgos en la atención social, con especial énfasis en la dependencia.
3) Establecer parámetros para predecir la utilización de servicios y su ajuste presupuestario, tanto en la financiación de instituciones públicas como privadas.
4) Valorar la introducción de elementos de redistribución en los presupuestos de la dependencia.
5) Identificar elementos de mejora en el reparto presupuestario por geografía, prestaciones, …

Estos objetivos se pueden formular de forma operativa como se relaciona a continuación:

1) Calcular la magnitud y variabilidad de la carga de atención social, expresada en Conjuntos Agregados de Atención Social (CAAS), a partir de la información de los sistemas de información del Ministerio de Sanidad, Servicios Sociales e Igualdad, y de la que se obtenga al aplicar una clasificación de usuarios mediante los GRASS.
2) Obtener los pesos relativos medios del coste de la asistencia para cada uno de los CAAS.

3) Estratificar la utilización de recursos en bandas de utilización de recursos (BUR) que permitan también distinguir la proximidad o riesgo de que un salto en el grado de dependencia y calcular los índices de eficiencia en utilización de esos recursos.
4) Construir un índice general para evaluar la eficiencia en el reparto presupuestario de recursos. El índice incluirá los diversos elementos de la medición de la calidad asistencial, utilizando datos de estructura (gasto en los niveles primario y especializado), proceso (índices de eficiencia en utilización de recursos) y resultado (datos de evaluación de la calidad de los indicadores).

Como objetivos específicos del modelo establecemos:

- Establecer el método para conocer la variabilidad intragrupo de los GRASS obtenidos en función de la codificación CMBDS de las `altas´ sociales en el Sistema de Atención Social e Historias Sociales y así poder agruparlos en CAAS.
- Aproximar un modelo de gestión por procesos en base al diseño estandarizado de los mismos, reflejados en las Guías Integradas de Atención Social (GIAS).
- Definir un marco metodológico que habrá que aplicar a la imputación de costes de cada uno de los GRASS:
- Aproximar un modelo de evaluación de la calidad de los procesos sociales con herramientas que permitan compartir los resultados en aras de la calidad y eficiencia.
- Construir un modelo teórico, para evaluar la eficiencia en el reparto de recursos, denominado índice de Eficiencia General (EG). Este modelo integra variables de estructura (presupuesto de gastos de personal y gastos generales), proceso (índices de eficiencia en recursos utilizados en el cálculo de los GRASS/CAAS) y resultado (resultados de evaluación de una batería de indicadores).
- Partimos de la premisa de que es posible delimitar ciertos grupos homogéneos de usuarios de los servicios sociales en función de una serie de parámetros, tales como, características de la necesidad o problema social aparejado, gravedad de la situación y tipo e intensidad de los servicios sociales prestados, y según estos calcular el gasto que generan.
- Para ello primero tenemos que clasificar todos los usuarios y para ello seguimos la referencia del Catálogo de Servicios Sociales: esto da lugar a los GRASS. Una posterior agrupación, ponderando esta los por isoconsumo, nos lleva a obtener unos conjuntos de similar comportamiento que denominados CAAS (Conjuntos Agregados de Atención Social).
- A continuación, se estudian los procesos con metodología ABQ (Activity Base Quality, Calidad Basada en la Actividad). Este estudio dará lugar a las Guías Integradas de Atención Social (GIAS); y sobre estas guías se aplicará el Modelo de Asignación de Costes a los Procesos de Atención Social (MACPAS). Este último será la base para aplicar modelos compa-

rativos y de evaluación de la calidad de la atención. Esto se puede realizar con la Herramienta para la Evaluación de Resultados en Atención Social (HERAS). A partir de una muestra de individuos, y de variables como: índice de privación socioeconómica, consumo de recursos en el nivel primario y nivel especializado, grado de discapacidad y su variación temporal, se podría realizar un modelo de regresión obteniéndose una fórmula que simule el gasto en la atención social (dependencia, riesgo de exclusión…) y su pronóstico.

- Uno de los elementos fundamentales del modelo MIRAS es la herramienta para la asignación de costes a los procesos de atención social y de gran utilidad para valorar el coste de cada uno de los CAAS y finalmente, poder establecer y realizar comparativas y benchmarking.
- Constituye el módulo de asignación de costes derivados de los GRASS y CAAS por ciudadano para los diferentes centros de coste sociales. Para ello implementa un método de contabilidad que asigna los costes con un detalle arborescente de acuerdo al gasto total en un determinado periodo de tiempo.
- MACPAS es la herramienta que permite modelar y definir un sistema de costes asociados a los procesos de atención social. Al igual que en el ámbito de la salud y en otros ámbitos se hace patente la necesidad de un modelo de costes. Por ese motivo se introduce como soporte a los procesos de atención social un sistema de establecimiento de costes basado en metodología ABC (Activity Based Costing).
- Su filosofía se basa en el principio de que las actividades son realmente las causas que determinan el consumo de recursos y los costes subsiguientes. En el ámbito social, este sistema identifica las actividades realizadas en el proceso y emplea unos inductores de costes (cost drivers) que permiten llevar los costes de estas actividades a los distintos productos o servicios en función de los procesos sociales realizados. De este modo, los centros o departamentos incurren en costes en la medida en que realizan actividades y el coste de los productos es resultado del consumo de las actividades necesarias para obtenerlos. Por consiguiente, la excelencia en la gestión de costes requerirá una excelente gestión de las actividades. Los principios de los sistemas ABC pueden aplicarse a cualquier tipo de organización y entroncan perfectamente con las más novedosas tendencias de gestión, como los modelos de gestión de la calidad y la reingeniería o rediseño de procesos.

Todos estos datos contenidos en la Historia Social Única (HSU), junto con la clasificación de pacientes según su etiología y necesidades (GRASS) obtenidos del análisis del CMBD específico social (CMBDS), y mediante un sistema de ajuste de riesgos gestionado a través de un Conjunto Agregado de Atención Social (CAAS) que nos permite conocer el coste de los procesos sociales para poder realizar tanto comparaciones (benchmarking) de eficiencia y calidad y asignar recursos en función de los costes obtenidos en los diferentes procesos del catálogo de servicios sociales, nos

permite posteriormente realizar Guías Integradas de Atención Social (GIAS) para la estandarización de los procesos.

Los datos a gestionar, gracias al gran desarrollo de los biosensores y de la computación ubicua (inteligencia ambiental) los podemos transferir (datos biológicos como el ECG, Sat 02, Presión Arterial, Frecuencia Cardíaca, Temperatura…) y realizar diagnósticos a distancia mediante la uHealth y nuestra plataforma de uHealth, SiestaCare basada en los nuevos sistemas de TV digital interactiva por Internet (IPTV), siendo esta una herramienta clave en los nuevos modelos de gestión sanitaria integrada y en los procesos de atención socio-sanitaria y cuidado de las personas con dependencia. SiestaCare, nos permite ofrecer un conjunto de aplicaciones destinadas a los pacientes, y a los profesionales del sector socio-sanitario. A través de la interfaz intuitiva, se puede acceder a los distintos servicios de uHealth que van desde la atención médica con Video-consultas, e-Chequeo y hospitalización en el hogar, hasta servicios de tele-educación para la salud, y sesiones clínicas entre profesionales con videoponencias, o emisión en 3D por videostreaming, lo que permite dibujar un escenario real de hospital sin barreras. En este escenario, el paciente está rodeado de sensores autónomos (básculas, tensiómetros, resgistradores de ECG, y otros dispositivos que pueden ser implantados en la piel o en tejidos, pasando por sensores ambientales de temperatura, humedad, posición, etc. que formando redes ad hoc, ya sean BAN (Body Area Network), PAN (Personal Área Network) y/o HAN (Home Área Network), adquieren y transmiten toda la información de interés. Además, la plataforma no está únicamente orientada al paciente, y los médicos, farmacéuticos y demás actores implicados en el cuidado de la salud pueden actuar en sinergia, mejorando la calidad asistencial y la eficiencia del Sistema Sanitario, que son los principales retos al que se enfrenta la medicina actual y del futuro inmediato.

Todas estas técnicas, impulsarán el mundo de la medicina, realizando a medio plazo un cambio de paradigma total en el campo de la gestión integral de la asistencia socio-sanitaria.

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Building informative audio-visual content automatically: a process to define the key aspects

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Abstract. Related to the population ageing that most of the countries are witnessing, several new challenges emerged in areas such as health and social care. Often, governments and entities does not have human, physical and infrastructural means available or in sufficient number to support all citizens' needs. This trend requires different approaches to address their related problems. In this context, several technologies have recently emerged and have been explored as an important ally to cope with seniors' needs. Interactive television (iTV) infrastructure have a lot of potential to deliver adapted solutions to seniors, although it is essential that such products are designed and developed with inputs from potential end users. The application of a participatory design approach is a key factor to assure high levels of final products' adoption. In line with this, the present paper describes the process of data collection that aims to analyse the audio-visual elements that compose a set of videos that will be transmitted by an iTV platform and that intents to deliver informative contents about social and public services to Portuguese elders. The results will provide guidelines for the development of similar products that address older people's needs.

Keywords: audio-visual content, iTV platform, elderly

1 Introduction

Population ageing is an undeniable fact, faced by almost all countries. As a result of improvements in living conditions, such as access to better food and nutrients, water and enhancements in sanitation and health systems, since 1970 the world average age of death has increased 35 years, with declines in death rates in all groups of the age pyramid [1]. According to projections, this tendency will persist and the number of elderlies will increase dramatically in the medium-term future. Challenges and opportunities that come with ageing, both at personal and community level, are drawing the attention of several sectors of society. One example of this is the increased concern shown by Governments and civil societies to follow the World Health Organization recommendations to promote healthy and active ageing [2].

The quick evolution and the high volume of technological innovations related to seniors' needs that have emerged in the last decades show that this is a dynamic area.

The huge relevance of this subject is assumed both by the academic and industrial market as well as by the European authorities who believe there is great potential for the development and implementation of a wide range of new technologies. Health care, disability support and remote support for the elderly are some of the areas in which technologies can play a key role [3].

One of the pillars that influence the quality of life in advanced age stages and improve the empowerment of older people is related to the access to information and knowledge [4]. Increasingly, it is important to build inclusive digital environments that promote the ease of digital and social access, so that the elderly can maintain and improve their quality of life [5]. Although, several times, technologies developed did not consider the needs and expectations of the target population which affect the perceived benefits and, consequently, the level of older people's adoption and use of technologies [6]. To avoid this problem and to transform technology into a real asset for the elderly, it is important that they become involved from the onset in the process of building and developing the products, through the listening of their perceptions and expectations.

Therefore, the aim of this paper is to present and analyse the data collected with a sample of Portuguese seniors with the purpose of defining the audio-visual elements that compose the videos to be transmitted by an interactive television (iTV) platform, specifically for the elderly population. In addition to the present introduction, this article is organized in the following sections: section 2 presenting a theoretical framework on the questions of population ageing, the importance of technologies to support seniors' information needs and the attention that should be taken when building audio-visual content for this population segment; section 3 a brief description of the +TV4E academic project; section 4, which illustrates the methodological steps followed to define the elements that will compose the videos delivered through the +TV4E platform; section 5, where the obtained results are presented and discussed in detail, and finally, section 6 that presents some of the conclusions drawn from this study and orientations for future work in this field.

2 Theoretical Framework

The expected slowdown in population growth in the next 90 years, due to the reduction in fertility rates, will increase the number of older people over time. By 2017, around 13 per cent of the global population are people with 60 years or over, which corresponds to 962 million citizens. By 2030 is expected that this number will increase to 1.4 billion, reaching nearly 2.1 billion in 2050, and could rise to 3.1 billion in 2100 [7].

Portugal follows this demographic trend and it is expected that this process will be accentuated. The last report indicates that between 2015 and 2080, the number of people with 65 years or over will increase from 2,1 to 2,8 million, accompanied by a significant reduction in the number of inhabitants in the national territory (from 10,3 to 7,5 million people) [8]. It is also expected that the highest number of elderly will be reached around 2040, moment when this growth trend will decline. Although, population ageing index will be more than double between 2015 and 2080, with 147 elderlies in 2015 reaching 317 older people in 2080 [8].

To better understand the ageing concept it is important to refer that this is a natural, universal, progressive and irreversible process influenced by the interaction of internal (genetic traits) and external factors (e.g. education, life styles) [9]. In biological terms (primary ageing), the human body suffers several physiological and anatomical deteriorations gradually. Structural and functional modifications have significant implications in the individuals' functionalities. Delay in reaction time, difficulty to control posture and balance, loss of fine motor skills, hearing impairment and reduced visual acuity are some of the typical functional changes related with the ageing process [10]. These changes can influence and limit the individuals' ability to respond to situations in their daily lives, endangering the promotion of an active life.

The concept of "active ageing", adopted by the World Health Organization, advocates that a longer life must be accompanied by continuous opportunities in health, participation and security in order to enhance quality of life (QoL) [2]. QoL is a broad ranging and complex concept, and at advanced stages of life is highly influenced by the individuals' ability to maintain autonomy and independence [2]. Concerning this, getting proper information may represent a key factor to face daily living challenges promoting an autonomous and independent ageing process [11], reinforcing the pillar of participation that determines active ageing. Even if accessing information concerning the world that surrounds us is often dependent on a proactive attitude of the individuals and, nowadays, often requires minimum levels of digital literacy so that the information accessed is perceived as a whole. Unfortunately, often times many people do not accomplish these criteria, staying away from the information that is passed to them by others (e.g. information sources, informal caregivers) and sometimes they do not understand the information meaning [12]. One of the possible ways to answer this notorious requirement is through the use of technologies available to most citizens [13].

Today's society is characterized by high levels of information dependence, with the communication networks playing a key role to fulfil these needs, promoting economic and social development [3]. The emergence of new digital technologies, such as the appearance of personal computers and the Internet, led to a technological revolution that transformed the citizens' experience by easing the access to information and entertainment contents [12, 14].

Regarding the older population's needs referred above, it is unquestionable that providing adequate information helps the elderly to support the daily decision-making process. There are several information sources to achieve informative contents, such as journals, radio, books, magazines, pamphlets, social networks, etc. [15]. In addition to the internet, television (TV) has also been one of the great discoveries and agents of change in societies in the last decades [16]. TV is still in a prominent position as the preferred information source for the Portuguese elderly [15], which is confirmed by the high average of daily television consumption among people with 65 years or more (5 hours and 8 minutes a day watching TV) [17].

Taking benefit of the advances of the technological world, several products, that aim to support the ageing process, were developed. These products cover a wide range of areas such as health, social and informational fields [3, 12]. The combination between traditional TV with features available via the internet, lead to the development of iTV

platforms, a technological basis with an enormous potential for the creation and application of gerontechnological solutions. The potential of iTV platforms was already recognized by the European Commission a decade ago, by providing public entities with the means to make Information Society services accessible to all citizens [12]. In this context, and concerning the informative needs and expectations among Portuguese elderly [15], is under development an academic project that aims to promote seniors info-inclusion through an iTV platform. Following, more details about +TV4E project will be presented.

3 +TV4E Project

The +TV4E project, is a Portuguese action-research project headed by the University of Aveiro that aims to promote the info-inclusion and improve the QoL of Portuguese seniors through the transmission of video spots with informative content about social and public services. These videos include an audio track narrating the news content that is crawled from specific internet sites. This project comes up with an iTV platform, running in set-top boxes, to enrich the TV viewing experience with the integration of high-valued informative contents. The system that supports the platform will be developed in a personalized way, considering the user's preferences, needs and expectations so that only relevant content for the user are sent. The information presented in the videos is aggregated into seven macro-areas of interest, previously studied with experts in public health and public policies, as well as, with a sample of Portuguese seniors, titled *Assistance Services of General Interest for Elderly* (ASGIE) [15]. These seven areas are: (1) health care and welfare services; (2) social services; (3) financial services; (4) culture, informal education and entertainment; (5) security services; (6) local authority services and (7) transport services.

The video spots delivered through the platform are automatically produced based on web news and, regularly, the system verifies if there are new contents on the information sources that feed the platform, generating new informative videos. To achieve this, an algorithm selects content from different web sources and builds audio-visual pieces on its own. Technologically, this is one of the differentiator element of this project. The video spots are then injected into the linear television transmission, while the regular TV broadcast is locally paused and resumed after the presentation of the informative video. Regardless the macro-area of interest information, all videos have a similar structure and are composed by a set of elements with a defined ordered, following presented: (1) intro card with +TV4E logo animation, with a plain colour background; (2) card with the logo, and a conforming colour background that identifies the ASGIE targeted by the video; (3) video with the corresponding title, description and background images, specific to the macro-area of information; (4) project logo with one of the ASGIE related background images and (5) another card (project logo with a plain colour background). As is noted in the previous description of the cards' flow, there are several audio-visual elements that compose each video card, specifically: icon that identifies each specific ASGIE; specific colour background associated with each

macro-area of information; background images palette defined to each ASGIE; opacity/transparency of images; background music; audio track that narrates the news article; font size shown as video caption. In addition, there are functional components integrated into the informative videos, such as: narration's speed; video length; reading's synchronization with transitions between screens and narration speed; transition effects between screens and news' interest.

Technological solutions must be adapted to the needs and expectations of end users to promote the technology acceptance [18]. This process is even more important when the target population is the elderly. In line with this, is crucial that from the outset of the product development process, potential end users are involved through a participative design approach to create a valuable product, easy-to-use and that fulfils seniors' needs, increasing the chances of guaranteeing a comfortable experience [11]. Thus, some of the audio-visual and functional elements that will compose the video spots delivered through the +TV4E platform will be created with a sample of Portuguese seniors, supported by the inputs gathered participatory design approach.

Although is the intention of the +TV4E research team, the complexity and slowness entailed to the creation process does not allow the development of all the elements concerning the inputs from seniors. However, this constraint was surpassed by a test performed with a sample of seniors, in which all elements were presented in an aggregated form, described further.

4 Methodology

The present study was held within the +TV4E project's context and it focuses on the validation of functional and technical aspects of audio-visual informative videos in collaboration with senior users. These video spots, brought to elderly people's televisions through the +TV4E platform, intends to show new and updated information from credible sources, in order to contribute to the seniors' independency and autonomy.

Czaja and Sharit (2012) affirm that seniors are willing to adopt and use new technological systems, but there are obstacles that interfere with that, including lack of access and knowledge of potential benefits of the technologies, lack of technical support, costs, fear of failing and the complexity of interfaces that are frequently designed and developed without considering their needs. So, an interactive system directed to the senior population should be designed and developed taking some important factors into account, for it to become a valuable instrument [20]. It is essential that their perspectives and needs are well represented in the final product and that ageing process and age-related changes are kept in consideration during its development.

Considering this, the present study was conducted through a research development methodology due to its collaborative nature. It was developed with potential users who tested and evaluated audio-visual solutions to reach a conclusion, through participative design sessions adequately organized to validate certain aesthetical and technical elements of the videos.

It was always intended to include seniors in the study who could contribute with their personal inputs about the best and most adequate ways to design the final product.

During the videos' construction process, this research counted on the collaboration from two Senior Universities that invited some of their students for the data collection sessions. The participants were selected by convenience. It is often difficult to select a random sample or even a systematic sample and so the research team contacted two universities in Aveiro region, mainly due to localization motives and to guarantee that the participants would form a solid and consistent sample in every data collection sessions, establishing empathizing with the project. This led the participants to start feeling familiarized with these sessions' goals. However, it was considered that a convenience sampling could suffer biased and cannot be representative of the whole population. Each one of the sessions was aimed to test, discuss and validate audio-visual elements about the information's presentation in the videos, registering the gathered opinions from the seniors for the videos 'design. The Senior University of Curia and the Senior University of Cacia were the two institutions that accepted the invitation to participate in the audio-visual elements definition process of the videos to be transmitted through the +TV4E platform. The involvement of two different institutions guaranteed a greater number of inputs and a diversity of the sample considering their different environmental influences.

The present paper focuses on the final design session. The previous sessions were focused on validating several elements composing the audio and visual structure of the videos including textual elements, sound elements, iconography and colour distinction for each ASGIE. After testing and validating these aspects the research team returned to the universities to obtain a final opinion about the most important aspects and to validate the overall result.

All the previous data (text, sound, icons and colours) was gathered at specific moments and relatively far between. So, there came a need to bring, once more, the obtained results and the adjusted solutions to potential users, in order to validate them all together, with a more general point of view. Besides these elements, the team also decided to ask seniors about some other audio-visual aspects that were not tested until then but revealed to be essential to the project's refining.

In this line, a final focus group session was planned with 8 participants from the Senior University of Cacia, at May 31st, 2017. A distance of 3 meters between the television (a full HD TV set with 42'') screen and the participants were assured and the session was recorded in audio format upon their approval. The elements tested in this moment were: text characters size; speech velocity; music perception; iconicity level; colour distinction; video's duration; reading synchronization with transitions and speed; screen's transitions; background images; background opacity and the information's interest.

In an initial moment, the participants were shown different videos already generated by the platform, in order to analyse all the elements that the team intended to work with the sample in this focus group. After this, each variable established to talk about was tested one by one.

Firstly, regarding textual elements, the informative text's font size was shown at 55 pts which was the size agreed in a previous data collection moment with the same participants. After watching the video example, the participants were asked about their

opinion concerning the difficulty and the effort towards reading the text at the established font size. Sound elements were after discussed, specifically music perception and speech speed. Two video spots from the same ASGIE (Local Authority Services) were shown, yet with different duration times (23 seconds and 1 minute and 23 seconds). Both videos were narrated by a feminine voice generated by a text-to-speech tool, as it was the preferable genre in a previous moment with the senior participants. This time, the participants were asked if the background music caused some kind of distress and if the speech's speed was the most adequate. Regarding iconography, an association exercise was planned, showing to the participants an image where they could see a list of all the ASGIE accompanied with the icons set without associated labels, that was designed based on their previous inputs and opinions (see Fig. 1).

Fig. 1. ASGIE's list with the icons developed

The participants were asked to connect each icon with the correct ASGIE. This exercise aimed to assure that the icon design was perceptible and that it would be easy to associate each symbol to its correspondent area.

To validate the colours associated with each ASGIE, the discussion process was held through the visualization of each introduction bit of the videos, one by one, from the different 7 areas. The introduction of the videos consists of a brief animation, displaying the platform's logo transitioning to a coloured background with the ASGIE icon on it, as explained in Fig. 2.

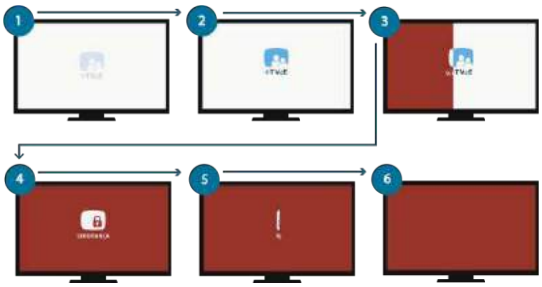

Fig. 2. Transition screens in the intro moment

The use of colours to distinguish each ASGIE, not only contributes for the identity of each one, but also helps the senior to easily and quickly identify the kind of informative

content to expect. The participants were questioned if they would change any of the colours, if some colour was too strong or distressful, or if some of them were too similar between them.

These were the elements that were brought previously for testing and now were validated in this final moment. The other aspects that were not tested before were considered convenient and relevant to be put to test, as they could still be improved or adjusted. These variables were the transitioning effects between screens, the selection of background images for each ASGIE and the coloured background opacity.

The interest had on the information was assessed using different screens from five of the defined ASGIE, showing news content created in the past week. The other two ASGIE were not had in consideration because their information sources were not available (Social Services and Transports). For the Health Care and Welfare macro-area two different news articles were shown, presenting different contexts, one was political related and the other focused on the general-interest.

To evaluate the transition effect between screens, the participants were displayed with various examples of effects different from the already established in the showed videos, both based on vertical and horizontal movements. Afterwards, the participants were asked if they had any suggestion regarding transition effects that could give a better viewing experience for them or if the transition effect made any significant difference for the information comprehension.

For the background images of each ASGIE, the participants were presented with a series of slides. Each slide contained a set of images within the same thematic accompanied with the 7 icons. Subsequently, the participants were instructed to associate each set of images with one of the icons, in a similar approach used in the association exercise for the icons. The image below (Fig. 3) represents an example of a slide showed to the participants, in this case, for the Health Care and Welfare Services ASGIE.

Fig. 3. Slide show of Health Services ASGIE presented

Finally, it was necessary to obtain validation regarding colour opacity from the background layered on the image during the informative content exhibition. In this field, it was presented a slide with a background image beneath a coloured layer with three different transparency levels (5%, 15% and 25%), as shown in Fig. 4. The participants were asked to come to an agreement about which level would work best, considering the image perception and the reading process.

Fig. 4. Slide with background image with coloured layer

The next section presents and discusses the results achieved.

5 Results and Discussion

After putting in practice the presented methodology, the following results were achieved:

1. Font size – Excepting one participant, every other felt comfortable with the font size, used in the title and content of the news, and considered it easily readable. Confirming the previous results from other data collection moments.
2. Speech speed – From the videos shown, the participants considered that the longest one had a lower speech speed than the shortest one, stating that the narration of the shortest was not only fast, but as well hard to understand. This is an interesting observation since both have the same speed. This result may be due to the lower speed and bigger difficulty seniors have in processing data when much is presented in a short space of time.
3. Music perception – The background music did not cause or seemed to cause any disturbance on the perception the participants had of the narration of the informative content. Being so, this element is properly working as a link for better comprehending the speech synthesis.
4. Iconicity – In this test, it was clear that every icon was successfully associated with its correspondent ASGIE by every participant. It was also noticeable that the previous data gathered was accurate enough to design icons easily perceivable by seniors.
5. Colour distinction – The colours used were approved by every participant, which found them proper for each ASGIE, validating, as well, other moments of data collection.
6. Video duration – The preferred video was the one having a duration of 1 minute and 23 seconds. For the participants, because they perceived it as having a slower paced speech, this one was more comprehensible and clear, which is one of the main reasons why they chose it. The videos produced by the Automated Video Engine (AVE) do not have a time limitation because their duration is dependent on

the size of the news content it has, though there exists room for improvements. In this manner, some more data must be collected in other sessions or at least during a phase of testing in a domestic environment.

7. Reading synchronization with transition duration - The synchronization respects to the news description text shown according to what is being narrated in the moment of a transition for another slide. Being verified, in some occasions, a certain delay between both to narration and the text. For the participants, there was no objection regarding this subject and it was stated that the moment of transition between screens was easily understandable, having in mind, once again, both the narration and text being presented.
8. Animated screen transitions – From the presented transition animations, none seemed to convince the participants to have some added value for the informative audio-visual content.
9. Background images – During the tests every image was correctly associated with its correspondent ASGIE, with the exception of Social Services, where some notorious difficulties were felt in this task, referring that the image was ambiguous. For both Financial Services and Security Services, some feedback was exchanged in relation to images that could be used. For Financial Services were suggested images containing elements such as money or graphs related to the stock market, and for Security Services more involving cops and less involving certain aspects that could offend the sensibility of some viewers. For instance, one image shown for this area was a black man in handcuffs, which was considered to presumably lead to some misinterpretations regarding prejudice against a certain ethnic group, as it was predictable.
10. Background opacity – The entire sample chose the transparency level of 15%, which matches the opacity already in use for the videos being produced in the context of the project.
11. Information interest – There was a lack of interest in one of the news article about Health Services. It was related to a visit from a political entity to a Portuguese Hospital that was followed by a political commentary. The participants stated that they prefer that each ASGIE focuses on the general-interest rather than approaching a specific context, which in the present study was a political approach to the Health Care and Welfare Services macro-area.

Although it was difficult to maintain the seniors focused on the discussion, their contribution was important, providing, through their opinion and perspective, relevant approaches to improve several aspects of the informative audio-visual content. In general, the participants showed very interest on the informative videos, as they complimented and appreciated the informational pertinence of the presented content. This supports the idea that the engine, that is providing informative audio-visual content, is well prepared to gather data in several web pages and create, according to each ASGIE, the informative videos.

As the AVE is developed in such way allowing to easily change certain key aspects of all the process (such as font size, speech speed, information sources, background

images and colours, music volume) some simple solutions can be made in order to adjust the videos accordingly to the senior's expectations gathered in this focus group. These adjustments do not reveal major problems in any of the video components but result important to make them suitable for the potential end users.

6 Conclusions and Future Work

As it was understood, iTV platforms have a great potential to spread information amongst the elderly population, which can represent an important ally to ageing well. Developing technological products that have in consideration the potential end users' inputs will enhance the possibilities of success of its use. Regarding the specific subject addressed in this work, the moments carried on, were essential to define elements that will be included in the video spots of +TV4E platform according to seniors' preferences. Globally, the presented elements pleased all the participants. It is also highlighted the importance and the added value of the end users' participation in the development of the iTV platform that, despite their low digital literacy levels, do an effort, get involved and understand the requested topics.

After several moments of data gathering, this process, being the last in the +TV4E project's schedule, has revealed a big significance for the validation and evaluation of numerous components and features of the informative audio-visual content, some tested with the Universities of Cacia and Curia, and others such as this, with only one of the Universities. The validation of previously obtained data allows to identify and closure new problems as well as making sure that the data being used is trustworthy.

The trajectory of the +TV4E project is defined by most of the information obtained within these moments, where the small elements analysed are all put together, acting as an influence for other similar ones and serving as important links for the end result.

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El Rol de la Interactividad Hoy en Brasil

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Resumen. Esta reflexión posee un carácter interdisciplinario, que involucra temas sobre estudios de comunicación y sobre tecnologías de la información. En ese sentido, los aportes sobre el contexto de Brasil se hacen necesarios para que sea posible entender lo que ha pasado y sigue pasando con el proyecto de televisión digital en ese país. El trabajo presenta rápidamente la encuesta realizada en 2016 con un grupo de 56 personas seleccionadas entre población de baja renta del Distrito Federal que ha recibido caja de conversión sobre televisión digital, su relación con los recursos interactivos y la campaña realizada por EAD, la empresa creada por empresas de telecomunicaciones y de medios de comunicación para divulgar el apagón analógico.

Palabras clave: Televisión Digital Terrestre, Interdisciplinariedad, Interactividad, Aplicaciones y contenidos

Abstract. This reflection has an interdisciplinary character, which involves topics on communication studies and information technologies. In that sense, the contributions on the context of Brazil are necessary to make it possible to understand what has happened and continues to happen with the digital television project in that country. The study quickly presents the survey conducted in 2016 with a group of 56 people selected from the low income population of the Federal District that received a digital television conversion box, their relationship with interactive resources and the campaign carried out by EAD, the company created By telecommunications companies and the media to publicize the analogue blackout.

Keywords: Digital Terrestrial Television, Interdisciplinarity, Interactivity, Applications and contents

1 Introducción

Creado en 2007, el sistema brasileño de televisión digital interactiva (TVDi) tiene se mostrado un proyecto de implementación lenta como política pública direccionada a la población de baja renta. El proyecto presenta innovación brasileña que po-

sibilita 1) el uso de recursos interactivos[1] con el middleware Ginga a partir del control remoto de televisión; 2) recursos de accesibilidad, desarrollado para gente con necesidades especiales, entre ellos los con problemas de audición, 3) recursos de usabilidad, donde los aplicativos y contenidos audiovisuales son desarrollados para ser fácilmente comprendidos y utilizados en la pantalla de televisión y otros dispositivos; 4) recursos de movilidad, para la utilización en aparatos móviles, 5) recursos de portabilidad, para utilización en aparatos que se pueda llevar a todos los lados y 6) recursos interoperables que permiten que los distintos aparatos "hablen" entre ellos. El middleware Ginga aún permite el uso del sistema *One Seg*; es decir permite asistir televisión gratuitamente, con transmisión por el aire, en dispositivos como *smarthphones* e mobiles que posean esa tecnologia.

Inédito em el mundo, el sistema fue desarrollado em software libe para ser multiplicado dentro y fuera del país por la comunidad de software libre existente en la Región que cuentaba con 12 mil personas en Brasil y otros 3 mil en Latinoamérica en 2010. La idea de sus proponientes, como Luis Fernando Gomes, de PUC/Rio de Janeiro, era que el sistema se multiplicara por ello mismo haciendo crecer la producción de aplicativos y de contenidos audiovisuales. En términos de políticas públicas planteada a nivel interno y a nivel externo, para los vecinos de la Región, el gobierno del expresidente Lula da Silva (y después el de Dilma Rousseff) estaba interesado en incrementar las relaciones Sul-Sul, pero pasados 07 años de la implantación del modelo brasileño de televisión, eso todavía no se concretizó y poca gente, mismo dentro de Brasil, conoce y utiliza los recursos interactivos de televisión digital.

Estamos hablando de um país donde 97% de la popblación urbana posee televisión (IBGE, 2015) e donde circulam 244 millones de mobiles, siendo que 67,48% son aparatos de prepado (Anatel, dezembro de 2016)[2]. Es decir, la gente es compradora de tiempo y, en general, son más recibidores que productores de videos, informaciones o datos . Como si fuera poco, 51% de los aparatos móbiles son de segunda generación, de acuerdo con datos de UIT (2015).

El proyecto de televisión digital interactiva de Brasil exportado para 19 países, ha encuentrado espacio en Latinoamérica y África, países de bajo acceso a redes de internet de banda ancha y donde el acceso a internet se concentra en las capita-

[1] Los recursos de interactividad – a través de la capa de middleware fueron creado em (removed for blind review)). Esa capa de middleware desarrollada a partir del lenguaje NCL/Lua se quedó conocida como Ginga C. La interactividad permite que las audiencias "hablen", utilizando en control remoto con el campo de la producción de contenidos audiovisuales (empresas, instituciones y/o órganos de gobierno). Es decir, las audiencias particularmente de baja renta, sin recursos, dejan se ser solamente recibidores de informaciones.

[2] Disponible en www.teleco.com.br.

les, en las grandes ciudades y en los barrios de clases alta y mediana, donde no existen zonas de sombra[3].

Entretanto, televisión digital interactiva hasta entonces era una propuesta desarrollada en el ámbito académico y aún corre el riesgo de seguir siendo, pues está pendiente de las políticas públicas para el sector. Los primeros testeos de campo[4] fueron puestos a prueba a través del Proyecto Brasil 4D en Paraiba (2013) y en el Distrito Federal (2014/2015), coordinado por la Empresa Brasil de Comunicación (EBC)[5], la empresa pública federal de comunicación. En la etapa Distrito Federal el proyecto ha involucrado distintas etapas del proceso de implantación, como engeniaria, informática, diseño y comunicación. En este caso, especificamente para la produción de contenidos y aplicaciones audiovisuales interactivas para televisión y videojuegos. Recentemiente aparecieron iniciativas (personales) de investigadores ligados a la Entidad Administradora da Digitalización (EAD) en Campo Grande (GO)[6] y en el Districto Federal[7] en 2016 que han intentado comprobar las posibilidades de inclusión social y digital de la TVDi.

A ejemplo de otros países el cronograma de televisión digital en Brasil ha ocurrido por distintos motivos, entre ellos la falta de infraestructura del país para realizar el pasaje del modelo analógico al digital. También hubo un constante intento de frenar los recursos interactivos en las reuniones del Fórum do Sistema Brasileiro de TV Digital (SBTVD) que se han extendido a las reuniones del Grupo de Implantación del Proceso de Redistribución y Digitalización de Canales de TV y Retransmisoras (GIRED). Hubo una constante tentativa de retirar los aplicativos y contenidos audiovisuales interactivos ofrecidos a las familias de baja renta hasta al punto de restringir el beneficio a las familias participantes del Programa Bolsa Familia, dejando de afuera otras 12 millones de familias participantes de otros proyectos sociales.

Aparte las dificultades, el middleware de la interactividad, el Ginga C[8] - la versión más completa que permite interactividad plena y gratuita en los aparatos de televisión digital y aparatos móviles con sistema One Seg – es la oficialmente válida en Brasil. Pero, ¿ cual la diferencia entre el mundo oficial – el middleware elegido por el gobierno en 2007 es el Ginga C - y la práctica de la campaña realizada en

[3] Zonas donde la señal de internet alcanza. En muchos barrios pobres hay zonas de sombra, incluso para el señal terrestre de televisión

[4] Sobre los testeos de campo en Paraíba, mirar el informe "Impacto Sócio-Econômico da TV Digital em João Pessoa", coordinado por Andre Barbosa Filho, editado por Castro (2014), publicado por EBC/Banco Mundial y que está disponible gratuitamente en internet). Mirar también los artículos sobre el Proyecto Brasil 4D en Distrito Federal en Castro (2014, 2015, 2016 e 2017).

[5] Disponible en http://www.ebc.com.br

[6] Sobre el tema, mirar el trabajo de Deisy Feitosa disponible en internet.

[7] Sobre el tema mirar el trabajo de Alexandre Kieling disponible en internet.

[8] Hay dos tipos de Ginga: uno mas restricto, sin interactividad, llamado Ginga A, que interesaba más a las empresas.

2016 en el Distrito Federal por la empresa EAD formada por los representantes de las empresas[9] de telefonía móvil vencedoras de los 700MHz y también por representantes de las empresas de televisión¿ Esa no es una campaña restricta al Distrito Federal. Se trata de una campaña que también está siendo realizada en 2017 otras partes del país, como en San Pablo, la provincia con más grande población del país, con 44,6 millones de habitantes.

En Brasilia y otras nueve ciudades del entorno el apagón analógico ha ocurrido en 17 de noviembre de 2016. Este artículo analiza el resultado de las entrevistas estruturadas realizadas con 56 familias que solamente fueron informadas sobre os beneficios de la interactividad en el día de la entrevista, pero sin comprobar la práctica interactiva. Eso porque la campaña realizada por EAD con toda la infraestructura de divulgación de los medios de comunicación comerciales, incluso con la participación de artistas de telenovelas y cantantes de Red Globo y con la participación y apoyo de asociaciones de la industria no ha tratado del tema interactividad, no trató del tema interactividad.

Como es posible observar abajo en la foto 01 del sitio web de la campaña Sea Digital en internet, la invitación para conocer los beneficios de la televisión digital apuntan para: 1) la mejora de la imagen; 2) para una mejora en el sonido; 3) el fin de los ruidos e interferencias; 4) la posibilidad de la movilidad y de la interactividad y 5) la continuidad de la gratuidad en la televisión digital abierta. Entretanto, además de esa frase – posibilidad de interactividad – no hay ninguna otra explicación sobre lo que es interactividad, cómo funciona en televisión abierta o cómo aprender a utilizarla.

Fig. 1. Sitio Web de la campaña Seja Digital

[9] Vivo, Claro, TIM y Algar

2 El Público de la Transición del Analógico al Dgital

De acuerdo con estudios de la Investigación Nacional por Amostra por Domicio (PNAD/IBGE) de 2015, 45% de la población de Brasil, es decir 66, 1 millones de de casas, ya ha migrado para el sistem digital. Entretanto, es preciso tener cuidado con ela afirmación, ya que la migración digital se concentra entre las clases altas de la población, la que no necesita de los servicios interactivios de la televisisón digital abierta, pues suele comprar aparatos digitales de última generación y poseen acceso a internet.

En el Districto Federal, el índice de migración para el mundo digital es todavia más grande, ya que el DF posee uno de unos mas altos patrones de vida del país, particularmente por la media de soldo de la funcionarios del Judiciario, Legislativo o del Ejecutivo.

De otro lado, 55% de la población del país, 80,6 millones de los brasileños – casi el doble de la población de España, por ejemplo) – todavía miran televisión analógica. Y, como sus compañeros del Programa Bolsa Familia y de proyectos sociales del DF beneficiados por los equipamientos de telelvisión digital que han participado de la investigación de campo, siguen tendo en la televisión su más grande fuente de información. Y es exactamente ese público que la interactividad podría beneficiar en la práctica. Fueron entrevistados familias, en general de grande porte, que ganan entre 01 suledo mínimo[10] y 03 sueldos mínimos[11] que viven en ciudades y barrios con elevado índice de inseguridad urbana donde miran más television.

La relación entre pobreza y aumento de la audiencia televisisva no es algo novedoso, pero muchas vezes es olvidada por estudiosos de distintas lineas teoricas que analizan el mundo a partir del punto de vista de los países desarrollados o aún a partir del mundo y del barrio donde viven, una burbuja que incluye las clases media y alta, repercute en los medios de comunicación y es analizada en la academia. Por eso no es raro en Brasil que se lea o escuche discursos académicos y técnicos que apunten que "toda la gente tiene acceso a internet", que "comprenden las tecnologías digitales aunque 30% de la población siquiera tenga tarjeta en los bancos o sepa como ultizar un cajero electronico" (IPEA,2013). Otro discurso burbuja es la afirmación de que los jóvenes ya no asisten televisión, cuando la gente, independiente de clase social, sigue mirando narrativas audiovisuales desarrolladas en el formato televisivo, aunque no necesariamente en una pantalla televisiva.

Eses discursos enseñan desconocimiento sobre la realidad brasileiña, la probreza general existente en el país, en especial familias de baja renta que residen en areas de dificil acceso y con bajo nivel de alfabetización, ya sea analógica o digital. Eso apunta un borramiento por sectores de la academia de una parte importante de la

[10] Actualmente vale 221 dólares. Busca en internet realizada em 17/07/2017.
[11] Actualmente vale 663 dólares. . Busca en internet realizada em 17/07/2017.

población, aquella que no tiene acceso al mundo del consumo, que no puede ser llamada de producer y que, sistematicamente es borrada de los análises sócio-esconómicas, tecnológicas o comunicaciones. E ese sentido, los resultados de la investigación de campo ayudan a pensar desde la inclusión social y digital, para un grupo social que no tiene condiciones de comprar contenidos audiovisuales ni tampoco apliacaciones, pero que necesita urgente de la interactividad de televisión digital como espacio de información, comunicación, estímulo a ciudadanía y a la literacia digital.

3 ?Qué Dicen las Entrevistas?

Además de enseñar um público pobre, sin inclusión digital y pendiente de los programas sociales ofrecidos por el gobierno federal o distrital, los 56 entrevistados tienes huecos importantes en la formación eudcativa, pues 50% tenía el primer grado incompleto, 02 no sabían leer y de todo el grupo solamente 01 persona ha concluído el según grado. De acuerdo con la Unesco (2016), en Brasil hay 12,9 millones de analfabetos, lo que representa 8,3% de la población con más de 15 años.[12] Y en esta reflexión nos hemos restringido a los totalmente analfabetos, porque hay otros 14% de la poblacion que es considerada analfabeta funcional. Es decir, sabe leer, pero solo compreende frases sencillas, no alcanzando párrafos completos.

El nível educacional se refleja en las ocupaciones y sueldos. 20% de los entrevistados eran mujeres, dueñas de casa; otros 15% estaba desempleada (independiente de género) y 7% estaba jubilada. Entre los que poseen ocupación, pasan trabajando hasta 12 horas por día, volviendo a la casa solamente para dormir entre familias que llegan a tener has nueve personas de distintas generaciones conviviendo en el mismo sitio.

Al público entrevistado le encanta la televisión abierta (92% de los entrevistados), particularmente los telediarios y las telenovelas. Entre esse público, 74% cree que lo que pasa en la televisión el muy real. Eso refuerza un estudio realizado por Instituto Reuters en 2017 que ha apuntado que 60% de la población brasileña todavía cree en los medios de comunicación, en especial la televisión abierta, ya que en Brasil solamente 18% de la gente posse televisión de pago (Anatel, 2016).

La mayor parte de la gente (66%) posee un aparato de television en casa, siendo que 90% de la gente poseía un o dos aparatos analógicos. En 2014, un estudio con 60 familias realizado por televisón pública (EBC) ha apuntado que 1/3 de los entrevistados tenían aparatos de 14 pulgadas. Eso ha obligado a los expertos y

[12] En el mundo existen 758 millones de adultos que no saben leer sabem ler . Disponible en https://noticias.uol.com.br/ultimas-noticias/bbc/2017/03/17/aos-42-anos-catadora-de-lixo-aprende-a-ler- com-filho-de-11-anos.htm?cmpid=copiaecola. Acceso en marzo de 2017.

técnicos a replantear el desarrollo de aplicaciones y narrativas audiovisuales interactivas adaptados a esse formato de aparatos tecnológicos. Distinto de las clases mediana y alta, 63% de los entrevistados no tenía pantalla plana ni tampoco smart television. Es decir, es necesario proponer proyectos tomando en cuenta que la gente no tiene presupuesto para pagar por aplicaciones y contenidos audiovisuales interactivos, tomando en cuenta que no poseen eses aparatos en sus casas y que 18,5% de los entrevistados siquiera conocían esas tecnologías ni tampoco su significado.

Ese mismo público que se queda en según plane en la hora de proponer políticas públicas, pero que son el espejo de una población de 80 millones de personas, ha afirmado que nunca ha usado internet o la ha utilizado solamente una vez en la vida (71%). Ese porcentaje representa las dificultades de la población de baja renta a acceder a un mundo digitalizado de acuerdo con los informes académicos, las noticias del telediario que invitan cotidianamente a la gente a acceder a su sitio web para tener más informaciones. Entre aquellos que poseen acceso a internet, muchos utilizan desde la casa de amigos o parientes, utilizan desde el trabajo o desde la escuela. 30% de los entrevistados ha afirmado que sensillamente no accesa inernet[13].

Em cuanto a la utilización de aparatos móviles, 69% de los entrevistados poseen smartphone y otros 43% poseen aparatos sin acceso a internet. Los aparatos en general son utuilizados para recibir llamadas o combinar trabajos temporales. La mas grande parte de la gente no utuliza los móviles para mirar televisión porque no poseen aparatos con sistema One Seg, que permite acceso gratuito a televisión digital. Entretanto a 77,8% les encantaría tener un modelo de móvil que les permitise mirar televisón gratuitamente.

Esa respuesta permite apurar el desconocimiento de la gente – independiente de clase social o nivel educativo – sobre el sistema One Seg o mismo sobre los recursos interactivos de televisión que puden ser utilizados también en los móviles. Eso ocurre porque la campaña distrital y nacional de EAD no habla sobre eso ni lanza luz a esas importantes imnovaciones. Tampoco las empresas de telefonía móvil se han interesado en realizar divulgación masiva sobre sus aparatos con One Seg, ya que el precio de los aparatos no es compatible con el presupuesto de la población de baja renta.

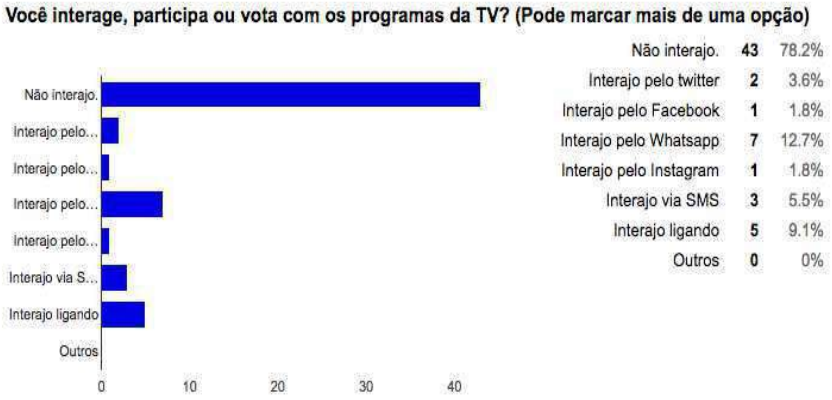
4 Interacción e Interactividad

En Brasil, la televisión abierta – a diferencia de los países europeos y muchos países de Latinoamérica que utilizan televisión de pago – sigue teniendo un rol central en la vida de la gente, particularmente entre las audiencias de baja renta. Pero esa

[13] Entre los que usan Internet, o *Whats App* (WA) es la red social digital preferida (97,3%), seguido do *Facebook* (89,2%). *Whats App:* es uma aplicación que permite recibir llamadas sin cobro, desde que haya conexión con Internet.

centralidad todavía sigue el modelo analógico en términos de costumbres, porque la gente prefiere comentar la programación con otras personas y no a través de otros dispositivos (50% de la gente que tiene acceso a internet), Algo muy distinto de las clases alta y mediana.

Entre el grupo que tiene acceso a internet, les gusta comentar los programas de televisión en Facebook (14,8%), utilizando un aparato móvil. Para los entrevistados, mirar televisión sigue siendo una manera de estar acompañado, hacer parte del mundo y desarrollar lazos sociales, manteniendo temas y charlas comunes entre las personas.



Quadro 01. Interacción com otros Dispositivos. Fuente: Estudios de Contenidos Digitales Transmidiáticos e Interactivos

En lo que respecta a la diferencia entre el señal analógico y el digital 100% de los entrevistados apuntaron una mejora en la señal transmitido y 57% una mejora en el sonido. Entretanto, casi nadie apuntó la interactividad como un diferencial del proyecto brasileño, como enseña el cuadro 02.

Eso ha pasado porque la campaña de EAD no enseña a la gente cómo utilizar los recursos interactivos. Solamente cuando los entrevistadores llegaban en la casa y hablaban sobre cómo es la interactividad en la practica es que la gente de baja renta lograba imaginar los cambios posibles con acceso a través del control remoto. Pero a diferencia de las experiencias de la televisión pública de Brasil en Paraiba y en el DF - donde la gente ha participado de workshops sobre cómo usar y conocer para qué sierve televisión digital interactiva; donde la gente pobre ha experimentado los contenidos y aplicaciones digitales por lo menos por un mes – en el Districto Federal hubo un terrible borramiento oficial sobre el tema.

Cuadro 2. Cambios en la Televisión.
Fuente: Grupo Estudios de Contenidos Digitales Transmidiáticos e Interactivos

5 Para Finalizar

Dos preguntas enseñan bien la falta de interés en enseñar y practicar la interactividad en televisión abierta y apunta la interactividad como la gran excluida de la campaña nacional sobre televisión digital, dónde los aspectos técnicos del imagen y sonido fueron supervalorados. El Cuadro 03 apunta que 74,5% de los entrevistados siquiera tiene noción del significado de la palabra interactividad y su utilización en televisión digital abierta.

Cuadro 03. Conocimiento sobre Interactividad.
Fuente: Grupo Estudios de Contenidos Digitales Transmidiáticos e Interactivos

Como un reflejo de lo que ocurre en el resto del país do solamente 7,3% dos entrevistados – cuatro personas - ya habian utilizado alguna aplicación o mirado contenidos audiovisuales con recursos interactivos nen televisión Digital.

Cuadro 04. Desconocimiento sobre TVDi.
Fuente: Grupo Estudios de Contenidos Digitales Transmidiáticos e Interactivos

Otros 92,7% de los entrevistados han afirmado que no conecen y consecuentemente, no no han utilizado los recursos interactivos disponibles en la caja de conversión que han recibido.

Es decir, no es posible utilizar lo que no se conoce.

Al seren cuestionadas (y al tener derecho a la voz), las personas han revelado que desean recibir cursos de capacitación, tener acceso a las notícias sobre deportes, programar alarmas por la televisión para tomar medicinas por ejemplo y particularmente para recibir informaciones actualizadas sobre derechos ciudadanos.

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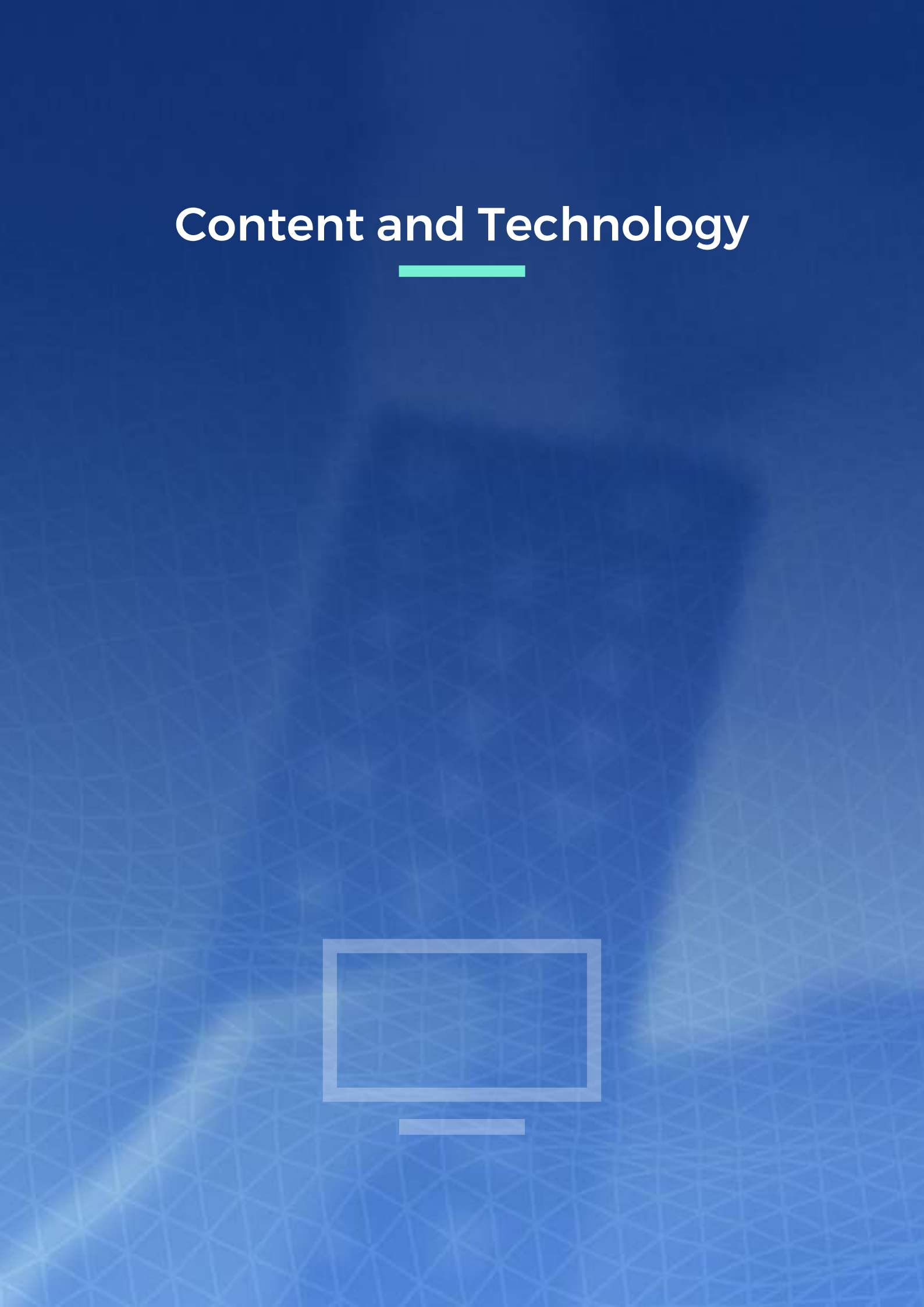

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An end-to-end toolset for the creation and delivery of video-based multi-device content

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Abstract. We introduce an end-to-end toolset for the production and delivery of synchronous multi-device content. We outline the application scenario requirements and the challenges involved in creating video content that works across the TV, companion screens and head mounted displays. We describe the three main components of the toolset. The production tool is implemented as a custom Adobe Premiere Pro plugin. The publication and delivery process is implemented as an online service controlled through a web application. The content playout is implemented with a multi-device video player that combines video decoding and playout based on the GStreamer media framework, combined with the Unity3D game engine. Finally, we detail the system performance on different devices, and next steps.

Keywords: Multi-device synchronization, multi-device content, virtual reality, omnidirectional video

1 Introduction

The majority of TV consumers now watch TV programs in a multi-display environment [5]. Companion screens –most often smartphones - are generally used to check information not directly related to the events in the TV content being watched, or to interact in social media on topics related to the broadcast [1], sometimes at the expense of local social interaction [2]. Broadcasters have tried to orchestrate these different platforms, and there is reason to believe this contributes to user engagement [7]. Traditionally, companion screen applications have been developed ad hoc, and only very recently the industry has considered the need for specific production tools and production processes adapted to the reality of multi-device consumption [4]. In this context, it remains challenging to create and deliver synchronized video across the TV and companion screens.

The arrival of virtual reality devices to the living room introduces more possibilities, but also further challenges. To deliver the feeling of *being there*, head-mounted displays (HMDs) need to support sensorimotor correlations [10]. Since traditional video was not conceived to support interactive rendering techniques, the solution generally adopted in the audiovisual industry is the delivery of an omnidirectional video stream. Omnidirectional video is quite different from traditional video: the rendering process

requires the image to be projected, typically, on a sphere or on a cube, and only a small portion of the image is rendered, depending on the head orientation of the user, as detected by the HMD. As a consequence, an image of much higher quality has to be transmitted to render the same effective quality on the end-user screen.

In this article we introduce our efforts to enable the easy creation and delivery a new form of broadcast multi-device video within the European H2020 ICT project ImmersiaTV[1]. The main challenge addressed is to streamline the creation and delivery of a video-based synchronous experience across displays, including TV, companion screens such as tablets and smartphones, and HMDs. An additional challenge addressed is that we want the content delivered to be device-specific both in terms of video format (omnidirectional or traditional) and on how it supports interactive input (or lacks interaction support, for the case of the TV). For TV, this means that content can be consumed simply by sitting on the couch and watching, without further input, and that the audiovisual language used follows established conventions. For tablets and smartphones, it means that user input works seamlessly with the specificities of each device (head movements for HMDs, or finger-based input for smartphones or tablets).

To address these requirements, we have designed and implemented an end-to-end production, delivery and rendering pipeline for offline content production which specifically addresses these needs. In the following sections we further outline the design principles adopted, the modules developed, the performance of critical components, and next steps.

Fig. 1. Left: an image typical of a traditional TV showing a football match. An insert informs the consumer that content is also available for tablets and HMDs. Right: a capture of an omnidirectional video with inserts of traditional cameras. This content is delivered synchronized with the main TV stream. Image courtesy of Lightbox (www.lightbox.pt).

2 Design principles and related work

2.1 Synchronous multi-platform playout

To create content for all devices, we need to create content that is adapted to each of them, and play it synchronously [5,7,12] . To play synchronized content, we have

[1] www.immersiatv.eu

adapted emerging standards[2] and Gstreamer's version of the Precision Time Protocol (IEEE 1588)[3], as done, for example, in [11]. We have also embraced the use of omni-directional video for HMDs and smartphones, in order to allow the user to visualize the scene in different directions. In other terms: the audience is still able to watch TV sitting on their couch, or tweet comments about it. However, the audience can also use immersive displays to feel like being inside the audiovisual stream, or use tablets and smartphones to explore these omnidirectional videos, or even, in the future, to zoom in, or share portions of it through social media.

Fig. 2. Top: a camera setup to record traditional and omnidirectional video simultaneously. Bottom: a schematic diagram of possible directive inserts located within the omnidirectional video. Image courtesy of Lightbox (www.lightbox.pt).

[2] http://www.etsi.org/deliver/etsi_ts/103200_103299/10328601/01.01.01_60/ts_10328601v010101p.pdf

[3] https://gstreamer.freedesktop.org/data/doc/gstreamer/head/gstreamer-libs/html/GstPtpClock.html

2.2 Portals

The idea of portals is inspired from the homonymous and famous videogame Portal.[4] In the context of streaming omnidirectional video, we introduce the idea of portals as video inserts that can be rendered in the HMD. These portals can be portions of other omnidirectional videos, which allows introducing basic interactive storytelling techniques such as scene selection or forking paths. These portals can also be inserts of traditional or directive videos. These traditional video inserts also allow reintroducing classical audiovisual language that is not possible to render solely with omnidirectional videos, such as close-ups, slow motion, shot-countershot, etc. (see also Fig. 2). These strategies will not avoid the necessary precautions needed for shooting omnidirectional video [8], but they offer more options to integrate classic audiovisual conventions, particularly in a TV-centered consumption context.

3 An end-to-end pipeline

Designing and implementing a broadcast audiovisual production chain is challenging due to the diversity of processes, technologies and production practices that it requires. In this section we outline the main solutions, either adopted or implemented, for our purpose, with content examples.

3.1 Capture

The creation of content that is both omnidirectional and traditional requires shooting simultaneously in both content formats. Preliminary tests with separate shootings for omnidirectional and traditional cameras revealed it was unfeasible to synchronize two different shootings, even when the actors in the scene were repeating the same actions.

The solution found by the production team was to use two *BlackMagic Micro Studio Camera 4k* micro-cameras for the traditional shooting, which could be hidden or, if visible, removed in post-production with a reasonably small amount of effort. This combined with an omnidirectional capture rig composed of 6 GoPro 3 Black Rig cameras allowed capturing simultaneously traditional and omnidirectional footage. However, for a joint shooting, we must address the fact that omnidirectional cameras capture the whole visual field, and therefore would show the traditional camera and the film crew behind it. This is not problematic for sports or music events, but it goes strongly against the conventions of fiction or documentary.

3.2 Edition

Dedicated stitching tools such as video-stitch studio by Video-stitch, or Autopano by Kolor, allow stitching video footage captured with camera rigs in order to create om-

[4] http://store.steampowered.com/app/400/

nidirectional video. Tools for omnidirectional video edition, such as CaraVR[5] and Mettle's suite[6] allow further post-production. However, we are not aware of an editing tool targeting synchronous rendering across devices. To address this fact, we have designed and implemented a plugin for Adobe's Premiere Pro. The ImmersiaTV Premiere Pro plugin allows defining the inserts that are placed within an omnidirectional scene, and how they should behave relative to the movements of the user. For example, they can either be static on the screen, or static on the omnidirectional scene. They can also trigger transitions between different omnidirectional videos.
The ImmersiaTV Premiere Pro plugin also allows selecting which tracks should be rendered in each of 3 possible devices (TV, tablet or HMD). It works both with Mac and Windows, and we have validated that, after going through a tutorial, a normal editor can use it to create multi-platform content.

3.3 Encoding

The media encoding uses readily available and methods, concretely H.264 and AAC encoding, and adaptive bitrate streaming based on MPEG-DASH (ISO/IEC 23009-1:2014). Encoding is implemented as a cloud service, running on a Linux server using the Dockers virtualization tool as well as MP4Box from Gpac's MP4Box for MPEG-DASH multiresolution encoding[7].Video decoding uses the Gstreamer library[8].The additional metadata required for playout, which relates audiovisual streams with devices (i.e., allows selecting different streams for TVs and tablets), as well as to define interaction and media orchestration requirements, follows closely the format of MPEG-DASH manifests, and its XML specification is publicly available.[9] Content publication is performed through a custom built website which allows triggering media conversion, as well as monitoring progress on media encoding and publishing content generating a list of content parsed at the delivery stage.

3.4 Delivery

To combine universality, ease of use and flexibility, we combine an app-based solution together with a player based on web technologies. In both cases, metadata parsing is done with a custom parser, which also generates the appropriate geometry and provides the DASH player with the appropriate DASH manifests.

The web player is based on WebGL and MPEG-DASH, implemented in a module for the generation and reproduction of the contents, and based on three.js and dash.js standard libraries. A second module synchronizes the contents following the DVB-CSS standard. Our web-based solution allows scene rendering without third party players or native applications. It can be served from a Content Delivery Network (CDN), allowing automatic updates of both the contents and the player. In addition,

[5] https://www.thefoundry.co.uk/products/cara-vr/
[6] http://www.mettle.com/
[7] https://gpac.wp.mines-telecom.fr/mp4box/
[8] https://gstreamer.freedesktop.org/
[9] http://server.immersiatv.eu/public_http/metadata/ImmersiaTV.html

since it is based on web standards, it can be easily adapted to HbbTV solutions. In practice, this solution can reproduce up to 4096x2048, with 15Mbps of bitrate and 30frames per second. However, web-based solutions are intrinsically limited by the web browser stack to support communication and streaming technologies. For our use case, this has limiting implications for performance, codec constraints and hardware integration.

As an alternative, to facilitate the integration of video rendering with user input on native apps, the simplest option seemed to combine GStreamer, the reference library for multimedia pipelines, and Unity3D, the most accessible game engine for video-game and virtual reality developers. We designed and implemented the GStreamer Unity Bridge (GUB) to realize precisely this. The GUB has three parts. The GStreamer part receives the video and decodes it. This process is based on the GStreamer component playbin, and allows playing at least .mov, mp4 and MPEG-DASH. The texture passing is a key technical element: each frame decoded in GStreamer is passed to Unity3D as a hardware texture, and is suitable for rendering in the standard game engine environment. Specific code for windows (Direct3D 9) and Android (OpenGL-ES 2.0) has been developed for texture passing.

Table 1. Performance measurements for different test vectors, showing Frames Per Second and estimating a Mean Opinion Score. Test vectors are: Test vectors: Hd (1980x1080) , Bitrate: 3 Mb/s ,Framerate:25 , Codec: H264, 2K (2560x1440) , Bitrate: 3,5 Mb/s ,Framerate:25, Codec: H264; 4K (3840x2160) , Bitrate: 5 Mb/s ,Framerate:25, Codec: H264 PC is Processor: Intel Core i7-6500U CPU @ 2.50Ghz, Ram: 16Gb, Graphics card: Intel Graphics 520, SO: Windows 10 Home edition 64 bits

Device	Test Vector	FPS	MOS
Samsung S6	4K	25	5
	2K	25	5
	HD	25	5
Samsung S7	4K	20	4
	2K	25	5
	HD	25	5
Galaxy Tab S	4K	--	0
	2K	20	4
	HD	25 fps	5
PC	4K	25	5
	2K	25	5
	HD	25	5

In addition, since copying full textures between system memory and the graphics processing unit (GPU) can have prohibitive performance costs at certain resolutions,

particularly in low-end devices such as Android mobile phones, in the Android pipeline we have implemented a *Rendering to Texture* solution based on a Frame Buffer Object. This allows rendering a frame decoded in Gstreamer without leaving the GPU, which brings significant boost in performance. Despite the overhead of handling a 3D Engine like Unity3D, the GUB can play resolutions that are competitive with commercial players (see table 1). However, we also need to consider that rendering for mobile-based HMD, either cardboard or Samsung GearVR, imposes a double rendering process (one for each eye), which further decreases performance. Therefore, despite we can currently reproduce synchronously video up to 4096x2048, bitrate of 50 Megabits per second (Mbps) and 30 frames per second on a Samsung Galaxy S6, this resolution drops to 1024x512, bitrate of 2.3 Mbps and 25 frames per seconds when VR rendering is required.
To facilitate user adoption, we have made it publicly available under a LGPL license,[10] raising considerable interest (In the first 10 months since it was published, we have had an average of over 250 downloads per month).

4 Conclusions and future work

We have developed an end-to-end solution to enable the production and delivery of video-based multi-device synchronous and, at some extent, interactive experiences, with a performance that is comparatively equivalent to standard commercial videos. Performance tests show that the limit in delivered quality is determined by hardware processing load, rather than bandwidth limitations. Further work will be needed to optimize the media quality delivered, particularly for VR-based content, which requires separate renderings for each eye. For this purpose, tiling strategies [6,9] seem a good direction to explore. For mobile devices, we are also considering more heterodox DASH client which considers additional factors, beyond bandwidth, to select the most appropriate encoded quality [3]. On the content creation side, further development of content examples exploring more exhaustively the interaction possibilities enabled by inter-device is a different but complementary work that we would also like to pursue. In this direction, further work to refine and expand the possibilities given by the ImmersiaTV Premiere Pro plugin is desirable, particularly regarding the definition of interactive functionality, such as how the consumer's input affects the media being rendered, or other aspects of the experience.

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[10] https://www.assetstore.unity3d.com/en/#!/content/59897

Piesik, from PSNC, as well as Ibai Jurado, David Gómez, Einar Meyerson, David Cassany and Juan Gordo from i2cat Foundation.

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360º Hypervideo: an interactive documentary around the refugee crisis in Greece

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Abstract. We present an interactive 360º documentary around the migratory crisis in Greece. Omnidirectional content is recorded using a 6-camera array and rendered in an equirectangular projection and played later by an HTML5 web application. Interactive hotspots are placed on specific coordinates of the space-time of the production, introducing a connection of the viewer with the story by playing additional multimedia content. Usage analytics are recorded and permit us to obtain metrics on the user behavior, like most popular areas or most viewed additional content, and detect possible usability issues.

Keywords: Hypervideo, 360º video, interactive documentary, 360º documentary.

1 Introduction

Over a million people have arrived in Greece since 2015. Refugees flee from war horrors and dreadful armed conflicts. Babies, children and elderly people are especially vulnerable. Migrants arrive and will be still arriving while conflicts last.[1] PROEM-AID[2] is a group of emergency professionals who voluntarily help in Greece.

Equipped with a 6-camera array, the team recorded 360º footage in the refugee camp and, together with additional, regular video content, we present a use case for a novel format of interactive documentaries, letting the user to explore a 360º video and obtain additional information in the form of audiovisual content at their request.

We propose the following format for describing an interactive experience with a 360º video: a main video track plays as a panorama, allowing the user to pan the scene and look at any direction. This track serves as a common thread for additional media that is linked to specific points in the space-time of the main track. In these moments, a marker is displayed in the scene, linking to a follow-up video of what is seen in the main track.

[1] Adapted from http://www.proemaid.org/en/lesbos/
[2] http://www.proemaid.org/en/

This section includes a revision of the current state of the art in interactive multimedia and documentaries and 360º videos. Section 2 details the creation of such media and the tools needed to make it interactive, play it and collect the users' actions. Section 3 introduces the initial results obtained from this work. Finally, the conclusion can be found in section 4, with some thoughts in the future.

1.1 State of the art

A hypervideo is a navigable stream of video that offers the viewer the possibility of choosing a path in the narrative combining several multimedia tracks through spatial and temporal links present in the media [1]. We extend this concept to support 360º media, including links around the sphere of the 360º panorama. Interactive documentaries have been analyzed in [2], encouraging users to explore and navigate the production, rather than simply viewing it.

Bleumers et al. introduce the users' expectations of omnidirectional video in [3]. 360º multimedia belongs to the field of virtual reality (VR) [4, 5]. This field has traditionally made use of several gadgets and devices to create an immersive experience, like head-mounted displays (HMD) or the CAVE [6]. Despite this, there is an increasing trend to display 360º video in an interactive scene inside web browsers in desktop and mobile devices, given the recent adoption of this novel medium by popular online video platforms, like YouTube[3] or Facebook[4], that have begun offering immersive 360º video upload and visualization services. This is thanks to the ability to display a 3D scene to project the equirectangular video texture inside the browser itself since the introduction of WebGL[5], in 2011. The current state of 360º video playback is shared between HMD like the Oculus Rift[6] and web based navigation in video services like the ones mentioned before, featuring a desktop drag-and-drop interface and a sensor-enabled view for smartphones. In the literature, omnidirectional lectures were given using HMD [7], a drag interface for 360º hypervideo is presented in [8], and more recently Augmented Reality has been introduced in smartphones [9].

Regarding the representation of the users' actions inside a 360º video, commercial solutions like Wistia[7] or LiveHEAT[8] use heat-maps to show the area in the 3D space that is watched by the users. Similar techniques are used in the literature [10, 11].

[3] https://youtube-creators.googleblog.com/2015/03/a-new-way-to-see-and-share-your-world.html
[4] https://facebook360.fb.com
[5] https://www.khronos.org/webgl/
[6] https://www.oculus.com/
[7] https://wistia.com/
[8] http://www.finwe.mobi/main/liveheat/

2 The interactive 360º documentary

In this section we will introduce how this production was created, by recording the raw images in situ and editing them, how these videos are turned interactive and how the final product is displayed in the viewers' web browsers.

2.1 Recording and editing

Two kinds of footage were recorded in the refugee camps in Lesvos and Piraeus, Greece: the 360º media and several linear clips. Four 360º scenes of approximately 90 seconds each were captured using a 6-camera array, placed on a stick. The media was stitched using Kolor's Autopano Video Pro[9], obtaining an equirectangular clip.

Since both the equirectangular and the linear clips were recorded using high bit rates, not easily supported by most network conditions, they were encoded following the MPEG DASH standard [12] into multiple bit rates. This resulted in several multimedia files and the MPD file for each multimedia file, including the 360º one.

2.2 Introducing the interactivity

The process of creating the interactive production from the main 360º video track and multiple linear video files is supported by a web application that generates the metadata needed to display the markers.

The editor application provides an interactive interface to edit the list of positions that this marker takes in the 360º video. The user is able to navigate the media to select a desired position in space and time to place one of these key positions. This application is designed and built with React[10], and makes use of a scene component to preview and place the key positions of the markers that is also included in the player.

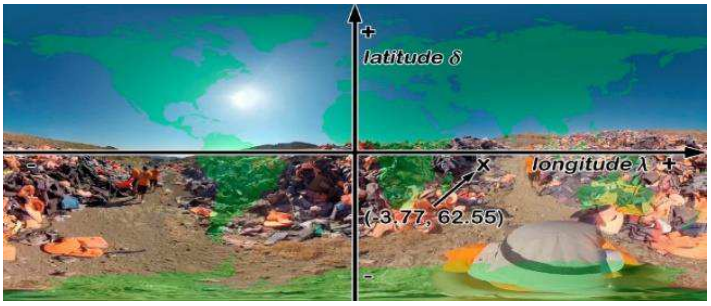

Fig. 1. Notation of latitude and longitude in the equirectangular frame

The representation of the positions of a given point of interest is a sequence of points (at least two) in the space-time of the 360º video track, where *t* is the time in seconds;

[9] http://www.kolor.com/autopano-video/
[10] https://facebook.github.io/react/

δ is the latitude in degrees from the equator of the scene; and λ is the longitude in degrees from the meridian zero of the equirectangular frame (see (1) and **Fig. 1**).

$$(t_0, \delta_0, \lambda_0), \ldots, (t_N, \delta_N, \lambda_N) \quad (1)$$

The additional metadata for each point of interest includes a descriptive name, an IRI (Internationalized Resource Identifier) to identify that point, the IRI of the video that should play when selected and an optional image to customize the marker that appears in the scene. This information is stored in a JSON file and retrieved by the player.

2.3 Playing the production in a web browser

Once the interactive 360º video has been defined, it can be played in a WebGL enabled browser. The player is also a web application built with React, and it recycles the same scene component included in the editor to display the 360º video. This time, the extra functionalities of this scene are enabled: the video controls, the marker help area and all events are actually listened (see **Fig. 2**).

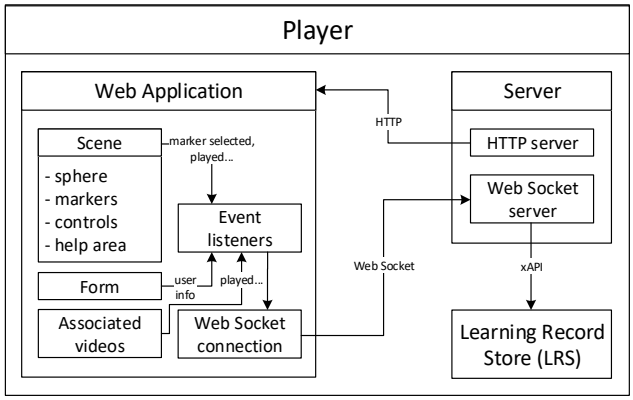

Fig. 2. Architecture of the interactive 360º video player environment.

Before playing the production, a form prompts the user to share some personal information (gender, age, profession, country) with us, so we will be able to obtain some statistics by this information.

By listening these events, the player is notified when a marker is selected, so its associated video will play in a pop-up view, interrupting the main track playback. When this video ends or the user closes the pop-up view, the main playback continues.

A Web Socket connection is established with the server keeping track of these events, which are stored in a Learning Record Store (LRS) via the Experience API (xAPI).

Every video file in this production has been encoded at multiple bit rates. In the player side, the MPD manifests are loaded by the DASH.js[11] JavaScript player and, when the media starts playing, it automatically adapts its bit rate.

The 3D scene. This component, shared by the editor and the player, houses a WebGL scene managed by Three.js. The core of this scene is the sphere used to display the frames of the 360º texture provided by the main equirectangular video track. This component is provided the list of points of interest, from which circles are created in their respective positions, firing an event when selected. That position is calculated via linear interpolation in spherical coordinates using Ed William's aviation formula[12]. For a particular time t, $t_0 \leq t \leq t_1$, and knowing two key positions at t_0 and t_1, $(t_0, \delta_0, \lambda_0)$ and $(t_1, \delta_1, \lambda_1)$, the position p_t in Cartesian coordinates for that marker in that time at a distance of R is obtained via (2).

$$
\begin{aligned}
f &= \frac{t - t_0}{t_1 - t_0} \\
d &= \cos^{-1}[\cos\delta_0 \cos\delta_1 \cos(\lambda_0 - \lambda_1) + \sin\delta_0 \sin\delta_1] \\
A &= \frac{\sin(1-f)d}{\sin d} \\
B &= \frac{\sin f \cdot d}{\sin d} \\
p_t &= R \begin{bmatrix} A\cos\delta_0 \cos\lambda_0 + B\cos\delta_1 \cos\lambda_1 \\ A\sin\delta_0 + B\sin\delta_1 \\ A\cos\delta_0 \sin\lambda_0 + B\cos\delta_1 \sin\lambda_1 \end{bmatrix}
\end{aligned}
\tag{2}
$$

To be able to detect when a marker is selected, intersections are looked for with a ray casted from the camera position to the selected position. Other events are fired when play conditions change, that will be used by the component that includes the scene, either the editor or the player.

Fig. 3. User interface of the interactive player, featuring the markers in the scene, the help zone with its markers and the controls with its PoI appearances.

[11] https://github.com/Dash-Industry-Forum/dash.js/
[12] http://edwilliams.org/avform.htm#Intermediate

Additional parameters can be passed to the scene to enable two player-specific features: the controls to adjust playback of the 360º video, featuring a progress bar that hints the times when points of interest appear and a help area that displays again the markers that are shown somewhere in the scene, so the user can still see them if they are outside the camera's field of view (see **Fig. 3**).

Usage tracking. The events fired by the scene are listened by the player and then forwarded via a Web Socket connection to the server. Instead of collecting all the data and submitting it in the end, this approach was chosen to permit us to visualize in real time the users' actions. Once this information is received by the server, it is stored into the LRS via xAPI. See **Table 1** for a relation between events and statement verbs. The vocabulary used in this application is based on ADL's video vocabulary [13] and on the general xAPI vocabulary registry [14]. Additional vocabulary has been created and submitted to the general registry.

Table 1. Relation between events and xAPI statement verb IRIs

Event	Verb
The form is submitted	https://w3id.org/xapi/adl/verbs/logged-in
A video track is ready	http://adlnet.gov/expapi/verbs/initialized
A video track is played	https://w3id.org/xapi/video/verbs/played
A video track is paused	https://w3id.org/xapi/video/verbs/paused
A video track is sought	https://w3id.org/xapi/video/verbs/seeked
A video track ends	https://w3id.org/xapi/video/verbs/completed
The main video track is navigated	https://ltim.uib.es/xapi/verbs/lookedat
A marker is selected	http://id.tincanapi.com/verb/selected
The associated video is closed	https://w3id.org/xapi/video/verbs/terminated
The user closes the player	http://id.tincanapi.com/verb/abandoned

The actor for these statements is specified either with using their e-mail address, if provided, or a version 4 UUID as the name of a local account, to deal with anonymous users. The *logged-in* statement is sent to store the users' personal information. Just after that, an *initialized* statement is submitted specifying the main video's IRI, creating a video session from its ID, according to the video vocabulary.

The *played*, *paused*, *seeked* and *completed* statements are used according to the video vocabulary, attaching the following video extensions: *session-id*, *quality*, *screen-size*, *user-agent*, *volume*, *video-playback-size* and *time* (or *time-from* and *time-to*, in the case of a *seeked* statement, refer [13]). An additional extension is defined: *https://ltim.uib.es/xapi/extensions/orientation*, containing an object with the current view's latitude and longitude.

Following the same design, the *lookedat* statement is submitted when the user changes the current view. Successive submissions are throttled to 250 ms so as not to flood the LRS. In this case, *orientation-from* and *orientation-to* are used instead of the *orientation* extension, following the design of the *seeked* statement with *time*.

The *selected* statement is sent to the LRS whenever a point of interest is selected through its marker. This statement includes the additional data present in the *played* statement as context extensions and the IRI of the point of interest as a result extension. From this moment, the associated video window opens and it begins to load. When it does, an *initialized* statement is generated following the previous behavior, but specifying an object definition type of *https://w3id.org/xapi/video/activity-type/video* and still using the previous *initialized* statement ID as its *session-id*.

As it is natural, the user is free to interact with the associated video, and *played*, *paused*, *seeked* and *completed* statements will be generated much like previously specified, but with the following differences: the object definition type changes, as in this second *initialized* statement; this second *initialized* statement's ID is used as the *session-id* and the *orientation* extension is unused.

Whenever the user closes the associated video's window, a *terminated* statement is stored in the LRS, including the same additional data these previous statements would. This marks the end of the session of an associated video.

Finally, when the user closes the player, an *abandoned* statement is submitted, marking the end of the session.

3 Results

A preliminary set of results have been obtained so far from the data collected in the LRS using xAPI. An initial selection of the desired metrics and analysis is detailed next.

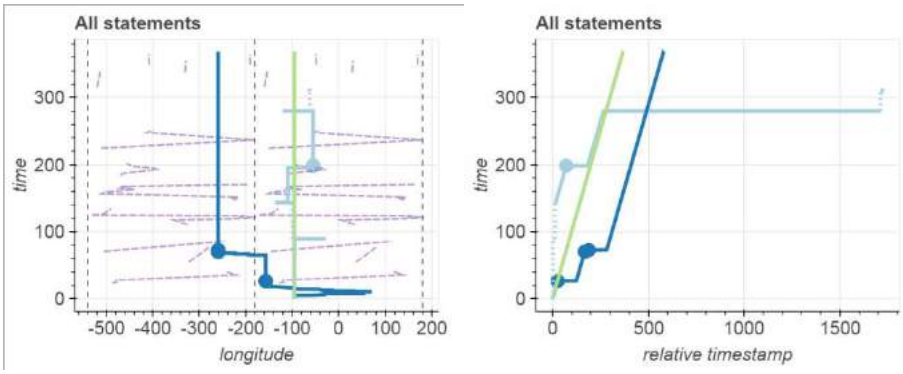

Fig. 4. Statements generated during three sessions.

For example, in **Fig. 4**, two complementary graphs are drawn with data coming from three different 360º video sessions (each session has its own color). They are complementary because the same information is represented in both graphs (with different coordinates). The graph on the left represents playback time (in seconds) versus longitude (in degrees). Dashed indigo lines are superposed to help us know where the markers are displayed in the scene (dashed black vertical lines separate consecutive 360º areas). The graph on the right represents playback time (in seconds)

versus relative timestamp (in seconds): relative to the *initialized* statement, to be able to coherently compare different sessions.

Solid lines indicate that the video track was played, was paused or was navigated. Dotted lines indicate that it was sought. Circles indicate that a marker was selected (and an associated video was played, partially at least). Any session starts at longitude -95º, as the left graph represents.

These graphs allow us to observe, very quickly, how a user has interacted with the video: if they have made left and right movements (the graph on the left tells us exactly where), if they have paused the video (the graph on the right tells us exactly how long), if they have selected markers (and which ones), if they have sought to a new point (the graph on the right tells us if a student has watched all the video content or just made jumps over it until they have reached the end), etc.

For example, in the particular case of **Fig. 4**:

- The green session corresponds to a user whose attention has not been grabbed by the interactivity offered by the activity: they have only played the 360º video from the beginning, nothing else.
- The dark blue session corresponds to a user that has moved left and right during the first 20 seconds, until they have played an associated video. Then they have continued watching the 360º video, without interacting with it, during about 40 seconds, followed by new movements before another associated video has been played twice. No more interactions come later and the 360º video has been watched until the end.
- The pale blue session corresponds to a user not interested in the beginning of the activity: they have directly sought to second 90 (where they moved for a while, with the 360º video still paused), followed by a new jump to second 140 (where new movements have been made). Then they have watched the 360º video, without interacting with it, during nearly 60 seconds, followed by some movements until they have watched an associated video. Later, they have watched the 360º video, without interacting with it, during about 80 seconds, at which moment they have paused the activity for around 25 minutes (1,500 seconds), with some movements in the meantime. Finally, they have sought to second 310 and have skipped the rest of the activity.

Although this is only an example of the many other possible results that can be obtained from user interactions, it starts to unveil the potential of this platform. By posting users' actions in a standardized way, studies can be conducted on the interactive experience by reading the statements generated by their actions using an analysis module, even permitting us to reuse this module to study other productions using different interactive paradigms, while xAPI statements are used.

4 Conclusion

The work presented in this document is an extension of the state of the art in interactive documentaries, introducing user-navigable 360º video and interaction in the form

of additional videos that give further details about a specific topic. A use case was conducted with 360º and linear video footage in the refugee camps in Lesvos and Piraeus, which resulted in an interactive web application available to the public. Precise user interactions are logged in real time and analyzed to comprehend their decisions and navigation choices in this novel format.

Knowing (almost) everything the user does with the application enables us to perform very accurate monitoring of their behavior. Simply by observing the proposed graphs we can detected, in a moment, in what proportion users watch the 360º video, both in time and in position: if a video is linearly played or if users like to move inside the 360º environment (and to what extent: if they navigate around markers or if they navigate randomly). This way, we could determine if the activity has been well designed (if most users fulfill it) or not. With a brief glimpse, we know which associated videos interest them most (and in which longitude and in which time their markers are selected). It could be analyzed, in a future, why some markers are less selected: because of their position inside the 360º video, because there are too many markers or because other reasons.Anyway, we have shown a very specific way of representing stored information about how the activity is used, just to try to explain the kind of system we have developed. As we have just mentioned, we know almost anything about video usage, so lots of other statistics could be obtained, depending on how we define our interests (for instance, studies about how each associated video is watched should be developed to get a deeper understanding of the goodness of the activity).

Further enhancements are planned for the 360º hypervideo model, introducing questions or quizzes and for the video player, designing a mobile specific interface, using the device sensors and enabling the use of VR technologies like Google Cardboard. We have realized there is an issue with bandwidth waste when streaming 360º videos, since a great part of the frames are not visible in the scene at a given time, strongly constraining playback in mobile devices. We will focus on solutions for this problem in the future.

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Towards a TV interaction model to elicit user preferences on a recommender system of informative videos

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Abstract. Technologies play an important role to promote higher levels of quality of life and independency of senior citizens. Given the popularity of television among seniors, in the scope of +TV4E project an Interactive TV (iTV) platform is being developed to provide these citizens with personalized information about public and social services from which they could benefit. This research is part of the conceptual phase of a recommender system of informative videos, aiming to assess seniors' preferences by identifying possible implicit and explicit feedbacks retrieved from interactions performed within the iTV application. The paper describes the methodology used to define an adequate interaction model to elicit seniors' preferences based on these feedbacks. Such interaction model will support the +TV4E content recommender system in selecting and matching the informative contents with the users interests accurately. Future works include prototyping and validating the interaction model in field tests with potential end-users.

Keywords: Interactive TV, User references, Recommender systems, Seniors, User profiling, Interaction model.

1 Introduction

Increasing human longevity is, by many reasons, an achievement to be celebrated, but it can be very problematic both for the individuals themselves and for those around them if no proper conditions for being independent, active, and healthy for a longer time are made available [1]. To promote greater levels of participation and autonomy in old age, a set of technological solutions to support seniors' daily activities in a more reliable and secure manner have been developed, in areas ranging from health, mobility and leisure to communication and work [2]. In this context, given the popularity of television among seniors in a daily basis [3–6], some of these technological solutions have used this device to improve wellbeing and quality of life by adding interactive features to the traditional television experience [7].

Particularly in Portugal, seniors often face recurrent scenarios of info-exclusion [8], low literacy levels [9] and digital divide [10], which makes them unaware of information regarding public and social services from which they could benefit (e.g. health

campaigns, income taxes notifications, and laws changing alerts). Thus, in order to follow the European Commission orientations for sustainable development and active ageing [11], Portuguese public authorities have been investing strongly in new communication channels to disseminate information about public and social services [12]. These channels have been playing a vital role for Portuguese citizens to obtain valuable information on various governmental assignments. In this context, the +TV4E project comes up as a platform to provide senior citizens with information about public and social services according to their preferences and expectations [13].

The +TV4E platform aims to take advantage of the proximity and familiarity seniors have with the television to enable an enriched viewing experience, featuring the integration of informative videos automatically generated from a set of predefined news and institutional Web feeds [14]. Then, these generated videos are pushed to the end-users through an iTV application, which in turn, is in charge of interleaving them with the linear TV broadcasted presentation, according to short interruptions [15]. In order to achieve a more personalized approach, this study aims to assess the preferences of seniors as end-users of +TV4E platform. To this end, the present research sets out to identify and classify implicit and explicit data, retrieved from interactions performed within the iTV application, which may somehow infer users' interests. Such interactions are on the basis of an interaction model, which will support the +TV4E content recommender system [16] in selecting and suggesting contents.

The remainder of this paper is structured as follows: The next section presents some related works on recommender systems of TV and video as well as user feedbacks and user profile construction. The third section describes the methodology used to define the interaction model, including a literature review, an interview with an expert in designing iTV applications for people with special needs and physical limitations and interviews with some users which took part in the field tests of the +TV4E platform. The forth section is dedicated to discussions and practical challenges, while the fifth and last section highlights the main conclusions and future works arising from this study, especially with respect to the context of +TV4E project.

2 Related work

2.1 Recommender systems of TV and video contents

The advent of Smart TVs, the expansion of TV program/contents and the popularization of VOD (Video on Demand) platforms have contributed to an exponential growth of video contents available. Most of these contents are accessible through many different screen devices (e.g. smartphones, tablets, TVs) and transmitted using broadband (e.g. Internet) and broadcasted TV (e.g. terrestrial, satellite, and cable) networks [17]. On the one hand, there are obvious advantages and, as such, benefits to viewers in having a wide range of reachable contents. However on the other hand, such a huge amount of video contents has enforced TV/set-top box manufacturers, broadcasters, content producers and streaming providers to search for automatic tools to support users in decisions about what to watch next, and thus, offer a more personalized viewing experience [17]. These tools are composed by algorithms and data collection schemes that predict

and recommend contents (or items) matching users' interests and/or needs, in the so-called recommender systems [16]. Therefore, in order to provide an enhanced experience for these viewers during the discovery of new content, several pay-TV services providers and research projects have benefited from recommender systems to cope with this scenario of information overload [18].

With the expansion of digital networks and the increase of the number of channels, TV program recommender systems turned into the most popular application of personalized recommender systems for video contents [19]. These systems "assist TV watchers by recommending interesting TV programmes to watch more comfortably and avoiding the traditional way of channel surfing" [20]. First implementations of TV program recommender systems emerged in the 1990s and aimed at suggesting programs from the Electronic Programming Guide (EPG) [21]. Nowadays, some of the most complex and renowned recommender systems are implemented by online streaming services [18], such as Netflix [22] and Youtube [23].

As reported by Kumar and Sharma [20], there has been a significant increase in the movie recommender systems in the scientific literature, like MovieLens [24], a platform which recommends movies based on user past preferences; and Hulu [25], an VOD service which suggests movies and TV shows streamed to internet-connected devices at any time. Véras and his colleagues [18] conducted a broad literature review to analyse and classify scientific works according to different aspects of recommender systems in the TV domain, such as the recommended item types, algorithms, architectural models, output devices, user profiling, and evaluation. These authors reviewed techniques, methods, and applications of 282 studies published between 2003 and 2015 and among the main findings, it is worth to mention the growing focus on recommender systems of video contents beyond the traditional TV programs accessible through an EPG. It was noticed an increasing amount of studies using Web (browser) and mobile platforms as output devices for TV and TV-related contents, creating relevant opportunities for research on new types of video contents in multiple sources of information (e.g. cross-domain recommendation).

The main task of a recommender system for video services is to provide viewers with content suggestions they will most probably be interested in watching. To achieve this, these systems essentially estimate how much a user will like a given content, predicting how relevant it will be for the viewer using one or more prediction (or filtering) techniques [16]. Common examples of filtering techniques are collaborative filtering and content-based filtering. In the classical collaborative filtering technique, suggestions for a specific user are calculated based on the similarity between their interactions in the system, since individuals of similar interactions should have similar tastes [16]. Thus, in this technique users are clustered according to their behaviours in the past to predict potentially interesting items using similarity between clusters. On the other hand, content-based filtering prediction technique is based on descriptive data of recommended items to find items similar to those ones consumed previously, since past interests and tendencies are indicators of future preferences [16].

Barneveld and Setten [26] presented a generic prediction model for a TV recommender system (see Fig. 1). In this model, the prediction technique process calculates a probable interest value of a TV program for a given user, which consists in the item

prediction (or suggestion). This process has as input all knowledge stored in the user profile, on items' data and metadata information, and on profiles of other users. Prediction techniques learn the interests and preferences of users from their feedbacks, which are basically constituted by direct and indirect interactions with the system. Some techniques may also provide users with explanations about their reasoning for providing a given item suggestion (e.g. "Because you enjoyed that one, you may like that also"). Optionally, a set of internal validity indicators may be employed to improve predictions when multiple prediction techniques are combined [26].

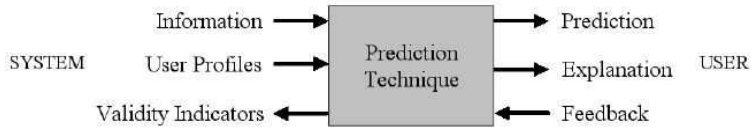

Fig. 1. Generic prediction model [26].

In order to create an intuitive, easy-to-use iTV application, tailored for seniors, to present informative videos along wih regular TV broadcasted contents, this study particularly focuses on the possible feedbacks and interactions viewers would perform to support +TV4E recommender system in learning their preferences and interests with respect to these videos.

2.2 User profile and feedbacks in recommender systems of TV and video contents

According to Iglesias and his colleagues [27], the user profile concept can be defined as "a description of the user interests, characteristics, behaviours, and preferences". In general, user profiles can be constructed in a lot of different ways [16]. Many of the very earliest systems used to ask users to build their own profiles by actively providing information in the terms of items or characteristics they would be interested in. However, sometimes this turns out to be rather confusing and time-consuming for users. Hence, for more compelling and acceptable process of eliciting preferences, a user profile should also consider regular user actions with the system (e.g. read an article, click on a link, and buy a product). Moreover, apart from the prediction technique or algorithm chosen to generate personalized item suggestions, data concerning relationships between users and these items must be collected by the recommender system. These interactions support the recommender system in learning the interest of a given user regarding the items that were somehow consumed.

In the particular case of TV and video services, there are two ways to obtain user interaction data to compose a user profile [16]: by analysing their behaviour during the viewing experience, which is called *implicit feedback*; and by requesting *explicit feedbacks*, which is when the user provides their opinions on a given content. So, user profiles can be built upon direct requests to users, which are clearly defining their positions in relation to the video contents; or by monitoring the system usage and user behaviour, based on interactions that may be indirectly linked to viewers' interests [16].

The main difference between implicit and explicit feedbacks is the main purpose of the associated interaction. In the implicit feedback, user is just following the normal system flow and performing interactions whose main purposes are not to inform a preference or an interest. Implicit feedback interactions range from global actions, such as the amount of time spent watching a video, to detailed actions (e.g. buttons pressed on remote control) [23, 26]. Though at the first place, these actions were envisioned by the system developers to perform a functional task, they may also infer how interested the user is in a content. In explicit feedback, in contrast, users evaluate the relevance and utility of a video, which is generally done by rating it.

According to [28], the simplest and most straightforward approach to elicit users' interest on a certain item is by actively asking them. However, explicit requests for feedback may also be annoying to and inefficient, since user's perceptions regarding the options presented may be quite subjective and divergent. For example, what does it really mean to give 4 out of 5 in star rating? More demanding users might have a very different judgment from less demanding users. In addition, users may be not interested in giving their opinions as it usually breaks their normal experience [28]. In addition, as providing explicit feedbacks usually distracts users from the TV and video viewing experience, requesting them should be as discreet and simple as possible [26, 28].

User feedbacks collected by recommender systems are intrinsically related to contents (or items) and the graphic interface. Some of the most common interfaces used for requesting explicit feedbacks are [28]: (i) scale ratings, where the user evaluates an item based on a scale, from the least to the most interesting/relevant; and (ii) up-down voting, where only two values are used to indicate the user's opinion. As an example, Amazon online store[1] uses the 5-star scale ratings system to allow users to indicate their level of interest in products, while the YahooAnswers[2] uses a thumbs up-down voting strategy to organize and display more relevant answers.

As using explicit ratings is not enough to generate reliable recommendations [29], considering implicit interaction data is crucial to generate recommendations more accurately. However, for many applications it may be very challenging to relate or even quantify these interactions with respect to user preferences, specially to infer negative preferences. For example, considering the example of recommending online texts, what would it mean to spend only half of the average reading time on an electronic article? Several additional components would have to be analysed (e.g. average user read time, subject and word quantity of the article). Additionally, it is worth noticing that often the collection of implicit data is done asynchronously. Thus, in case of momentary network breakdowns, the precision of the implicit feedback may be affected.

Netflix is one of the most popular TV and video streaming services, with almost 100 million subscribers worldwide [30]. In this service, both explicit and implicit feedbacks are used to compose user profiles [22]. Implicit feedbacks include information about partially or completely viewed content and content searching; while explicit feedbacks mainly include user voting data, which used to be implemented in a 5-star rating approach. Recently, however, this approach has changed to a thumbs up-down voting

[1] https://www.amazon.com/Wired-Douglas-E-Richards/dp/0982618492/
[2] https://answers.yahoo.com/question/index?qid=20100419154819AANIzGC

system in order to avoid subjectivities of scale ratings as well as to create a simpler approach to viewers [31].

Considering that user interaction data is just a fraction of the viewing experience, Youtube recommender system [23] also uses both data retrieved implicitly and explicitly from users as input for its recommender system. Explicit data include favoriting, sharing or liking (thumbs up-down voting) a video, and subscribing to a channel; while implicit data is extracted from users' watching time and interacting with videos history (e.g. viewer started to watch a video, viewer watched a large portion of the video, viewer saved a video to a playlist).

3 Methods

The present study is part of the ongoing +TV4E project [13], a two-year action research project, which proposes an iTV platform to deliver informative videos about public and social services tailored for the Portuguese elderly. Particularly, this research composed the conceptual phase of the +TV4E recommender system [32] development and aimed to find adequate answers for the following research questions:

[RQ1] What implicit and explicit data gathered from interactions performed within the +TV4E iTV application could represent seniors' preferences on informative videos?

[RQ2] What associated weights each of these interactions should have in order to provide more accurate content suggestions to seniors?

The process of identifying and weighting interactive actions seniors will perform within +TV4E iTV application was a spiral and evolutionary process, where the outputs of a given phase served as input for the subsequent step to evolve, improve and validate the interaction model proposed by this study.

The initial part of this research consisted in an exploratory approach, a literature review to gather information about implicit and explicit feedbacks in TV and video services. **Table 1** lists feedbacks used by recommender systems of TV and video contents. It is worth noting that, though many scientific studies clearly define the interactions used as input for their respective recommender system, no metrics or weights are associated to any of them.

Table 1. Feedbacks commonly used by recommender systems of TV and video.

IMPLICIT	EXPLICIT
- Amount of watching time [18, 22, 23, 25, 26] - Favorited contents [18, 23] - Subscribed content channel [23] - Search history [22][25] - Remote control general key logging [26]	- 5-star rating scale [18, 22, 24] - Up-down voting [18, 23] - Questionnaires [24] - Content tagging [24]

Then, considering the interactions listed on **Table 1**, a draft interaction model was designed. In order to enable a less obtrusive as possible experience for the seniors, this interaction model count with two feedback approaches only: an up-down voting request to explicitly get seniors' opinions and the implicitly collected amount of watched time. Thus, data would be collected according to five possible interaction scenarios and their

respective weights (**Fig. 2**): Video not started (0); Exhibition interrupted before 50% of video time (-1); Exhibition interrupted after 50% of video time (+1); Exhibition completed and user voted up (like) (+2); and Exhibition completed and user voted down (dislike) (-2). In this model integer values would be used to weight the interaction scenarios (see **Fig. 2**), which is a simpler and easily implemented solution.

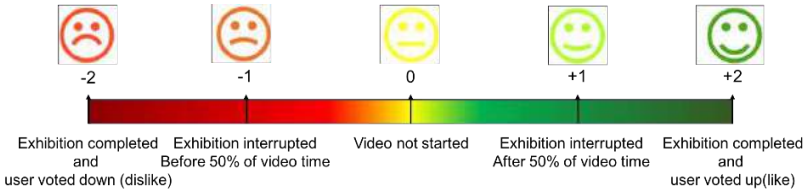

Fig. 2. First interaction model.

An evolution of this model would consist of a more elaborate and complex approach to calculate the implicit score associated to the viewing experience. Instead of using integer values in a small set of possible scenarios only, and moving from a negative value to a positive value abruptly at 50% of video watched, it is assigned a proportional weight per percentage of the video watched (see **Fig. 3**).

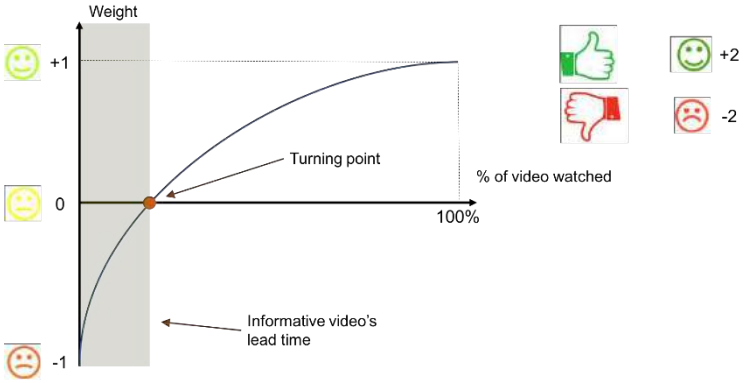

Fig. 3. Second interaction model.

Fig. 3 shows how this interaction model works, with fractional weight values ranging from -1 to 1. If the user interrupts the video exhibition before the lead is presented, a negative value will be assigned to that viewing experience; while a positive value will be assigned otherwise. Similarly to the first model, an up-down voting explicit request could be used to collect users' opinions, which would assign maximum and minimum values to the viewing experience: +2 (up) and -2 (down).

Interview with an expert

Before reaching out potential users, a preliminary step was carried out in order to validate the interaction model in a 90-minute interview with a postdoctoral researcher

whose main areas of interest are developing iTV services for persons with special needs and physical limitations. Applying this interview proved to be a profitable approach to gather valuable ideas from external experienced members as well as to validate previous literature review work.

In order to contextualize the interview it was presented a video on the Youtube platform [23], which has a robust and complex video recommendation system. This initial approach led the interviewee to identify possible user interactions leveraged by Youtube. Then, considering the context of the +TV4E project, the envisioned interaction model was presented and the following questions, derived were addressed:

1. What spontaneous user interactions could be used as inputs to infer the relevance and usefulness of a video?

2. To what extent each spontaneous interaction should influence video suggestions?

3. What kind of feedback could be explicit requested to measure the relevance and usefulness of a video?

Findings from the interview were in line with the literature review, and no new implicit or explicit feedbacks were identified. However, given the scientific background of the interviewee some important aspects were highlighted: an up-down voting could be implemented as an advanced feature, accessible at any time of the video presentation and available within a few seconds afterwards, with a countdown. After finishing the countdown, linear broadcasted transmission would be resumed accordingly. The interviewee pointed out that using non-integers weight values should be more effective and adequate, though it clearly has a more complex implementation. In addition, since only a visual notification of new video suggestion could go unnoticed by users (due to occasional hearing limitations of seniors), the interviewee advised to use sound notifications in addition to the regular visual notification.

Interviews with field tests users

The next step in the methodology consisted of validating the interaction model with a minor set of users which took part in the field tests of the +TV4E platform. So, before implementing a high-fidelity prototype properly integrated to the +TV4E platform, three field test users were selected to provide their opinions on the approach used to assess their preferences on the informative videos. Applying these interviews helped to confirm some assumptions as well as introduced some new perceptions on seniors' +TV4E platform usage.

Considering the context of +TV4E platform, the following questions were asked:

1. Suppose that a given video was not of your interest, how do you think this preference could be noticed by the platform?

2. If you interrupt the video exhibition, could this interaction be considered as an indicative of a lack of interest on the respective content?

3. Considering that the initial part of the video contains an overview of the informative content, should interrupting the video exhibition during this overview be considered as an indicative of even less interest on the respective content?

4. How about the system explicitly request your opinion after the video exhibition? How many options seems to be appropriate? Two options (I like it / I do not like it)? Or a five-star rating scale?

5. How often do you think the system could request your opinion?

Answers from all three interviews were mostly similar. Seniors stated that the remote control might have a special button to tell their impressions on the videos. Also, all of them agreed that interrupting a given video could be used as an implicit feedback, where the amount of watched time would be proportional to the interest. Regarding the explicit feedbacks, one interviewee felt more comfortable with the five-star rating approach, while the other two said that having three different options (e.g. I like it, I do not like, I don't like or dislike it) would be more adequate for most of the times. All interviewees said that answering questions should definitely be optional, though they could be requested after every video exhibition.

4 Discussion

Identifying proper data driving content suggestions plays an essential role in the development process of any recommender system, and independently from the prediction or filtering technique strategy implemented, the system must learn users' interests by collecting feedbacks from these users in order to provide more personalized recommendations [33].

Recommender systems of TV and video contents often rely on implicit feedbacks to build up user profiles, which deal with incremental updates on user's viewing history. Though implicit feedbacks may be noisier than explicit feedbacks, they are so ubiquitous that using them effectively can lead to more accurate suggestions [23]. This implicit nature of profiling enables a less disturbing experience, but also represents a challenge for system developers, as implicit data is less obvious to interpret. If a user has watched a video for only a couple of seconds, probably it's a negative sign, but what if the user has watched half the video? To what extent this experience was more positive than the previous one? It seems rather inefficient and arbitrary to require a minimum amount of video to achieve a positive score.

In addition, it is essential to consider the context of the + TV4E platform in order to apply an interaction model that creates a user profile properly. The videos generated by this platform usually have a news structure style (the initial part has a content overview, *aka* lead[3]). Hence, the user interest in a content would be proportional to the amount of video watched time (i.e. weights grow over time), having the initial part a greater weight in the score attributed to the viewing experience. As the user watches the video the initially negative weight turns gradually into a positive value after the lead is presented[4]. Furthermore, adopting a continuous heuristic seems to be a less disruptive and more precise alternative than the first drafted one, which uses integer values only and an arbitrary value of 50% of minimum watching time required to assign a positive value to the viewing experience.

Moreover, if making correlations between implicit feedbacks and user interests may be a rather labour-intensive and error-prone task, using explicit feedbacks, on the other

[3] https://en.wikipedia.org/wiki/News_style

[4] An example of video generated by the platform is available at https://youtu.be/smZIA9oUad0

hand, is a straight-forward strategy and often tells more about the user experience [16]. However, considering the low literacy levels [9] and digital divide [10] of older adults, graphical interfaces should be as simple and less demanding for user inputs as possible. Thus, considering the +TV4E platform and its end-users, explicit feedback requests would be preferably implemented should as a simple up-down voting, whicj could be optional for users to answer, and, as learned from the literature review and the interview with the postdoctoral researcher, it should be presented with a countdown after the video presentation. In this way, it is expected to diminish the potential impact in the overall TV and informative video viewing experience.

5 Conclusions and Future works

Challenges and opportunities of an ageing population, both at a personal and community level, are still drawing attention of public and private institutions [1] due to the recurring info-exclusion [8], low literacy levels [9] and digital divide [10] among senior population. In this sense, technologies play an important role to promote higher levels of quality of life and independency by providing them with information about public and social services. In addition, to effectively provide more adequate and high-valued information, such technologies should be implemented considering personalization techniques.

This study is part of the conceptual phase of the +TV4E recommender system development [32], and in order to provide more accurate and personalized content suggestions, we set out a process to identify and weight feedbacks gathered from seniors interactions to elicit their interests on informative videos presented by the +TV4E platform. These implicit and explicit feedbacks composed an interaction model that will support the recommender system in optimizing video suggestions. For a more unobtrusive viewing experience, it was chosen to use the amount of watching time as implicit collected data and an up-down voting request as explicit feedback from seniors.

The main goal of any recommender systems is to provide users with contents in which they would be possibly interested. If defining *what* content should be suggested is essential, selecting *when* it would be presented may be indispensable, imperative for providing seniors with a compelling viewing experience, as good or bad timing may determine the openness of the users to receive the information provided. Therefore, further studies on defining the most relevant moment for content delivery are under discussion. Also, contextual aspects influencing content suggestion will also be addressed soon.

Finally, as the conceptual phase is concluded, future works include implementing a high-fidelity prototype integrated to the platform to be validated in a series of field tests with seniors recruited in the context of the +TV4E project, to evaluate the real accuracy of the interaction model envisioned for the +TV4E recommender system.

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Interfaces and devices

Application for older adults to ask for help from volunteers through television: design and evaluation of a high visual-fidelity prototype

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Abstract.
Designing a television (TV) application for older adults presents specific challenges, especially when the issue is an application that aims to support volunteer activities which will benefit the elderly. This article describes the design process and evaluation of a high visual-fidelity and with some interactivity prototype of an application for a TV set-top box, which allows older people to request, in a simple and quick way, help from a group of volunteers, in specific tasks such as small household arrangements or go to the doctor. Concerning the User Interface (UI) design, a set of specific guidelines, directed for TV, older adults or both, were considered, as well as more generic ones of UI design. The result of this process was later evaluated in three heuristic evaluation sessions. These sessions were supported by a list of heuristics, drawn from other lists used in recent research and adapted to the context of the study. In a context in which several studies show that television is a highly privileged platform to provide information to the elderly population due to its high degree of use in Portuguese homes, this project may present important contributions to better understand some of the challenges that are associated with the development of TV applications whose target audience is the elderly and some good practices that should be followed to achieve a product that is easy and enjoyable for this public to use.

Keywords: heuristic evaluation, iterative design, application for set-top TV box, volunteering.

1 Introduction

The aging process is often associated with dependency, financial difficulties, loneliness and isolation [1]. In Portugal, about 60% of the elderly population live alone or in the

exclusive company of other older adults, which reflects a phenomenon of social isolation whose dimension has increased around 28% over the last decade [2]. Even if older people stays at home (which is commonly a sign of a good health situation), there are innumerable difficulties that they cannot overcome alone. Several times, these situations can be avoided if older adults are supported by other people that help them, for example, performing daily living activities.

Voluntary actions accomplishment is one way to fulfil situations of exclusion and social isolation and, at the same time, promotes independence, autonomy, quality of life and socialization of the elderly. It is possible to notice that there are already several several Information and Communication Technology (ICT) applications that aim to support voluntary actions, especially Web/mobile. However, many of these applications do not seem to give a special importance to the characteristics, preferences and needs of older people. In particular, it can be seen that the use of television (TV) as a platform to support requests to volunteers seems to still be a poorly studied scenario, although TV is one of the means with the greatest penetration in Portuguese homes and with which individuals, over 64 years old, are highly familiar with [3, 4]. Also, voice interfaces are not yet common, despite their recognized potential to ease daily living for the elderly [5].

It is against this background that arises the VoluntAge4Seniors project, a research project that aim to develop an application, to run in a specific TV set-top box, that will allow, in a simple and quick way, older people to request help from a group of volunteers in daily living tasks (such as a ride to the supermarket or do simple household arrangements such as change a lamp). This request can be made by entering the request and its details (such as category, date, time and location) by a TV remote control or through voice. The main objective of the voice interaction is to simplify the process of asking for help, considering the difficulties that often arise through the use of TV remote control [6] .

To ensure that technological solutions fulfil the needs and expectations of their target audience and, at the same time, guarantee that the products are easy to use, it is very important to follow an iterative cycle of design-evaluate-redesign from initial ideas through various prototypes to the final product [7]. Indeed, assuring high levels of usability is a critical aspect because it has a direct interference with decisions around adoption and use of technology-enabled products and services [8]. To achieve this, applying Human Computer Interaction (HCI) principles and guidelines when creating prototypes and identify usability problems in these artefacts in the context of usability evaluations is of the most importance. One popular method that has been used in usability inspections is heuristic evaluation [9].

It is under this scope that the authors developed a high visual fidelity prototype considering a set of User Interface (UI) design principles. In addition to this, a heuristic evaluation of the prototype was carried out. The results of these activities are here presented, aiming to contribute to a more informed design of TV interfaces, in similar contexts to the one that was approached under the scope of the VoluntAge4Seniors project, and to the identification of more adequate heuristics that can be used in the usability evaluation.

2 Considerations about the design of TV interfaces for older adults and its evaluation

When designing an application for the elderly, it is important to take into consideration that older people do not belong to a well-defined category of users and that they are not considerably different from other categories of users, as presented in most HCI work [10]. Furthermore, it should be taken into account that some UI design guidelines for a standard computer cannot be applied to the television [11].

As a result, for the design of the prototype, a comprehensive set of guidelines were considered, from a set of general guidelines for UI design [12][13] to others that approach the design of interfaces for Interactive TV [14] or for older adults [15], or even specifically address the design of interfaces for TV UI for older adults [16].

From this revision of guidelines, several important aspects had emerged, many of them related with the biologic changes that typically appear in the aging process [15]. One that should be highlighted is the attention that should be paid to ensure that the number of steps it takes to reach a given screen is the minimum possible and the design of the application must be consistent to facilitate recognition, avoiding the overload of the short-term memory. Regarding the information displayed, it must be precise and make use of a simple language, in order to give users time to read and focus on a single task at a time [15]. In terms of visibility, the interface must clearly show in which stage of the application the user is and which is the current selection or the possible interaction available [14]. Apart from the usage of simple and precise information, meaningful icons and labels also help in this task [12, 13]. To achieve readability, the typography must be large, sans serif and the text must be left aligned [4, 7].

Besides these guidelines being widely recognized as effective, it is essential to evaluate the usability of the prototypes where they are applied even because this could help to refine the guidelines to better adapt to specific contexts. Heuristic evaluation has been recognized as a popular usability inspection technique, where one of its main advantages is that it can be used at any stage of a design project, including in an early stage of design [7].

With respect to usability heuristics that can be used in the evaluation of UI targeted at older adults, it is observed that new lists of heuristics emerged from Nielsen's list of heuristics [11, 13] to better support the identification of usability issues of UI.

3 User interface design process

Besides the guidelines mentioned in the previous section, a set of practices that were provided by the team responsible for the development of the environment of the set-top box in the TV service company were also considered. One example of this is the need to create a "safe area" (around 20% of the total space) all around the screen without any content. In line with this, a high visual-fidelity prototype, with some content simulating the real one, was developed using a popular vector illustration tool (Adobe Ilustrator).

In the end of a first version of the prototype, which included the most important screens, the result was discussed with two people of the TV service company with a

great responsibility in the team that develops the environment and apps of the set-top box. Important feedback about some design options was received. One example was that some screens had a lot of information, even when particular care was taken with this issue since the beginning.

Figure 1 shows the *Request* area, where the user decides to do a new volunteer request. After this screen, the user selects the category of the request (for example animals or shopping) as illustrated in Figure 2.

The interface design, followed in almost all other interfaces, aimed to be minimalist, with short and meaningful information. Every menu option has its name, and a correspondent icon, to facility the memorization. It is also possible to see that the interface shows clearly the current location and that it has considerable negative space, to facilitate the choice of a category and the finding of the information by the user. In the main area, the selected content area is highlighted with colour whereas the other elements are represented in gray.

Fig. 1. Request area: New request.

Fig. 2. New request: category selection.

To prevent possible user´s involuntary actions, the system triggers error messages in the final decision-making situations. In case of an error, the message occupies the whole screen of the TV, which means the side menu does not appear, avoiding misinterpretations by the user. In addition, to avoid time outs, the user should validate every message that appear on the screen making sure he had time to read all the information. For example, Figure 3 shows the resume screen that appears after making a request. The user should validate or edit the request to continue using the application.

Fig. 3. Request feedback.

4 Heuristic Evaluation Sessions

A list of heuristics was developed based on the heuristics suggested by [9, 11]. All considered Nielsen's heuristics and in our list they were also presented. In the end of the first iteration, an expert in TV applications development was asked to give feedback about the list.

Table 1 presents the final heuristics list that was used in the heuristic evaluation sessions.

Table 1. List of heuristics

Content	
H1	Provides clear feedback and when presenting error messages make them simple and easy to follow
H2	The errors messages are descriptive and use meaningful words and verbs when requiring an action.
H3	Used language is simple, clear and adequate to users.
Navigation	
H4	The user interface navigation structure is clear, simple and straightforward.
H5	The "cancel" button behaves in a predictable manner.
H6	Promotes user control and freedom, allowing for alternative and flexible flows of interaction.
H7	Disable options are inactive.
Dexterity	
H8	Avoids pull down menus.
H9	Avoids the use of scrolling.
H10	Large sized user interface elements in general.
Cognition	
H11	Focus on one task at a time instead of requiring the user to actively monitor two or more tasks, and clearly indicates the name and status of the task at all times.
H12	Avoid the use of interaction timeouts and provide ample time to read information.
H13	Provide familiar mental models.
H14	Supports recognition rather than recall.
H15	Uses pictures and/or graphics purposefully and adequately to minimize user interface clutter and avoid extraneous details.
Perception	
H16	Does not rely on color alone to convey information. Be aware of color blindness.
H17	Makes information accessible through different modalities.
H18	Provides a good contrast between background and content.
H19	The background is consistent among all sections.
H20	Reduces the demand on working memory by supporting recognition rather than recall.
H21	Unambiguously shows the user's location.
Aesthetic	
H22	Ensures that text types, styles and sizes are appropriate to users, that is, for instance, but not exclusively: large-sized fonts, sans serif, non-condensed typefaces, non-italic.
H23	Buttons are clearly visible and distinguishable from other user interface elements.
H24	Information is visually grouped (makes good use of color, text, topics, etc.).

H25	Provides sufficient space between elements to ensure a balanced user interface design.
H26	Uses simple and meaningful icons.

For the evaluation, some interactivity was added to the prototype presented in the previous section using Invision, a tool that allows to transform a static design into a clickable and interactive prototype. A laptop was used to present the prototype and record the audio from the sessions as well as the screen activity.

The evaluation sessions were conducted with people with background in HCI (number of 3). All had at least some experience in developing heuristic evaluations and interfaces for older adults. One of the participants did not have experience with development of TV applications. The heuristic evaluation session developed in three distinct main stages: (1) set the context to the evaluator regarding the application usage scenarios, developed interface functionalities and adopted heuristics; (2) the heuristic evaluation itself over the prototype. As recommended by Nielsen [9], the evaluator firstly explored the interface freely and secondly focused on specific interface elements and report. As they went through the interface, evaluators verbalized the problems identified, the usability principles that were violated and suggestions of solutions while an observer registered them in a grid; (3) the evaluator answers a questionnaire about his/her profile and, in open questions, points the interface strengths and limitations.

5 Results and Discussion

The data collected in the sessions was compiled and analyzed to identify the major usability problems and problematic aspects of the design. Table 2 presents major findings of these analysis, following a similar approach as the one presented in Silva *et al* [11].

It can be observed that the most infringed heuristics were H3 (related to clarity of the used language), H13 (related to the familiarity of the application mental model), H1 (related to feedback clearness) and H4 (related to navigation clearness). This data can be accessed in Table 2.

Table 2 – Violated Heuristics (amount of violations)

Most violated heuristics overall
H3 (19)
H13 (12)
H1 (9)
H4 (9)
Violated heuristics of the main screens

	Login	Home	Volunteer evaluation	Volunteer confirmation	Requests	Make a request by voice	Edit request	Profile
	H1 (2)	H3 (5)	H13 (2)	H3 (5)	H1 (2)	H4 (2)	H3 (2)	H3(3)
	H3 (2)	H13 (3)	H4 (1)	H13 (3)	H3 (2)			H1 (1)
	H13 (2)	H1 (2)	H11 (1)	H1 (2)	H13 (2)			H21 (1)
	H4(1)	H4 (2)	H20 (1)	H4 (2)	H26 (2)			
	H18(1)	H20 (2)		H21 (1)	H4(1)			
		H11(1)		H24 (1)				
		H24(1)						
Total	8	**16**	5	**14**	9	2	2	5

The most frequently mentioned problems are related with the overuse of text using bullets, the selection area that moves in the screen instead of the content and the fact that in some areas the text missed clarity and simplicity.

The absence of records in some heuristics (e.g. H2, H5 and H7) may have different interpretations. This can be related with the lack of elements in the interface where these heuristics could be applied or even with the preference for other heuristics by the evaluators to describe a certain usability issue.

The questionnaire filled by the three evaluators pointed out strengths such as the project goals, the possibility of interaction using voice, the consistency of the interfaces, the fact that the interfaces focus a single action at a time, adequate font types and sizes and general navigation. The most critical weaknesses highlighted were about how the elderly are asked to interact by voice and excessive density of information for a TV UI in some screens, besides other usability problems that were also mentioned during the prior phase of UI inspection.

6 Conclusions and Future Work

This article presented the result of the design and heuristic evaluation of a high-visual fidelity prototype of a TV application that will support older people to request help from a group of volunteers in daily living tasks.

Regarding design, a set of guidelines from distinct categories and from diverse backgrounds was taken into consideration. Although there are already some studies that present design recommendations for TV for the elderly in similar contexts of the project here presented, it is considered that the results of this work are an important contribution to the validation of these recommendations and to highlight some gaps that seem to exist, namely related to the integration of voice in a TV application. The validation of the design with professionals from the TV company, with a vast experience in TV

applications development, also proved to be beneficial, allowing the identification of some issues that could be revealed in problems in the context of use.

The heuristic evaluation was also an important contribute not only because of the input that was given to the developed interface at this stage of the project but also because the heuristics list that support the evaluation. A list of 26 heuristics was developed based on other lists and adapted to support the main potential usability problems that could arise in the UI developed. The results reinforced the importance, pointed by Nielsen [9], of not considering only a standard list of heuristics to support the development and evaluation of more specific products as the one here presented. In general, the procedures followed in the evaluation sessions were revealed as adequate but further analysis should be done towards the validation of the heuristic evaluation method that was used in different scenarios.

Both design guidelines and heuristics proved to be fruitful to design and assess problems, specially related with the visual part, of TV applications that will be used by older adult, although the authors consider that they can be easily adapted to a broader group of users.

As improvements, the authors recommend reducing the number of heuristics to become easier for evaluators to remember. Also, it would be useful to perform the evaluation using a TV screen and remote control. It is important to note that developing an interactive high-visual prototype to the TV was considered but a solution was not found without the programming component. Regarding future work, the authors consider conducting usability tests with potential end users to analyze specific features such as voice interaction.

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Six Cube: a tangible interface for enhancing TV accessibility

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Abstract. The computational innovations of recent years have enabled the emergence of a new technological paradigm that allows everyday objects to integrate new uses and dynamics through the reception and transmission of information. These objects are now referred to as smart objects, because they are connected to the Internet and can embed electronic sensors that extend the user interaction. The new use of objects in daily life presents several conceptual, technological, economic and social challenges.
This paper presents and describes the Six Cube, a tangible interface for changing TV channels. The cube consists of six acrylic faces, one of which corresponds to the standby function and the remaining five to different channels customized by the user. The Six Cube promotes the accessibility and inclusion of people with special needs, such as seniors, young children and people with disabilities or impairments. One of the aims of the Six Cube is the resolution of people's difficulties when they interact with a TV remote control, namely switching channels and while doing so, it improves their quality of life.

Keywords: Tangible Interface; Accessibility; Television; Internet of Things; Cube.

1 Introduction

Computing and electronics are increasingly common in people's lives and the interaction with physical objects, with affordance in place, becomes so intuitive that their materiality remains in the background and the attention is first directed into the task achievement.

The TV remote control is a common electronic device that is part of everyday life. However, the experience of using it is not always intuitive and efficient, it usually lacks affordance. Basic tasks as switching channels can become confusing and difficult for many people, such as seniors, young children and people with disabilities or impairments. The buttons are usually small, with little space between them and the labels and symbols are also small and difficult to identify [1].

The challenge of the present work is to design and create a tangible interface for changing channels that is easy to perceive, use and manipulate, which meets the needs of the largest group of users and adapts to the purposes of Universal Design.

The desired level of technology mediation is as close as possible to the interaction with the real world, in the way that the tangible interface operating mode should not impose restrictions or ruptures on everyday activities.

It is intended that the use of a tangible interface offers an inclusion opportunity to all those users that, from the point of view of accessibility, are somehow excluded from the electronic and/or digital world due to the impossibility of interacting physically and cognitively with conventional interfaces such as the TV remote control.

2 Theoretical Background

The direct manipulation of physical objects does not require, usually, a new type of learning for the user. According to the behavioral approach of cognitive psychology, people develop throughout their lives, in a process of adaptation to the environment, the understanding to act in the physical world that surrounds them. It is in this perspective that the concept of affordance arises, originally introduced by Gibson [2]. According to the author "the affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill".

Later, this concept was further developed by Norman [3] who understood that its application to the development of interfaces in the daily artifacts has the advantage of releasing the subject from the interaction with a set of technical conventions.

More recently, the notion of affordance, which in its core includes the physical properties of real world objects, has been appropriated and applied in the field of graphical interfaces. Norman, realizing that the concept of affordance could not designate the visual metaphors present in a two-dimensional graphics system, proposed the term of "perceived affordance" to differentiate this scenario. "[…] in design, we care much more about what the user perceives than what is actually true. [...] where one deals with real, physical objects, there can be both real and perceived affordances, and the two need not be the same" [4].

In this context, people interact with everyday objects in the same way they interact with another human being, through gestures, voice or eye movement. The objects and, in a broader way, houses, buildings and cities are extended with new features, uses and services through sensors and wireless connections that are present in our daily lives in different places and contexts. This is the paradigm of the Internet of Things, a term which is used to describe the connectivity between objects (things) and technology. The Internet of Things Council [5] defines it "as the seamless flow between the BAN (body area network): wearables, LAN (local area network): smart home, WAN (wide area network): connected car, and VWAN (very wide area network): the smart city. Key to this flow is having control of the data."

The idea of a physical object as an interface for a digital system explores the conceptual advantages of the Tangible User Interfaces (TUI) interaction paradigm. TUI "act as physical manifestations of computation, allowing us to interact directly with the portion that is made tangible – the tip of the iceberg" [6]. The integration of the physical and digital world will be highlighted by the advances in the Physics and Chemistry areas that will make intelligent and dynamic materials available.

3 Related Work

Regarding the interaction paradigm through objects with TV, namely cubes, there are no available options on the market that exclusively interact with TV. Currently, the available cube-shaped devices assume the role of remote controls for smart houses, controlling several appliances at the same time. Three products are described below:

a) The Xiaomi Mi Cube [7] is a small cube with a 45mm edge that contains a gyroscope and an accelerometer. The Mi Cube controls smart home devices through six pre-programmed movements (push, shake, double-tap, rotate, flip 90 degree and flip 180 degree). For example, with the Mi Cube, it is possible to change the home light intensity by flipping the cube 180 degrees and turning the TV off with a simple double-tap on the cube. This cube only interacts with the Xiaomi ecosystem.

b) The "Family of the Arts" company created the Cube [8], a tangible interface that intends to be a universal controller for devices in smart homes. Cube fits in the palm of a hand and can be placed on any surface. To turn Cube on, it is necessary tap it on a surface, so that each side reveals its function through a backlit icon. For example, if user wants to listen to music, Cube must be flipped with the face with this function on top. It is not yet possible to purchase Cube, as it is still in the prototype stage.

c) Orvibo Magic Cube [9] is a smart home control center that can work with almost all infrared appliances (95%) on the market, such as TV, air conditioner, DVD player, electric fan, etc. This cube controls home appliances with one smartphone and allows creating a personal smart home control network. Magic Cube works like a bridge between a WiFi and IR signal. For example, in a hot day, it is possible to switch on the air conditioning and the electric fan, remotely, by a smartphone.

Concerning scientific works with cubes as tangible interfaces for TV, there are two prototypes that should be mentioned in the context of the present study:

a) Block et al. in 2004 [10] created an input device for changing TV channels in a more playful way. This prototype embeds gravity sensors and wireless communication capabilities. The software developed specifically for it includes a 3D graphical interface where the cube is virtually represented on screen and it has a TV channel stream rendered on each of its faces. The motion on screen of this virtual cube is connected to the physical motion performed by the user on the real tangible artifact.

b) The ARemote [11] is a cube that selects television channels in a predefined large list through simple rotational and translational gestures. A camera is used to visualize the movements of the cube and the cube's software interprets them and controls the selection of channels. The ARemote uses three interaction techniques: a) circular scrolling strategy, in which the list can be scrolled with rotational gestures and the item can be selected by performing a quick vertical gesture; b) circular scrolling with crossing strategy, with which the user can select the channel by crossing its graphical representation border with the mouse pointer and c) crossing strategy, where the items are displayed in an alphabetical grid around the screen and the user must move the mouse pointer to the desired item and cross its border.

The Six Cube, described in this paper, differs from these products and studies since it promotes the accessibility and inclusion of people with special needs. One of the aims of the Six Cube is the resolution of people's difficulties when they interact with

a TV remote control, namely switching channels and while doing so, it improves their quality of life.

4 Accessibility and TV

Promoting the inclusion of people with special needs is an increasing concern that has supported changes in social and technological terms. Nevertheless, there is still a need to create more and better mechanisms and tools to ensure an effective participation of these citizens in several domains of society.

In order to promote the development of strategies and methodologies to accommodate a wide range of users' skills, capabilities, needs and preferences, it is important to emphasize the Universal Design approach. The Centre for Excellence in Universal Design (CEUD) defines Universal Design as "the design and composition of an environment so that it can be accessed, understood and used to the greatest extent possible by all people regardless of their age, size, ability or disability" [12].

For many people with special needs, the accessibility to information and communication technologies is determined by how easy it is to work with the system interface. The emphasis on human diversity is the most distinctive element of the Accessibility area. Systems should not be designed without considering the characteristics, needs, interests, preferences and behaviors of users [13].

However, the exclusive focus on Accessibility as a measurable item is not the most appropriated strategy to help users with special needs. According to Nielsen [14], a Usability perspective must be adopted in order to support these users, when they perform critical tasks. It is important to note that Usability is not a one-dimensional property. The International Organization for Standardization (ISO) described usability by a combination of factors including effectiveness: accuracy and completeness with which users achieve specified goals; efficiency: resources expended in relation to the accuracy and completeness with which users achieve goals; and satisfaction: freedom from discomfort and positive attitudes towards the use of the product [15].

Regarding the Television area, there are studies that suggest the application of principles and standards of accessibility and usability to solve the problems of users with special needs in the access and use of television devices and interfaces.

One of these studies was carried out by Springett and Griffiths [16], who suggested the application of WC3 accessibility principles in the design of the interactive services provided by Digital Television. In this line, Chorianopoulos [17] also proposed a set of interface design principles for iTV applications, based on the Human-Computer Interaction discipline. Finally, Oliveira et. al [18] conceptualized, prototyped and validated an iTV service adapted specifically to users with visual impairment to promote their digital inclusion.

5 Six Cube

5.1 Description and User Scenarios

The Six Cube intends to be a tangible interface for changing TV channels. The cube name (Six), simply referring the number 6 and invoking the six degrees of freedom (6dof) in which an object can move in a three-dimensional space.
The cube (Fig. 1) consists of six acrylic faces, measuring 8,5 cm on each edge. One face corresponds to the standby function and the remaining five to different channels customized by the user. The electronic parts of the cube are integrated inside it.

Fig. 1. The Six Cube with personalized paper labels (standby symbol and channels logos)

The user activates the desired channel on TV by manipulating the cube and putting the corresponding face turned upwards. The object is also physically customizable by the user who can write the channel name or draw on each of its faces through paper labels on the transparent acrylic. Other materials can be used to wrap around the cube, such as rubber, plastic or padded fabric. For example, the cube's faces can be embossed with the numbers 1 to 6 in rubber or plastic, helping visual impaired people to identify each face.

Therefore, instead of associating buttons with numbers to TV channels, the user can move the cube and this action results in a channel change (causal reasoning), which makes their interaction experience more natural.

The cube is very useful for the senior public since its motricity is, sometimes, compromised (trembling hands and having imprecise movements), in addition to that, seniors usually suffer from visual impairing that makes it hard for them to see the small inscriptions on the keys of TV remotes. Another potential target audience is people with special needs, such as blind or partially sighted people and people with physical disabilities in the upper limbs. Finally, younger children (specifically between 2 and 3 years old) can also use the Six Cube, since they do not understand numbers and their fine motor skills are still in development. In fact, when young children manipulate the remote control, they tend to press the keys simultaneously and/or wrongly. The Six Cube, by simplifying motor coordination actions, allows the inter-

action of the users with the TV to become more natural and intuitive, while promoting the sensorial recognition and manipulation of the object.

Here are examples of user scenarios about the details of how this cube system might be interpreted, experienced and used:

a) Mrs. Robinson is a senior who has vision problems and trembling hands. As a hobby, Mrs. Robinson likes to watch television but she has difficulty in using the remote control. Her son, recognizing his mother's limitation, decides to offer her the Six Cube. He only had to add his mother's four favorite TV channels (free-to-air) to the cube's faces. He printed the channels logo in a bigger size, almost covering the entirety of the cube's face, so his mother can recognize better to which channel a face corresponds. Now, Mrs. Robinson can enjoy zapping and choose easily the program of her choice.

b) Mr. Smith became blind, unexpectedly, due to glaucoma. His visual impairment makes it very difficult to carry out his daily activities. Since then, Mr. Smith's daily company is the television. However, using the TV remote control became a near impossible task. Mr. Smith's grandson, realizing that his grandfather often asked him to change channels, set up a Six Cube with his grandfather's five favorite channels, with each face having a number embossed that corresponds to a channel. To achieve this effect, the grandson 3D printed the numbers 1 to 6 and taped them to the cube. Ever since, Mr. Smith can feel the numbers on the cube and change channels on his own.

c) Andrew is a 2-year-old little boy who loves watching the Disney Channel and the Baby TV channel. When he does not want to view certain cartoon shows, Andrew calls his mother to change to another of his favorite TV channels. As Andrew often asks for help, his mother decided to set up a Six Cube for Andrew, allowing him to switch the channels on his own. Concerned with her son's safety and wellbeing, his mother got some silicone pads for the sharp edges of the cube. Andrew loves to draw, so his mother arranged some sheets for him to draw his channels logos to attach to the faces of the cube. Now, Andrew has a lot of fun with his personalized cube, while changing the channels and he does not have to ask for his mother's permanent help.

5.2 Conceptual Model and System Architecture

A cube is a solid object with a strong psychological affordance, directing the subject's action to very standardized handling scenarios dominated by its six faces. In idle state, a cube has the natural tendency to immobilize on a single face, allowing the face turned upwards to be more prominent. When a cube is handled, through an exploratory movement, the attention is directed to one face at a time. These aspects give to a cube the true quality of a "state machine", in which only one of the elements is active.

The tangible interface of the Six Cube is in line with the TUI's approach that is based on the Model-View-Controller (MVC) pattern, in which the physical object is simultaneously an input (control) and an output (representation) of the system [19]. Like an abacus, the cube is both a representation and a control system, as it allows the user to send information of the wanted channel and to know what channel is displayed on TV by observing the top face of the cube. This double feature creates the feeling in the user that the concept of channel is incorporated in the cube.

In a conventional TV remote control, the physical buttons assume the role of the system input. The user is aware of the system status (selected channel, volume, etc.) through representations (outputs) that are not directly related to the TV remote control. Thus, the user does not know which channel is active from the simple observation of the TV remote control, since this information is only available through external representations in the system, such as the channel logo or the set-top box (STB) display. Opposite to the Six Cube, the conventional TV remote control is based on the Model-Control-Representation (MCR) interaction, in which the user input and the corresponding output can diverge both spatially and temporally.

Inside the Six Cube, a microcontroller, through an Inertial Motion Unit (IMU), recognizes in real time its orientation in space and sends to the STB an HTTP GET request with the key code that corresponds to the function, depending on the face that is facing up. The chosen microcontroller was the Arduino mini 3.3v, due to accessible programming and the existence of a miniaturized microcontroller model on a printed circuit board (PCI) with small size. The cube orientation detection is performed from the integrated data of a gyroscope and an accelerometer that are sensitive to the 3 axes (UC2, Fig. 2). The chosen unit was the IMU 6DOF – Ultra Thin that includes the gyroscope and the accelerometer in a single PCI of small dimensions. In the version presented here only the data from the accelerometer was considered, however, the integration of the gyroscope will create, in the future, analogue inputs (as volume control or image contrast) by the precise rotation of the cube. The system incorporates a WiFi Module ESP8266 that allows sending HTTP GET requests to the STB through a serial protocol based on AT[1] commands (UC3, Fig. 2).

The Six Cube was developed for the Portuguese IPTV service MEO[2], but can easily be adapted to other TV services and STB.

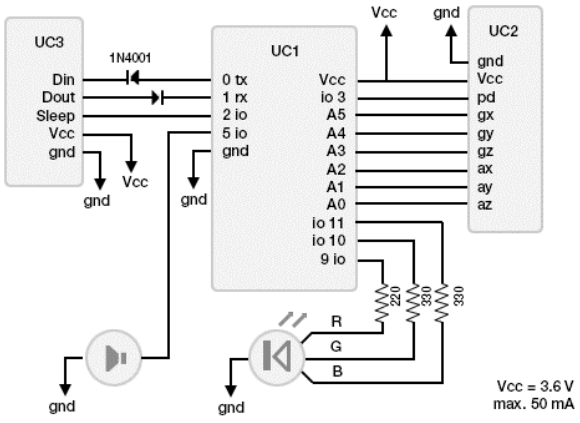

Fig. 2 – Electronic circuit diagram of the Six Cube

[1] The AT is an ATTENTION command and is used as a prefix to other parameters in a string.
[2] MEO is a trademark of the Altice Group.

6 Final remarks and future work

TUI devices emphasize the direct physical manipulation because the property of being touchable produces interfaces that take advantage of the human senses and of the kinesthetic involvement of the body in space. The Six Cube is within these assumptions combining accessibility and affordance, enabling people with special needs to change TV channels through a tangible interface easy to perceive, use and manipulate, improving their quality of life and sense of belonging to the domestic ecosystem.

At the moment, the Six Cube is a prototype and regarding the work to be done in the future, the authors will perform, firstly, a test with seniors (pilot experiment) which will allow the validation and verification of the methodological approach. After that, other tests with children and, possibly, with impaired people will be performed.

The methodological approach for the evaluation by real users of the Six Cube will be based on User Experience (UX) and Usability tests. The evaluation will be divided into two phases. In the first phase, the authors will provide participants with a brief explanation of what the Six cube is, how it works and they will subsequently record observations regarding the user experience and behavior through video and the think-aloud protocol. In the second phase, the authors will apply usability tests with specific tasks and goals. Thus, this methodological approach will aim to understand the expectations and needs of each subject through their user journey/narrative as well as to identify the dimension of affordance of the Six Cube. With these tests, the Six Cube will surely be improved in terms of its handling, interaction and appearance, meeting the needs of its target audience.

It is worth to point out that in a future paper, the authors will present the empirical study and discuss the obtained results.

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Evaluation of the Performance and Benefits of a Ginga-NCL-Based Interactive Content Decoder on a Raspberry PI

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Abstract. This paper presents the performance and benefits of an interactive content decoder in Ginga-NCL on a Raspberry Pi. Different operating systems were included in the card, being the most suitable for this scenario: Raspbian Jessie and Ubuntu Mate (14.05). The digitalization of the television signal and the better use of the bandwidth allow television stations to offer additional services to the audiovisual content broadcast, such as interactivity. The interactive television uses a middleware called GINGA through which it can be programmed in JAVA or NCL, obtaining applications that work through the use of a hardware device. To embed Ginga in Raspberry Pi, the best scenario was analyzed by testing two models of the Raspberry Pi Model B and Raspberry Pi 2 card, as well as evaluating the requirements for the installation of the Ginga middleware provided by TELEMIDIA (Brazil), attaching all the steps to be followed in conjunction with the appropriate commands for the installation and operation of the middleware, so that a programmable interface that allows to execute several interactive applications that are handled from the keyboard, can be implemented. Applications programmed in ECLIPSE (JAVA) were designed to perform performance tests with interactive activities, which were performed in the test scenarios of the cards, having a better reproduction in the Raspberry Pi 2. Solving a problem of decoding at low cost, taking advantage of the technology through multimedia resources like videos and images, and obtaining a prototype equipment of the design pretend to attract the population to this technology.

Keywords: Decoding, Interactive, Eclipse (Java), Middleware Ginga, Multimedia; Raspberry Pi.

1 Introduction

The implementation of Digital Terrestrial Television (DTT) generates a clear opportunity to develop the television industry and increase the degree of pluralism, democratizing the use of the spectrum, as well as the access to the contents guaranteeing the commercial expansion. This helps to a great extent the country since it can be based on the implementation of own software, being this a business opportunity to achieve the technological development [1].

Television industry for this technological change can offer additional services to the broadcast audiovisual content, such as: reception of the television signal on mobile phones, information on television programming, Internet access, interactivity, and portability and multiservice. The interactivity is considered as the most important change in relation to the analog system, since it generates the relationship between the person and the digital environment defined by the hardware that connects them [2]. In this area, the ISDB-Tb standard works through interactive applications and is run at the same time as the TV program is presented [3].

2 Development of Contents

2.1 A Raspberry Pi

The Raspberry PI is a minicomputer based on ARM, which must get an operating system installed. As the base of a numerous list of devices and equipment through a SD card [4, 5], Linux is the operating system (S.O.) chosen of this application.

2.2 Middleware Ginga

The middleware is a fundamental component for the reproduction of interactive applications on the receiver side. Alongside a number of software tools, the middleware allows the development of interactive applications running on top of itself [6].

The middleware used in this application is Ginga; it allows the execution of interactive applications on a terrestrial Digital TV receiver. The Ginga specification is described in ABNT NBR 15606 [7].

Ginga is an open specification of easy learning, allowing the production of interactive content, giving a new impetus to community television channels and content production by broadcasters. Adopting the GPLv2 license [8]. The architecture of digital television, is modified by adding a layer of Ginga middleware, so that is possible to introduce the way to interactive television [9].

Ginga is the intermediate software layer, which allows the development of interactive applications for Digital TV, regardless of the hardware platform of access terminal manufacturers (STB) [10]. The middleware is divided into two interconnected subsystems:

- Ginga J: Used for Java procedure applications.
- Ginga NCL: Used for declarative applications written on NCL.

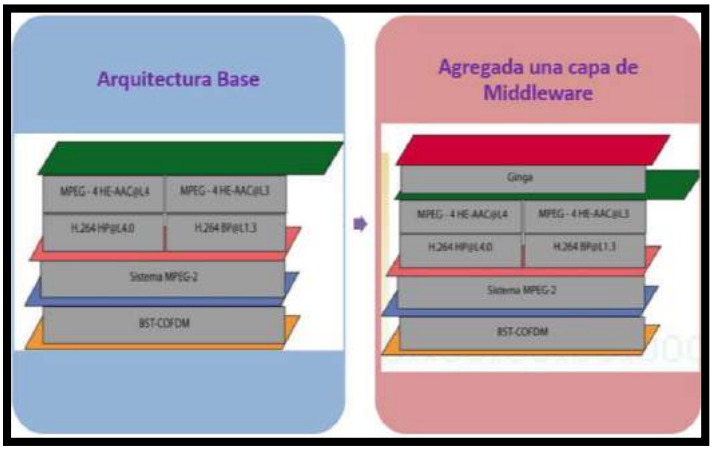

Fig. 1 TVD Architecture [11]

In Ginga, a declarative application can refer to a procedural application, in the same way, a procedural application [12] can refer to a declarative application. Ginga middleware is generated by Argentina under the name of Ginga.ar and by Brazil as Ginga Brazil [13]. The latest has as fundamental premise that true inclusion does not occur only through access to information, but also the right to know about the generation of information and the right to issue.

Ginga.ar is an implementation developed by the LIFIA laboratory of the National University of La Plata, based on the reference implementation of Ginga-NCL created by the PUC of Rio de Janeiro [14]. Ginga.ar is developed in C ++, is Free Software and the licenses used are GPLv2 and LGPLv2. It allows to run interactive applications written in NCL (Nested Context Language) [15]. Ginga.ar also runs on 32-bit and 64-bit Linux desktop distributions, as well as Windows. [16].

Ginga Brazil has as fundamental premise that true inclusion does not occur only through access to information, but also the right to know about the generation of information and the right to issue [13].

Ginga NCL is a multimedia presentation environment for declarative applications written in NCL and its Lua scripting language. Its presentation environment is the necessary logical subsystem of Ginga, responsible for running NCL applications. The applications are delivered in the Ginga-NCL by the subsystem "Common Core Ginga" (Ginga-CC).

Ginga is the result of the development of research projects coordinated by the Telemídia laboratories at PUC-Rio and LAViD at the UFPB. [17].

3 Implementation

The current version of Ginga Telemídia is 0.13.6, which has several requirements for its installation which are:

3.1 Operating System: Debian

Dependencies to be installed in Debian: XERCES-C, CURL, SDL2, SDL2_image, SDL2_ttf, FFMPEG, NCLUA, Berkelium.

The Debian operating system is equivalent to Raspbian, the current version that supports the Raspberry Pi is Jessie, so the installation can be directly from the image provided by the official card page [18]. In addition the tests will be done in Ubuntu to check the portability of the middleware.

To embed the middleware in the card, you must have installed the packages mentioned above, complying with certain particularities such as:

The FFMPEG package contains the following libraries: *libavcodec, libavutil, libavformat, libavfilter, libavdevice, libswscale,* and *libswresample.* To comply with the GINGA compilation you need to add the suffix *ffmpeg*, for example*: libavcodecffmpeg* [19, 20, 21]. To do this, you must compile with the following command:

```
./configure --prefix=/usr --incdir=/usr/include/ffmpeg --
enable-static --enable-shared -- enable-gpl --enable-
postproc --disable-programs --disable-sdl --enable-pic --
build-suffix=ffmpeg
```

In the requirements of the middleware indicates that the BERKELIUM library is needed, which is obsolete and discontinued, for that reason should not be installed, when compiling the GINGA will give a warning indicating that the library is necessary, but does not affect the functionality of the applications [22].

```
checking for FFMPEG... yes
checking for main in -lberkelium... no
configure: WARNING:
***
*** Checks for BERKELIUM failed.
*** Berkelium is required by Ginga-CC Player.
*** If Berkelium is not installed, some applications may not work properly.
***
checking for NCLUA... yes
checking for ld used by gcc... /usr/bin/ld
checking if the linker (/usr/bin/ld) is GNU ld... yes
checking for shared library run path origin... done
checking for libxerces-c... yes
checking how to link with libxerces-c... -lxerces-c
```

Fig. 2 Belkium Warning

4 Analysis

The tests were carried out in GINGA NCL because it is possible to create objects making the programming easier since it is exhibited through the NCL Formatter, these objects are also called "Content nodes", these can be audio, video, HTML elements, LUA. Instead, in the execution environment of Xlets, or Ginga-J, the number of Xlets required for presentation of the application is defined depending on the specific function each of them needs to fulfill within the application [3].

The tests were carried out with a program that has the theme "The Galapagos Islands", when starting to run the program starts a video with an image, after 10 seconds appear some pictures of colors: yellow, blue, green and red, which Are interactive buttons that are activated by means of the keyboard, simulating the buttons of the control of the television and by means of which we can have more information on the same subject.

4.1 Testing the Raspberry Pi Model B with the Jessie Raspbian operating system

While executing the program, video pixilation was evident, being reproduced as a sequence of images. In addition there was a delay in leaving the complete buttons corresponding to the interactive activities, although they were programmed to go out together, you can in Figure 3 that you have two buttons, completing the buttons in image 2 after a few seconds. Finally the video collapses in certain occasions being totally black in the screen, does not always happen in the same part of the video.

Fig. 3 Test of aplication in Respberry Pi Model B

4.2 Testing Raspberry Pi 2 with the Ubuntu Mate operating system.

Performing tests of the application executed without any problem, the video had a good resolution, without pixelating the image, however sometimes a few lines appeared due to the resolution of the screen. The interactive buttons appeared together as planned.
The interactivity of the application is shown in Fig. 4, it can be seen that in Fig 4 (Imagen 1), when the yellow button is pressed, photos of the typical animals of the Islands are displayed.
In Fig 4 (Imagen 2), when the blue button is pressed, you can know the flora. In Fig 4 (Imagen 3), when you press the red button, you can see the hymn of the region and in

Fig. 4 (Imagen 4), when the green button is pressed, the tourist places are displayed. Interactivity does not show inconveniences when it is used, it quickly changes according to the need to choose the desired icon.

Fig. 4 Test of aplicaction with interactivity

4.3 Testing the Raspberry Pi 2 with the Raspbian Jessie operating system.

Running the program worked correctly, the video advanced with little pixelated images, appearing the buttons of the interactivity as scheduled, just as pressing the keys related to interactivity showed the images and corresponding texts.

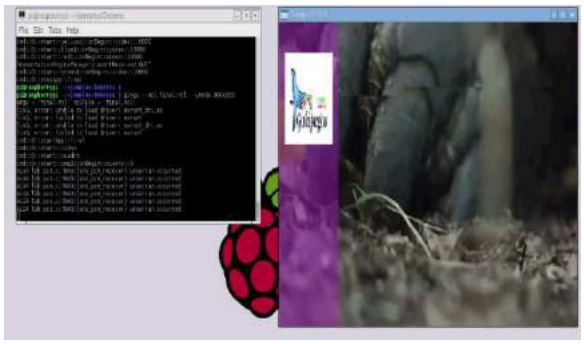

Fig. 5 Aplication running on Raspbian Jessie

4.4 Performance Measurement

To evaluate the performance of each of the cards next to the operating systems, we proceeded to take the time in seconds (s) of what the program is delayed in starting the application until the buttons related to interactivity completely. Data obtained is shown in Table 1

Table 1. Performance Measurement

Raspberry model	Raspberry Pi Model B	Raspberry Pi 2	Raspberry Pi 2
Operative System	Raspbian Jessie	Ubuntu Mate	Raspbian Jessie
Free Hardware (s)	22,12	13,32	14,61
Remote Desktop (s)	25,41	13,68	15,00

Taking the time it was verified that when running the applications using remote desktop, they have a delay of approximately 0.5 seconds on the Raspberry Pi 2 and about 3 seconds on the Raspberry Pi Model B, rather than running the applications. Using external hardware. In addition it is observed that the shortest time in running an application is given in the Ubuntu operating system mounted on the Raspberry Pi 2.

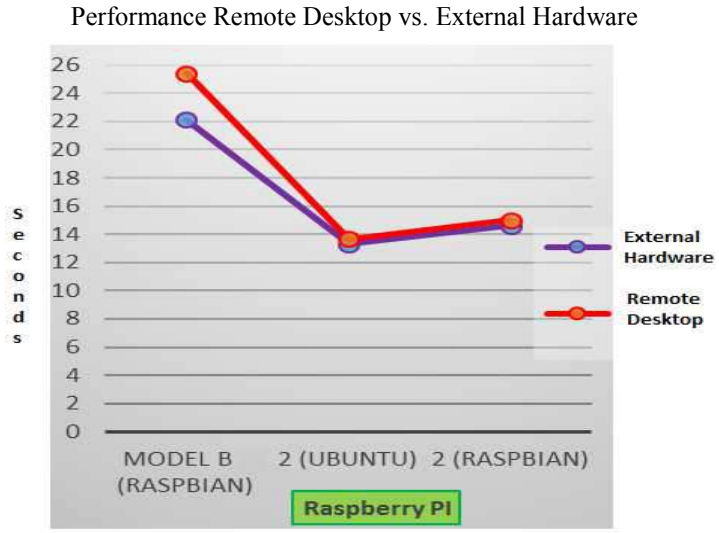

Fig. 6 Performance measurement statistics

4.5 Heat Measurement

The heat produced in the card is due to the processing when running the programs. According to Table 2 it can be seen that program 1 is the one that generates less heat in the Raspberry, in contrast program 3 generates more heat because it possesses a greater amount of videos

Table 2. Heat Measurement Values

0	**Nothing**	Room Temperature + 10ºC
1	**Little bit**	Room Temperature + 15ºC
2	**Much**	Room Temperature + 20ºC

Table 3. Heat Measurement

Programs	Raspberry Model B	Raspberry Pi 2	Raspberry Pi 2
Operating System	Raspbian Jessie	Ubuntu Mate	Raspbian Jessie
Program 1	1	0	0
Program 2	1	0	1
Program 3	2	1	1

The heat produced in the card is given by the processing when running the programs, according to table 2 it can be seen that program 1 is the one that generates less heat in the Raspberry, in contrast program 3 generates more heat because it possesses a greater amount of videos. Regarding the Raspberry that produces more heat is the model B, for its features and the processor that works with a RAM of 512 Mb unlike the Raspberry Pi 2 which is the most current on the market and has a RAM memory of 1 Gbyte.

The average consumption of the Raspberry Pi is 3.5 W, is a minimum amount compared to a desktop computer or a laptop, giving as an advantage in data servers, web, home automation, telephone switchboard or print server. However to work as a Ginga decoder, the power consumption will be much higher, since the heat will rise to high parameters, so you it is not recommended to stay connected for more than a few hours in order not to damage the devices or the plate as a whole.

Figure 7 shows the processing level of the CPUs, when running an application it is checked an increase in an accelerated way, in several occasions the CPU's are running at 100%, since the reproduction of images and videos put the card at the highest processing levels. This is one reason why the Raspberry goes through heating stages, because they switch signals producing a power consumption higher than the average level, being this card perfectly capable of the reproduction of the interactive activities in low times, although other authors give limitations, in the card for this type of reproductions of interactive applications has no limitations [4].

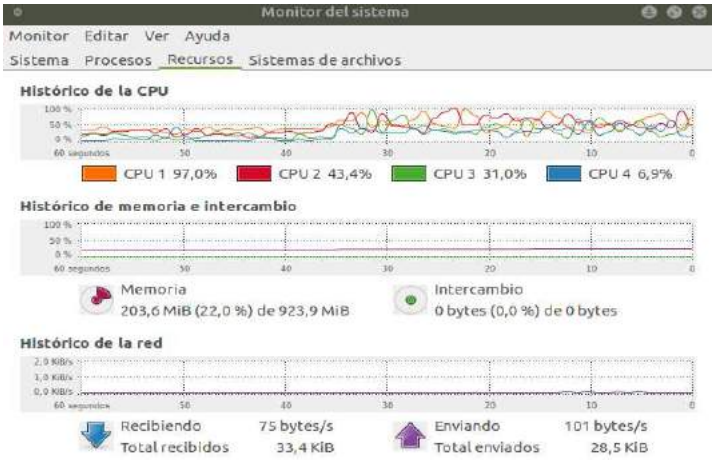

Fig. 7 Processing Level

5 Conclusions

We performed an analysis of the behavior of the minicomputer Raspberry Pi, in terms of the reproduction of videos, images and audios, giving an acceptable result in the card model 2, unlike the card model B that has a paused behavior in the video playback, Because it has a processor with ARM6, unlike the current model has a processor with ARM7.

The commands found for the installation are typical of the middleware, since if the installation of the bookstores is done in the conventional way will not have the correct operation of Ginga and will result in a series of errors.

The performance of the Ginga operation on the card was verified by the measurements of time that were made with the application up to a point, in addition it was performed in two scenarios: the first was by remote desktop and the other with external hardware, obtaining in The two tests that the card running in less time applications is the Raspberry Pi 2 mounted Ubuntu Operating System.

It was verified that when running the applications in the Raspberry, it gave a warm up due to the processing and the contents of the programs, for that reason there was an accelerated increase in the CPU's that conform the processor of the card, determining that the card that I present More heating was the Raspberry Pi Model B.

The Ginga middleware, has been developed by Argentina and Brazil, where each of them presents a version of the program with different requirements. For that reason the best connection with the card was sought and it was determined that Ginga Brazil required the Debian operating system which was equivalent to Raspbian and the image of the official page could be obtained; Instead Ginga Argentina required the Ubuntu operating system but in version 12. 04, which is not available for Raspberry and the image should be created.

It was determined that the audio of the cards has a high noise, because middleware needs more robust hardware.

It was determined that the Raspberry Pi Model B does not have a good embedded Ginga operation, since the replication of applications is given slowly and does not allow any additional operating system function, this is because it has a processor With a RAM of 512Mb unlike the current card has a processor with RAM of 1Gb.

In the Raspberry Pi 2 it was possible to mount two operating systems that were Raspbian Jessie and Ubuntu Mate, where it was verified that the performance in time of installation and execution of the applications gave better result in Ubuntu Mate, with a not very extensive difference By Raspbian Jessie.

For the selection of Ginga it is recommended to analyze the requirements of each of the packages, and the affinity they have with Raspberry, since not all libraries are compatible with Ginga.

As future work could be carried out the study of the implementation of a reception circuit that adheres to the Raspberry Pi, by means of reception modules under the standard ISDB-Tb, to send a Ts and in this way check the part of Reception, coupled with the interactive contents decoder based on Ginga NCL, and checking the arrival of the Ts and the reproduction of the same, obtaining a prototype of complete set top box at low cost.

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Interactive television UI: Industry trends and disruptive design approaches

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Abstract. Currently, consumers watch TV in many different ways. This scenario arises from changes in the users' habits and needs, such as accessing linear and nonlinear content either on the TV set or on a second screen device, anytime and anywhere they wish to watch it. In this context, many commercial players have been offering new features supported on innovative user interfaces to turn the experience of watching TV more pleasurable and engaging. Based on a mapping of user interface design trends, observed in 55 iTV industry platforms (supported by Managed Operated Networks and Over-the-Top players), this paper highlights disruptive approaches as potential stepping-stones towards the future of the TV ecosystem design. The addressed disruptive topics can be helpful to both industry players and academics researching on the theme of Interactive TV User Interfaces. Within the scope of UltraTV project, the findings of this research supported the development of new UI solutions for a TV eco-system based on unification of contents.

Keywords: User interface Design · iTV industry · TV ecosystem · Disruptive approaches · OTT · Linear Contents

1 Introduction

In recent years, the growing availability of audiovisual technology services, mainly related to television, has leverage a changing on user's consumption habits. Such transformation can be seen as a reaction to the emergence of new transmission and recording technologies, as well as to the increasing of Over-the-Top (OTT) content. This scenario culminates in a complete revolution in the television environment, which leads to the fading of the boundary between linear and non-linear viewing of content, changing the consumer interaction in many ways [1] [2] [3].

The traditional pay-TV players, namely those supported on Managed Operated Networks (MON), have suffered a transformation under the influence of the new OTT entrants, who present the content in proprietary Applications (Apps) opening the need for innovative ways to aggregate and unify content from different sources. Such approach can be expected to reduce the gap between different generations of users, in what concerns the contemporary hybridization of viewing habits [1] [2] [3].

Along these trends, there is a set of services introduced by those players allowing end-users to access TV contents through catch-up TV, time shifted, and Video-on-Demand (VoD) features. These features respectively allow the user to watch a content that has already been aired, pause, rewind, go forward or restart a program that has already began, as well as paying to have access to specific contents.

Simultaneously, all these changes demand innovative ways to interact with them. The emerging of new technologies in the Human Computer Interaction (HCI) field make it possible to control the TV using different User Interfaces (UI). Among these different interfaces, there are a variety of natural interactions based on gesture recognition (using cameras) and voice control. This diversity in interaction modes comes with the possibility to manage and watch TV content through multiscreen options and devices, e.g., smartphones, tablets, computers and wearables, like smartwatches.

In this framework, the main goal of this paper is to highlight disruptive UI design approaches lead by the iTV industry, based on the results addressed by the UltraTV R&D project - supported by a consortium of public and private partners, bringing together the academic field and the TV operators sector. Through a systematic search of scientific and empirical material addressing the most significant trends of UI design approaches lead by the industry (considering both MON and OTT players), between 2015 and 2017, a total of 55 cases were thoroughly analyzed and 15 of those are emphasized as disruptive solutions with the potential to leverage the future of the TV ecosystem.

This paper is organized as follows. Initially, a mapping with the main User Interface design solutions offered by commercial players (supported on MONs and OTTs) is addressed. Next, the main UI disruptive aspects presented both by commercial solutions and by prototypes are described accordingly to the two main criteria adopted. The final section presents the most relevant conclusions that can be helpful to both industry players and academics researching on this theme.

2 Mapping iTV UI industry trends (MON and OTT players)

Within the scope of the UltraTV project, with the main objective of developing an advanced TV ecosystem that supports a TV service with the most disruptive functionalities, a survey of the available UI solutions presented by the industry was conducted. The mapping of MON and OTT players has undergone a gradual filtering, which was initially characterized by the identification of technologically advanced players (in the case of the MONs refined by the offer of catch-up TV services), later filtered by the most relevant UI solutions in terms of graphic and interaction propositions. Following, the examples considered as disruptive were isolated, regarding new approaches breaking the current paradigms, based on the two groups of criteria defined: layout and grid; social component and customized experience. The mapping and identification of such disruptive factors grounds the development of iTV UI prototypes under the UltraTV project. It should be noted that for the present article only a few examples have been highlighted, specifically those focused on the user interface of MON and OTT players, which are particularly illustrative of the two components mentioned. Some other User

Experience (UX) aspects of iTV systems, namely the interaction with systems that include the use of remote controls or even control by gestures and natural language were not considered for this paper, although they are an important part of the UltraTV research.

The methodology adopted was established by the definition of categories that guided the performed survey, regarding the solutions provided by MON and OTT players, within a timeframe from January 2015 to May 2017. The primary selection gathered a total of 117 cases, being the MON solutions sourced from a previous study focused on the worldwide offer of Catch-up TV services [1]. OTT collection was retrieved on specialized webzines and online content repositories/platforms (e.g. Business Insider, CNET, Gizmodo, PC Mag, Techradar, Verge, Wired and Youtube) based on popularity and technologic innovation within several categories: Smart TV; connect devices; subscription video-on-demand (SVoD); free video-on-demand (FVoD); and hybrid broadcast broadband TV (HBBTV). A secondary selection conducted for an internal report was applied reaching a total of 55 cases, from which 15 were highlighted for this paper (see Table 1).

Table 1. Players selected for review

Heading level	Primary selection	Secondary selection	Highlighted cases
MON	74	22	7
OTT	43	23	8
Total	117	55	15

The 55 cases of the secondary selection were designated taking in account their UI and UX relevance, assessed by graphic interface design criteria, information architecture, differentiation of available services and interaction models. Finally, the 15 cases highlighted in this paper were selected since they portray the two groups of criteria defined to outline disruptive approaches within the iTV industry, namely: layout and grid; and social component and customized experience.

3 Disruptive approaches in User Interface Design

Several studies suggest different definitions of the 'disruption' concept in the technological domain. In this framework, we agree with the definition of Tellis [4], who finds that disruption is due not to technological innovation per se, but rather going against the mass market paradigm set in place using a visionary leadership to realize future potential. In contrast, the classical view proposed by Christensen [5] is centered on technologic innovation, which initially underperforms the dominant market demands but gradually keeps up and potentially overpowers it.

The contribution about the disruption concept, dialogized by the authors, served as a basis for the UltraTV project, which understands that disruption is the potential to break existing paradigms and take a chance on new solutions, aiming at future markets. Two groups of criteria were nominated to identify the disruptive level of the analyzed interfaces: graphic components (design elements, effects, grid layout and navigation)

and social components (profile customized experience, recommender systems, user-generated content, ratings and reactions). The following two subsections describe each one of the 15 considered examples: 3.1 layout and grid (1. Mur Vidéo, 2. Flow, 3. Apple tvOS, 4. Android TV, 5. LG Web webOS, 6. Infinite Video Platform, 7. Frog) and 3.2 social components and customized experience (8. Vodafone Live on TV, 9. MEO Kanal, 10. Trakt, 11. Facebook Videos app, 12. Netflix, 13. Hulu, 14. Humax On, 15. Altiview 3). While these examples are addressed a set of features based on their potential to break existing paradigms is highlighted.

3.1 Layout and grid

Voo introduces Box Évasion as the latest technology, which in addition to having removable disks to expand storage capacity also introduces some innovations at UX level. The main proposals are based on the possibility of using iWatch as a remote control, and briefly as a second screen, which can access television content anywhere through the Voomotion app. In terms of interface and interaction, their new breakthrough refers to the **Mur Vidéo**[1] viewing mode (see Fig. 1) which is stated as a new zapping experience, based on a panning functionality of the content currently being broadcast (also applied to the on-Demand content) supported on a dynamic grid with video thumbnails organized by genres. The transitions and three-dimensional effect of navigation suggest a floating and illusory infinite, highly dynamic space of interaction. However, this new form of visualization is the target of some criticism in user reviews [6], which point out the impossibility of using parental control filters or even the customization of the grid organization, namely by preference lists despite the system incorporates an intelligent recommendation engine based on television habits. This type of user feedback points to the increasing appreciation of customization and refinement of recommendations results.

Fig. 1. Voo, Mur Vidéo interface (left) and navigation effect detail (right)

Using a different layout approach, based on a flexible grid, the Argentine operator **Cablevisión** (acquired in 2016 by Altice USA) introduces the **Flow**[2] solution (see Fig. 2), which combines linear content, OTT and Time-shift TV services accessible on multiple devices. This solution offers a personalized recommendations and content filtering

[1] Voo Mur Vidéo: https://www.youtube.com/watch?v=dwLK2stDH0g
[2] Cablevisión Flow: https://www.youtube.com/watch?v=IE0n-WlGHYg

based on user profiling. The simple and intuitive UI presents a look & feel close to a desktop by displaying utility widgets on the left side of the screen. The homescreen layout has 3 navigation areas organized by vertical columns, allowing a high density of information with several levels of hierarchy. The iconographic menu is at the center of the layout, and refers to 3 main options (Live TV, On Demand and Recordings). Live content occupies 1/3 of the layout on the left side. In the section to the right of the layout, the navigation is made through cards with 6 visible columns. In other areas of navigation, such as the on-demand video catalogue, the layout includes only two columns, which shows the flexibility of the grid to provide optimized presentation layouts according to the type of content. There is also an additional color navigation and remote-control buttons for specific menus such as 'profile switching', 'search' and 'parental control'. Although the high complexity of the interface is prone to require a significant learning curve related with the various forms of navigation, this UI facilitates access to all content by using a balanced hierarchical system.

Fig. 2. Cablevisión, Flow homescreen (left) and interface app (right)

It is also important to highlight the influence that the two-main mobile operating systems have on television ecosystems design, embodied in the available TV guidelines, namely Apple tvOS and Android TV. These recommendations systematize the UI design focused on a responsive perspective that keeps in mind the multiple screen sizes used by devices, and the navigation structure relying on cards and apps.

Concerning the **Apple tvOS**[3], it stands out from the competitors for its fresh and airy look & feel provided by light gradients. At the layout level, the navigation is horizontal, using lines of cards, variable in number and scale according to the content requirements. Its minimalist character is bustled by the soft animations, transitions and parallax effects whose visual enrichment constitutes a distinctive feature of the tvOS. In terms of images, Apple uses several formats, namely covers, cards and banners, highlighted through shadow, animation and scaling when selected. Because these images alone introduce a high chromatic burst, minimal inclusion of color in the UI balances and directs viewer´s attention to content.

In turn, **Android TV**[4] stands out strongly for the unification of contents from Google sources and also for recommendations presented on the homescreen, by using a carrousel menu, which mixes different content in the same line. Since its development and

[3] Apple tvOS: https://www.apple.com/tvos/
[4] Android TV: https://www.android.com/tv/

launch in 2014 based on the Android 5.0 Lollipop version, Android TV has been running updates and adapting to diverse boxes, variable in hardware and cost (e.g. Nexus Player, NVIDIA Shield, Mi Box). The use of Android system on Bravia, Sony's Smart TV, embodies the operating system in a large-scale television format. Its interface and adaptability are examples of a platform that is perfectly shaped to the different devices, without ever losing its look & feel. With the tagline "Less browsing, more watching", the Android TV platform in the 6.0 format Marshmallow defines as main objective the consumption of content, instead of the high consuming task of browsing. With a focus on connecting to other Google features, it provides access to apps such as the Google Play Store, Google Cast, and voice control through Google Assistant. This functionality assumes a preponderant role in the manipulation of the interface, being the voice search suggestion always present to carry out any query. In terms of layout, Android TV uses different size cards: the largest to highlight and the smaller to present content and apps side by side. Through a simple navigation, the grid splits horizontally the space into thirds, with the background being occupied by a static image with a blur effect, corresponding to the selected card. This type of card carrousel navigation has become more recurrent in content display using categories, being equally used in television and mobile context. In this regard, **LG webOS 3.5**[5] (see Fig. 3) presents a bold and dynamic solution by depicting content through a diagonal carrousel navigation, which presents programs and apps in the same alignment. This type of presentation with a diagonal menu is applied in webOS homescreen as a footer menu and on the left side to present the catalog. These diagonal sections on the left are customizable and serve as separators between 'My content', 'My channels' (live content) and 'My apps' topics.

Fig. 3. LG webOS 3.5, homescreen (left) and customization detail (right)

In terms of middleware suppliers, Cisco and Wyplay stand out, particularly due to the customized UI solutions for MONs. In addition, both companies have ambitious proposals already disclosed in demos.

Infinite Video Platform[6], a new operating model for video services provided by CISCO, supports numerous platforms. With a hybrid approach, totally disruptive and distinctive from everything available on the market, CISCO's Infinite Video interface uses a flexible layout and an animated mask navigation with vertical or horizontal slides, according to the selected menu. These masks (see Fig. 4) emphasize the selected

[5] LG webOS 3.5: https://www.youtube.com/watch?v=v5471kC8heE
[6] Cisco Infinite Video Platform: https://www.youtube.com/watch?v=5LrVIablSJk&t=280s

information while partially disclosing the background video being broadcasted. The areas revealed by the mask are variable depending on the section the user is navigating.

Fig. 4. Cisco Infinite Video Platform homescreen (left) and Timeline menu (right)

Regarding IPTV solutions for operators committed to an open standard using HTML5, the French company Wyplay acquired a large market penetration. At the interface level, the product **Frog**[7] by **Wyplay** (see Fig. 5) introduces disruptive layout and navigation components in prototypes, that despite not being yet adopted by any operator is on the same standard of the latest concepts proposed by leading companies. One of the most disruptive UI concepts, presented by Wyplay, is evident in a proposal of horizontal navigation with circular items, using dynamic transitions. The circular graphic element is the main leitmotiv applied to the various interface screens with different functionalities, such as dock menu, item menu, preview window, preload, footage timeline, channel id, features icons, among others. The adoption of circular forms represents a breakthrough with the accentuated grid-based layout trend relying on cards, thus leading to a more organic and fluid environment aiming at younger audiences, familiar with bolder interfaces mostly available in mobile systems.

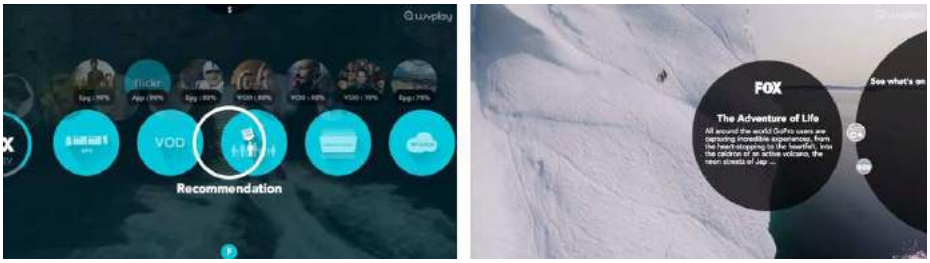

Fig. 5. Wyplay Frog active profile interface (left) and contextual menu (right)

3.2 Social components and customized experience

In addition to the unified display of sources and content on the UI, is also worth mentioning the disruptive potential of using TV companion devices as second screens al-

[7] Wyplay Frog: https://www.youtube.com/watch?v=cNSkoeDaGDY

lowing the distribution of the information density and enabling the expansion of additional content and features in full mobility. Furthermore, the arrangement of content based on user individual habits (profiles) and mass consumption (communities) are also important topics to be emphasized. Such phenomena are related to binge-watching and social recommendation [7] [8]. In fact, rather than just recommending and commenting, users tend to become prosumers (both producers and consumers) [9] with a growing influence on the content industry, which is becoming increasingly more attentive to its clients' thoughts and their collective impact.

An example of user-generated content and self-broadcasting in the television context in Portugal is present in two national Pay-TV operators, Vodafone and MEO. In the case of **Vodafone**, the **Live on Tv**[8] app allows users to share live videos with friends, using a mobile phone or a GoPro to perform livestreaming to the TV. In the same context, the Portuguese company MEO presents the **MEO Kanal**[9] service, which enables its customers to create their own private and public television channels and share them with other clients from the MEO network.

In standings of market niches, solutions aimed at spectators with a strong connection to streaming content begin to emerge. This is the case of **Trakt**[10] (see Fig. 6), a platform that can be integrated in several media centers through its API. The platform allows users to keep up with the television shows and movies that others are watching, as well as automatically track and get notifications about content available from different sources. Unification of access is achieved through the provision of a unified and growing catalog, that establishes connections (based on mass ratings and recommendations) between content and consumers, generating a social network of its own. Because it is particularly directed to a systematic consumption, namely for binge-watching or marathon-viewing that refer to the continuous visualization of several episodes of the same program [7] [8], the platform offers features such as calendar, playlists and popular content notifications. In this aggregated catalog preview links are provided (according to available sources), along a set of analytics like ratings assigned by users, total number of views, comments and general information.

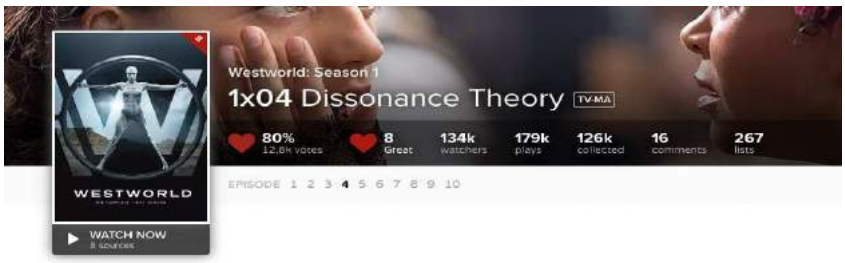

Fig. 6. Trakt catalog item interactive analytics detail

[8] Vodafone Live on TV: https://www.youtube.com/watch?v=N5UDtYPLUes
[9] MEO Kanal: http://kanal.pt/
[10] Trakt: https://trakt.tv/

Online social networks are also investing on targeting users from different platforms. In 2017, Facebook launched **Facebook Videos**[11], an app designed specifically for Apple TV (see Fig. 7). Under constant updates, the application provides (in its version of middle July) a navigation interface exclusively for video content, with horizontal playlists based on the user's profile. The minimal and sober interface provides access to categories such as suggested videos, live, topics, games and even search for new content. In addition to such features, it is possible to save videos, share and react (e.g. like, love). By having a carrousel format, navigation through the videos is quite straightforward, as well as the access to comments and reactions from users. When accessing a video in fullscreen, the reactions contextual menu is activated by the command tap & hold (see Fig. 7).

Fig. 7. AppleTV, Facebook Video app main menu (left) and reactions menu (right)

The use of profile-based recommender systems is also one of the focus of **Netflix**[12]. Positioned as a subscription-paid service with a diverse catalog including original productions, this platform allows streaming on different screens as well as the download of videos for offline viewing. The organization of content by categories, in conjunction with the existence of profiles with their own recommendations, facilitates navigation within the catalog and provides a richer and personalized experience. The enhancement of such customizations is boosted by the thumbs up/ thumbs down rating (see Fig. 8), used to improve the recommender system of the individual profile instead of being a global classification system applied to all users. This means that each content is rated individually with the percentage of relevance to a specific profile [10].

Other Video on-Demand platforms, such as **Hulu**[13] (which is the result of the partnership between The Walt Disney Company, 21st Century Fox, Comcast and Time Warner) also provides a unified interface across devices, including the access to live channels. The Hulu's focus on profile customization is translated into a dedicated section with a channel alignment recommended for the active user, e.g. Ben's Lineup (see Fig. 9).

[11] Apple, Facebook Videos app: https://itunes.apple.com/pt/app/facebook/id284882215?mt=8
[12] Netflix: https://www.netflix.com
[13] Hulu: https://www.youtube.com/watch?v=qLvS-G67pCU

Fig. 8. Netflix catalog item, matching and thumbs up/down ratting detail

Fig. 9. Hulu, customized Lineup interface

The customization of the experience has also been essential in TV ecosystem concepts and prototypes, particularly those relying in the activation and switching of profiles. In the case of **Humax ON**[14], an award-winning solution at IDEA 2015, the Korean company presented a mockup based on natural language and proximity using mobile devices as a second screen to login and activate recommendations, taking as a differential the combination of several layers of information, with navigation in a system of quadrants that guide the user by choosing channels and contents available (see Fig. 10).

In the case of the prototype **Altiview 3**[15] presented by **Alticast**, content customization is provided based on the user's habits. Factors such as location and the music the user is listening to are used to make an unfolding of new suggestions and recommendations. By recognizing a location of a user's photo, the platform suggests movies and series recorded at that location (see Fig. 11). The recommendations and suggestions are dynamic, and the user can navigate in different categories (metadata about a certain catalog item, such as actors, filmmakers, soundtrack) presented through distinctive forms of visualization (see Fig. 12).

Fig. 10. Humax On, profile login and second screen remote control

Fig. 11. Alticast, Altiview 3 movies recommendation by location detail

Fig. 12. Alticast, Altiview 3 movie metadata visualization detail

[14] Humax On: https://www.youtube.com/watch?v=Ya8iuEhPN88
[15] Alticast Altiview 3: https://www.youtube.com/watch?v=4g4TI9QAgKI

4 Conclusions and future work

Changes in the viewing habits within the television ecosystem have triggered consecutive innovations to the consumer market. The identification of models that promise to be the new standards in medium and long-term can envision future references in the industry. The presented mapping has identified some UI and UX trends in the context of MON and OTT players that are important to be considered not only by industry players but as well by academics researching on this theme.

Grounded on the reviewed cases, some features were highlighted based on their potential to break existing paradigms. In Fig. 13 the following 7 graphic components regarding layout and grid are systematized as disruptive solutions: i) adjustable layout according to content; ii) 3D grid effects; iii) desktop look & feel with widgets and icons; iv) multi-size cards carrousels; v) light themes using gradients; vi) masks to disclose background video; and vii) unconventional shapes (diagonals and circles). As far as Social components are concerned 8 topics stood out as upcoming possibilities for customized TV experience: i) user-generated content and self-broadcasting, ii) communities and social networks based on shared viewing preferences (mass viewing); iii) notifications and content tracking for binge-watching; iv) recommend playlists of videos arranged by categories; v) reactions menu and thumbs up/down to refine recommender system; vi) personal lists by profile; vii) context-aware recommendations; and viii) profile activation using proximity, natural language and second screen. Each of the disruptive approaches mentioned are cross-referenced with the commercial and prototypes cases highlighted in sections 3.1 and 3.2.

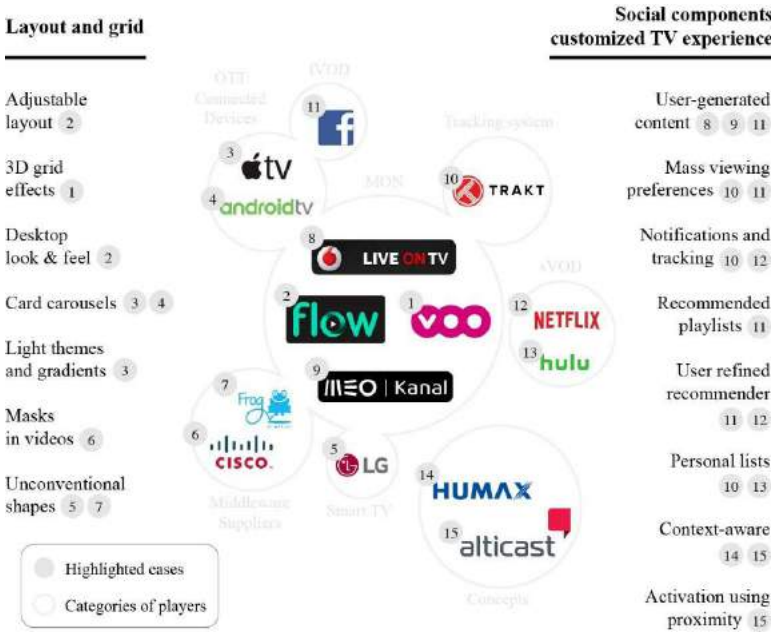

Fig. 13. Disruptive graphic and social components identified on the highlighted cases

Such disruptive proposals in the iTV context still strive as commercial exceptions. In this sense, the research made on the UltraTV project, by bringing compiled data that provides an overview of trends and disruptive approaches in the industry, sustains a contemporary framework of UI disruptive concepts to develop prototypes for new iTV market solutions.

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