Integrating Simple Recommendation Systems on Digital TV Widget Applications

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Abstract—**As Digital Television is becoming popular, an ever-growing number of television operators is providing interactive applications for its viewers. Due to the nature, usual employ and limited interaction possibilities with the device, an intensive use similarly to computer is hardly recommended. Instead, recurring to more casual and lightweight interfaces such as widgets, and obtaining information about the viewed contents has been considered a more appropriate employ of the potential of such a technology.**

This paper describes a recommendation system to be integrated with Digital TV Widget applications, which, by considering the user's program choices, is capable of presenting related commercial products and upcoming events, matching therefore the user's interests. The interface design is meant to be as simple and intuitive as possible, yet compatible with existing widget systems. This is achieved by recurring to similar button mapping and presenting color and geometric clues for its handling. This approach intends to offer simple, enjoyable, yet efficient personalized advertising features.

Digital TV; IPTV; Human computer interaction; Recommender system

I. INTRODUCTION

Nowadays the world is witnessing an increase of information flowing through the digital channels that can be accessed through a large number of different devices. However, the information is scattered, which makes it difficult to filter particular content to meet individual user interests. For this reason it is important to develop new methods and applications that facilitate the process of recovering information, managing it to reach its most relevant audience.

This research work presents the implementation of a recommendation system application. This application tries to relate the television viewer's likings with existing events and products, thus promoting them. Considering the example of a viewer who usually watches football on TV, it would be correct to infer that he probably enjoys football merchandizing products like the scarf of the top clubs, or the shirts of the best players. Such is the kind of inference drawn by this system.

The main challenge of this project resides on the interface design. Designing interfaces for TV applications greatly differs from conceiving for other electronic devices due to the different type of users. In TV, there are many different user profiles. This paper presents a 3-step iterative approach led for understanding different needs and how to address them.

Several users are not accustomed to deal with new technologies. For this reason the interface should be simple enough in order to provide the quickest adaptation possible. Complex interfaces are usually ignored by this type of users. Other users have visual impairments, such as color blindness which make it difficult for them to interact with interfaces with complex color schemes and foreground and background color combinations. This work also focused on these users, with the goal of reducing the handicaps caused by these disabilities.

The rest of this paper is organized as follows. First, some related work is presented, followed by the proposed solution which is based on the detected gaps in the state of the art. Section III presents the solution to this problem, namely the architecture of the application, its evolution and the main interaction problems as well as how to deal with them. Section IV describes the steps to implement the solution. Section V presents some user tests in order to validate this approach. Finally, Section VI presents the general conclusions and recommendations for future research work in this area.

II. RELATED WORK

This research work focus on important areas of informatics engineering such as human computer interaction (HCI), recommendation systems and simulation software. These areas of knowledge were grouped together to develop a system for a digital television (DTV) platform, which is more dedicated to serve the general public. The system was prototyped for integration into a real existing DTV platform from ZON [1], the leading company in digital telecommunications in Portugal.

To create applications for TV, the balance between simplicity and the number of functionalities is a critical issue [2]. This means that it is important to provide the functionalities that are required by the targeting audience, but some aspects such as avoiding the excessive presence of the application, overlapping the show, must be taken into account. Some of these challenges are described and dealt with in research works like [2]; where a semitransparent widget system based on color interaction is proposed; or [3] which describes

general problems of these type of applications, with emphasis on a real case in Brazil.

The type of functionalities that are present on DTV applications is related to the type of users. The most frequent features present on DTV systems are electronic programming guides, Enhanced TV, Video-on-demand, personalized TV, Internet, ITV advertisement, T-commerce, home banking, games and gambling [4]. Most ordinary TV viewers are interested rather in simplicity than in the quantity of features. The user interfaces should be simple enough to capture the viewers' interest. The work [5] proposes an UI evaluation framework to predict the viewers' interest on the general TV interfaces.

The proposed application is a recommendation system that intends to provide information based on different user needs. One good example of such system architecture is in [6], which describes a compact architecture that is able to deal with this problem. Another similar work is [7], which talks about personalizing dynamic and collaborative contents for TV viewers.

One important work is [8] which is a survey that presents a general state of the art about TV research in industry and content sharing.

III. A SIMPLE RECOMMENDATION SYSTEM

The proposed recommendation system intends to provide simple yet efficient advertising features, based on the programs watched by the viewer. The control and navigation over the interface is supposed to be as enjoyable and intuitive as possible for any kind of user.

In this section an overview of the recommendation system will be presented, starting by the basic concept, general architecture and interaction, followed by the various experimented approaches.

A. *Basic Concepts*

In order to define the system architecture, it is necessary to identify first the concepts and entities, as well as to describe their relationships. The following UML diagram in Figure 1 illustrates those concepts. Some are displayed in a simplified manner, allowing a more global view on the system.

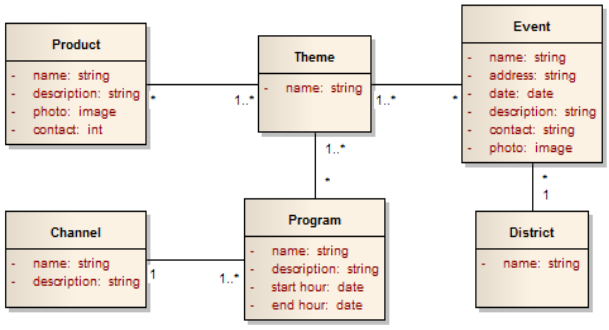

Figure 1. UML class diagram

As seen through the diagram, six different concepts can be identified:

- **Channel**: Represents a television channel. Each one has a name and a description of its contents. A channel consists of one or more television programs.
- **Program**: Represents a television program. Each one contains a name, a description of its contents, a start and end time. A program belongs to a particular channel and is associated with one or more themes.
- **Product**: Represents a product to be suggested to viewers, having a name, description, promoter contact and a photo. A product is associated with one or more themes.
- **Event**: Represents an event to be suggested to the viewers. It contains a name, address and date of occurrence, description, sponsor contact or an image illustrating the event. An event is associated with one or more themes and a district.
- **District**: represents a district or any kind of country geographic subdivision. The identification of this concept aims to group events by region, allowing viewers to get event suggestions on the region where they live.
- **Theme**: The concept of theme allows programs to associate events and products. When events or products are suggested to viewers, the ones that will be presented are the ones that have themes in common with the ongoing program.

B. *System Architecture*

In order to implement the application in a Widget System, client-server architecture was proposed. The following figure (Figure 2) gives a general view over the behavior of the system.

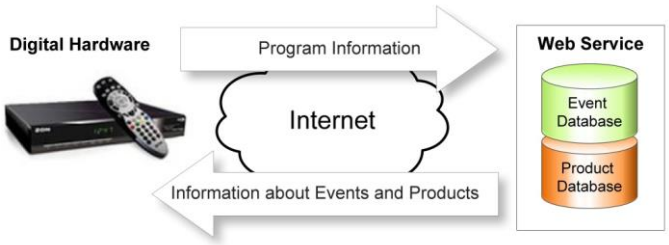

Figure 2. Widget architecture

The client application contains the widget, implemented on the television operator hardware. This equipment communicates through an Internet connection with a Web service, which provides the interface to access the server.

The Web service receives from the client information about the program that is currently being displayed. Upon receiving this information, the Web Service consults the databases in order to detect events and products related to this program. After this query, the results are immediately sent to the customer equipment and, consequently, to the viewer.

C. *Widget Interaction*

The interaction with the widget, achieved through a standard modern remote control, is intended to be simple and intuitive, requiring a reduced number different buttons: the four colored buttons (red, green, yellow and blue), a "back" button, up and down arrow buttons and, of course, an "exit" button.

While watching a program, the widget system can be accessed via the red button, which is very commonly used for accessing interactive TV applications. Figure 3 gives an overview of the conceived widget that is displayed once such button is pressed.

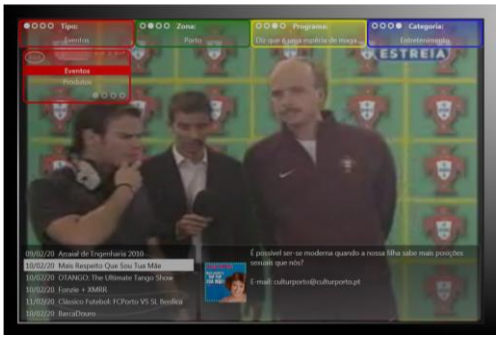

Figure 3. Overview of the Conceived Widget

As it can be seen in Figure 3, the widget is displayed as an overlay with transparency, meaning that it still allows the TV program to be watched, without presenting too much obstruction. Its arrangement is top-bottom which is different from what is normally seen in TV interfaces, which follow the L-shape arrangement [2]. The main reason for this decision is to allow the user to easily map and associate the button order in the remote control to the various top menus. There are four, each one associated with a color (which can provide additional visual clues to the user), to access four features:

- Red Button/Menu: Change between events and product display;
- Green Button/Menu: Change the location/district;
- Yellow Button/Menu: View events/products related to programs previously transmitted;
- Blue Button/Menu: Alternate between themes associated to the currently selected program.

Each colored top menu contain a label showing the currently selected item and well as an additional clue for colorblind users to understand which buttons correspond to which menu. Four circles are drawn, and the corresponding interaction button is filled while the others are hollow (see Figure 4).

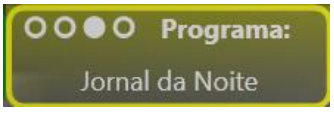

Figure 4. Button mapping clues for colorblind viewers

Whenever a colored button is pressed, a corresponding menu list appears below the colored block showing a set of items which can be scrolled down by repeatedly pressing the same colored button and scrolled up using the "Back" button. Figure 3 shows an example where a red menu list containing "Events" and "Products" is being displayed, and can be iterated over.

It is important to underline the fact that, while the events depend on selected location, program and theme, the same does not apply for products. Instead, only the selected program is a deciding factor, which is reflected on the interface when the "Products" option is selected: the green (locations) and blue (themes) menus become invisible.

On the bottom left part of the screen the events and products are listed, while on the right a more detailed description (as well as contacts) of the selected item is displayed. Navigating on the left list can be done through the up and down arrows. The contents of this list are refreshed whenever the selected items of the top menus are changed. As said, these are controlled by the user interaction with the four color buttons, but may also change automatically if the channel is switched or the current program finishes.

Finally, exiting the widget can be done through the assigned "Exit" button or, as expected, by switching off the TV.

D. *Widget Evolution*

In a first approach, the widget's purpose was to be integrated with a specific TV Widget System, owned by the TV operator "ZON", which had included it in their "ZON Box" devices. Therefore, the widget interfaces were designed to fit the existing system, as it can be seen in Figure 5:

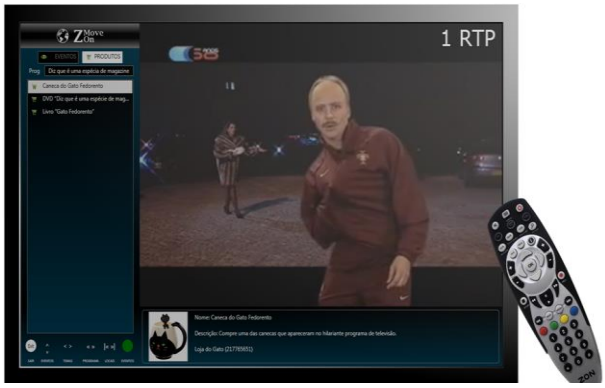

Figure 5. First version of the interface, adapted for the "Zon Box" device. On the right, the corresponding remote control is displayed.

While this system had the advantage for the said company to implement it within its system, it presented the following disadvantages:

- Non intuitive button interaction, which, besides requiring 4 sets of arrows and colored buttons for navigation, were difficult to remember and therefore required an additional label with instructions;
- Difficult text readability at medium range;

- Programs, districts and themes were displayed each in a text box with the currently selected item, which would give limited perception of item listing.

After obtaining some feedback from the potential users, the interface was further developed in order to correct some of the mentioned deficiencies, which resulted in the interface shown in Figure 6.

Figure 6. Second version of the interface

This approach was heavily based on the work of [2] which presented color as a more intuitive solution for interaction. By using colors, amount of required buttons for navigation was reduced to one set of arrows and the color buttons, eliminating the need for an additional label with instructions. Still, some problems remained:

- Iteration over districts, programs and themes could only be done in one direction, which could mean, for longer lists, a more difficult access to the intended item;
- Difficult text readability at medium range;
- Programs, districts and themes were displayed each in a text box with the currently selected item, which would give limited perception of item listing;
- While color support is helpful for most users, it can present difficulties to colorblind viewers which cannot perceive the differences.

In response to these new problems and especially the last, a more platform-independent approach was conceived (that is, having a completely different design than the one from "ZON Box"). It is displayed on Figure 7.

Figure 7. Third version of the interface

In this version a more powerful interaction was introduced, allowing scrolling through lists and navigating in both directions. The text was resized making it readable at medium distance even for smaller displays. Through some shape clues (a filled circle inside a larger circle, in a row with four circles corresponding to the four buttons), support for colorblind viewers was introduced. However, this approach required additional room and could not be clear enough for all users. Therefore this aspect was corrected, which resulted in the interface presented in the section C of this chapter.

E. Colorblind support

As soon as the problem of color blindness was pointed out, a constant concern regarding this aspect accompanied the remaining development stages. Although it could only be thoroughly tested with people with such deficiencies, it was possible, using specific filtering software, to simulate such view on the interface. Figure 8 shows an example the final version of the interface displayed in Figure 3 from the view of a red-blind person (protanopia).

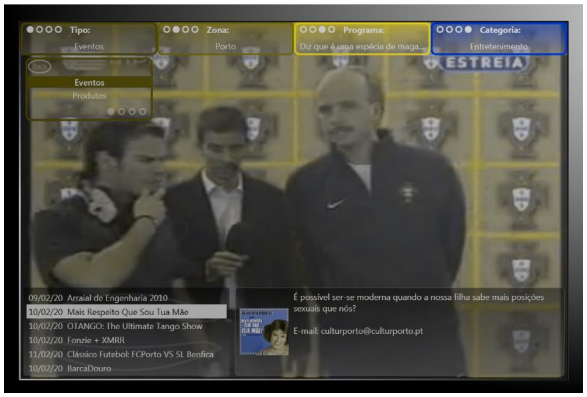

Figure 8. Red-blind vision (protanopia) of the widget interface

IV. IMPLEMENTATION

Since the TV operators' devices are commonly locked to avoid user reprogramming, the implementation of the concept in a real digital television device would be impossible. Even if that would not be the case, it would still require considerable work. Therefore, in order to test the concept, a desktop computer simulator was built, allowing the experimentation of the widget in an environment similar to a digital television system. The simulator uses pre-recorded videos as channels. Each video has different programs with small duration and advertising between them. The duration of the TV programs is small to speed up the tests.

A. Hardware

The television screen is represented by the monitor of a computer which runs the simulator. This avoids the need to deploy to any other platform and therefore allows quick altering and testing of interface features. The remote control, on the other hand, was replaced by a smart phone with a touch screen. The purpose of this approach is to enable easy customization of the remote as well, in order to seek the simplest, yet most effective layout possible (see Figure 9). It is

important to underline the fact that the base remote control layout tested matched the ZON TV [1] remote control.

Figure 9. Remote control interface on smart phone

The communication between the two devices is achieved though Bluetooth, which requires inexpensive hardware and is relatively easy to use.

Regarding the Web Service, which allows access to both product and event databases, it was implemented locally on the same computer for more immediate testing, but enabling remote access as well.

B. Software

The simulator interface was designed with the Microsoft Windows Presentation Foundation 4.0, a graphical subsystem of the .NET Framework 4.0. This choice was motivated by the great potential that this tool contains for interface creation. The chosen programming language was C#.

For the management of all data referring to the events and products, a Microsoft ® SQL Server Compact Edition (a simplified version of Microsoft ® SQL Server) was used. Regarding the Web Service, an IIS local server was set up, being the connection to it achieved through SOAP.

V. RESULTS AND DISCUSSION

A. User test groups

To test the developed interface three different user groups were defined. The definition of user groups aims to distinguish the results between users with different needs and different levels of affinity with technologies. The defined user types were:

- Group A: Users with low affinity with technologies, namely people who usually use computers and interfaces only for work, or do not use them at all (18 users).
- Group B: Users with high affinity with technologies, such as the current users of ZON Widgets or other Digital TV services from different operators (12 users).
- Group C: Users with some visual impairment, such as color blindness, but with a high affinity with technologies (4 users).

B. Test tasks

The usability tests consisted in measuring the time that each type of user took to perform a certain task as well as the number of mistakes before reaching the goal (like pressing the wrong key on the remote).

Four different tasks were considered:

- Task 1: Open the widget; consult the events of the current program; check events of different themes; close the widget.
- Task 2: Open the widget; consult the events from Lisboa of the current program; close the widget.
- Task 3: Open the widget; consult the products of the current program; close the widget.
- Task 4: Open the widget; consult the products of the previous program; close the widget.

C. Time tests

The average time (in seconds) that each type of user took to perform a given task is presented in the following Table 1 and the correspondent chart (Figure 10).

TABLE I. TIME TO PERFORM TASKS

	Task 1	**Task 2**	**Task 3**	**Task 4**
Group A	95s	86s	53s	38s
Group B	36s	25s	19s	14s
Group C	58s	32s	28s	20s

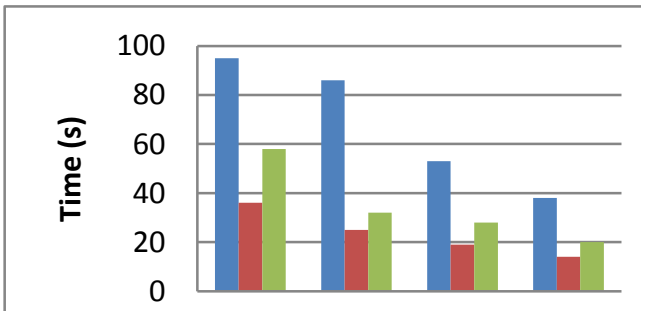

Figure 10. Time to perform tasks

It is possible to observe that the group of users that is more familiarized with technology is the group of users that took less time to perform all the tasks (Group B). For some tasks, the less experienced users (Group A) took almost twice or thrice as long to accomplish the same job. Regarding the users with visual impairments (Group C), they indeed took slightly more time than Group B, although they also had a high affinity with technologies. This was because these users had difficulties pressing the correct button, since they had to look at the remote to see the reassemble to the screen icons.

A tendency that was noticed in the various tests was the decrease in the necessary time to accomplish the tasks. This is expected, since it becomes easier when the mechanics are understood (and are the same for other tasks). Still, Group A

had a longer learning curve than the others. Group C always showed more difficulties than Group B due to the explained factors, but quickly adapted as well, coming closer to Group B in the last task.

D. Mistake tests

Some common interaction mistakes were noted while the users were performing the assigned tasks. Most of this errors consisted in pressing the wrong key for the desired action. The main mistakes are:

- Use of "back" button to close the widget – the button that should be used to close is the Exit button. This happens probably because of the high distance between the exit button and the color buttons (see Figure 11). The name of the button "back" can also confuse the users, because they might assume that back means to go back to the TV original state (without widget). Group A performed this mistake more often.

Figure 11. Full remote control overview, highlighting the distance between the buttons

- Use of the "back" button to close the "activated" menu. The users of Group B and C usually perform this error. They try to close the menu with the "back" button. The back button is used to navigate to the previous selection in that menu.
- Use of the "arrow" button to navigate in top menus. This mistake happens in all groups. When a color menu is activated, the users sometimes try to use the arrow keys to navigate between options, instead of using the menu's color key or the back button.
- Wrong color button: Despite having the icons presented on the screen representing the position of the color button that should pressed, the users of Group C sometimes have difficulties in selecting the right color.
- Use of other random button: This mistake happens mostly on group A. The ZON remote has too many buttons (48), which confuses the less experienced users.

VI. CONCLUSIONS AND FUTURE WORK

In this research project, the implementation and integration of a recommendation system on a real platform was presented. The implementation of a recommendation system for Digital TV is of great interest because it allows its users to receive information fitting its profile, as well as providing this type of service to new kinds of users that are less familiar with new technologies through the most used media system around the world - the Television.

This work focused on the interface of such system with emphasis on improving the interface for users with visual impairments. The implemented system showed that this type of users always have more difficulties using this kind of interfaces, but quickly adapted to the mechanics, leading to reduced access times, as was proven in the tests.

There are some areas where future research work could focus. First, the recommendation system itself could be improved by providing suggestions not only linked to the program, but also related to the user's viewing history.

In order to monetize the widget, the online shopping concept could also be integrated. This way, the users could directly buy the products related to the shows or the tickets for a related event. The hardware of the widget should also be improved, namely the ZON control remote which has too many buttons. The proposed smart phone system presents itself as an interesting and quick way of discovering the best remote control configuration. Another possible future development is the integration of this system in Multimedia Home Platform (MHP) which is a famous middleware for TV software development.

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