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Smart Remote Control Design for Seniors

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Abstract. Technology is present in almost all aspects of our modern lives, and technological advances have been more and more prevalent. One would expect that this would facilitate everybody's life, rendering common tasks more practical and easy to perform, but that is often not the case – at least for the elderly. Older people show significant difficulties in using technological equipment due to the visual, physical, cognitive and hearing limitations associated with the natural aging process; these aspects must be taken into account if the intention is that of integrating technology in the lives of the elderly.

In order to improve the quality of life of the elderly, as well as to prevent their social isolation, a mobile device application that acts as an intelligent remote control is presented. This mobile application deals with data from two different platforms that were previously developed for improving the quality of life of the senior population: HbbTV and +Social. The features built into this virtual remote control include the integration with the +Social platform, as well as a speech recognition mechanism and the possibility of making and receiving video calls with an integrated contacts list.

A comprehensive study was carried out, focusing on recommendations and rules for graphical interfaces for the elderly, so as to allow equipping the application with adequate usability standards. The most relevant result was the definition of a list of guidelines that was utilized to steer the development of the interface. An investigation of mechanisms and technologies for enabling the implementation of the required functionalities was carried out in order to define methodologies for freeing the user from the need of possessing any level of computer literacy.

A series of usability tests was also performed to validate the viability of the remote control application. These tests allowed assessing the quality of the application, especially concerning the Graphical User Interface, as well as to receive feedback from potential end users. Based on the data collected during the test phase we conclude that this product is useful and that it responds to a current necessity.

Keywords: remote control, elderly, graphical user interface, Android

1 Introduction

Statistics indicate a growing elderly population, and it is estimated that in the coming years this trend will continue [1]. It is also evident that older people are becoming increasingly isolated, both geographically and socially; many live alone in their homes and in need of specialized treatment.

It is necessary to find solutions to prevent feelings of isolation and insecurity, and technology can play a key role in this. The problem is that most existing technology is quite complex, and is designed to achieve high levels of elegance and intuitiveness; for younger users, this is not problematic; however, for the elderly, these conditions may not be the most favorable and, in fact, hinder the use technological devices.

The need to create systems adapted to this particular audience, that are simple and easy to use, is paramount; however, developing such a system can become a challenge. It is necessary to find solutions that take into account all the limitations that the elderly may present, whether there are visual, cognitive or mobility-related, so that the final product is able to mitigate these limitations and provide a pleasant user experience.

+Social [2] is a multi-service platform that aims to provide the elderly population with a range of services aimed at introducing technology in their day-to-day, so as to improve their quality of life and to increase the sense of security – both their own and that of their caregivers. One of services integrated in the +Social platform is a SmartBox responsible for the transmission of television channels to a monitor which provides some advanced and customized features, including full integration with the platform. The contents provided by SmartBox must be controllable; there emerged the necessity of the development of a remote control that can, for practical purposes, transform this platform into a SmartTV.

The objective of this project is therefore the development of a Smart Remote Control that allows controlling the SmartBox; to differentiate this remote control from traditional models, it will be designed as an Android-based touch-enabled device, and its development will take into account the common limitations of the elderly. For this purpose, a preliminary study was carried out on interfaces for the elderly, in order to ensure that the developed product complies with existing standards.

This paper is organized as follows. The following section provides background on the +Social platform and the technologies involved in the implementation of this project, while overviewing and contextualizing related work. Section 3 details the architecture of the platform. The process of defining the set of guidelines gathered for steering the development of the Smart Remote Control is explained in Section 4, while Section 5 details the design specifications adopted and utilized for developing this device. In Section 6, the tests carried out in order to validate are detailed and discussed. The final Section summarizes the main contributions of this paper and sets ground for future work.

2 Background and Related Work

The main objective of this project is the development of a Smart Remote Control with elderly targeted functionalities for integration in the myPhoneOnTV application [2]. The myPhoneOnTV application runs on a SmartBox developed in the context of the +Social platform and incorporates the several features, such as the streaming of television channels, content display in full and reduced screen modes, access to the television channels' programming and phone contacts.



Fig. 1. – The myPhoneOnTV application.

Other applications and solutions which target an elderly audience exist. TVKiosk [3] is a project that aims to simulate social interaction in order to avoid the isolation of the elderly. This platform uses a Vir-

tual Private Ad-Hoc Network so that information can be shared among the system's users, e.g. the elderly, their family and caregivers. The elderly typically interact with the television using a remote control designed for this purpose, while other participants may opt to use a computer.

The TVKiosk shares several similarities with the +Social platform; the crucial difference is the means of communication with the television set. Instead of using a traditional remote control, our proposal suggests the use of a Smart Remote Control command which supports more functionality and, therefore, offers greater possibilities in terms of accessibility and integration.

One of the great advantages of the Android operating system is the potential for customization, e.g. by means of custom-tailored application Launchers. Launchers are programs that aid the user in finding and using other applications, and also allow changing the graphical aspect of the system and the navigation approach employed. Several Launchers have been developed with the objectives of simplifying and adapting the operating system for usage by the elderly, such as Phonotto [4], BigLauncher [5] and the Protege SOS Launcher [6]. These typically focus on the graphical aspect and on exposing the most important features of a smartphone so that its use is direct, simple and effective, but do not include remote control capabilities. There is, nevertheless, a wide variety of applications which enable Android smartphones to act as remote controls, such as Able Remote [7], Iris Remote [8] and the MEORemote [9]; these applications, however, had no proper graphical interface for the elderly, with their interfaces being too complex; to the best of our knowledge, no remote control applications exist for Android-based smartphones which target elderly users.

3 Architecture

This section depicts the architecture of the +Social platform, showcasing its distributed nature and the way in which its components are connected, and focusing on the way in which the Smart Remote Control developed will be integrated.

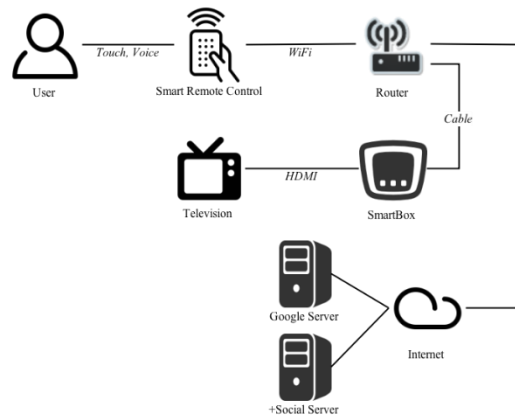


Fig. 2. General Architecture.

The Smart Remote Control is the Android device in which the Remote Control application will run; the user interacts directly with this device by touch, voice and video captures. In general terms, its objectives are those of controlling the myPhoneOnTV application and making / receiving calls. The Smart Remote Control needs to communicate the Google server to utilize the voice recognition feature.

The SmartBox is where myPhoneOnTV application is executed; the television is the device utilized by the SmartBox to output graphical content. The +Social server hosts and makes available a range of services related to +Social platform, including the IP Multimedia Subsystem which allows making video calls.

4 Interface Guidelines

The elderly are especially prone to possess specific physical and cognitive difficulties that hinder their perception of graphical interfaces. Vision loss, in particular, impacts the elderly at different levels, including: the ability to concentrate on the tasks; perception and sensitivity to color; pupil reduction, meaning that more light is required and there is a reduced ability to adapt to changing light; visual field reduction;

decrease of sensitivity to contrast. Additionally, there are common diseases that may occur and further affect vision, the most common being cataracts and macular degeneration.

It is important to comprehend the main adaptations that must be made, at the interface level, in order to target an elderly public. With this in mind, a set of guidelines for steering the development of graphical user interfaces for the elderly on Android-based touch-enabled devices was assembled.

4.1 Designing an accessible interface for the elderly

Accessibility plays a key role when designing interfaces for users with limitations at the physical or cognitive levels. Redish and Chisnell [10] consulted a vast array of documents published between 2000 and 2004 concerning adequate interface design for the elderly; relevant conclusions, such as the need for consistent navigation, clear writing, short text with lists, among others, were taken into account. The Web Content Accessibility Guidelines 2.0 [11] also provide recommendations for making content more accessible, specifically web interfaces for people with blindness and low vision, cognitive limitations and limited movement; these were adapted to the specificities of this particular project. Concerning the development of accessible interfaces for the Android platform, the “Android Developers” website [12] was the key resource considered; namely, the accessibility and usability recommendations for the buttons’ sizes. These were complemented by the observations of a study on the size of index fingers [13].

In [14], Poonsak e Teeravarunyou present a study on traditional remote controls for television, with the objective of reaching a set of guidelines suitable for the elderly, comprising criteria ranging from form, function, layout and grouping to user feedback. Problems identified with traditional remote controls include: the command format (usually too big), the keys’ functions (many of the elderly make mistakes when using remote controls for television by pressing the wrong button), the arrangement and number of buttons (in general, elderly patients need to memorize the layout of approximately 19 to 30 buttons) and the lack of button groups (older people require groupings of buttons in order to see and/or memorize them). It was also stressed that older people do not usually know the result produced by their actions when utilizing a traditional remote control.

4.2 Interface Guidelines for a Smart Remote Control

The following list contains a set of guidelines which aim to provide guidance with the process of developing interfaces and applications that target the elderly public, and are applicable in the context of the Android-based touch-enabled Smart Remote Control device proposed; they were compiled with basis on current literature on the subject, as detailed in the previous section.

1. Symbols and Images
 - (a) Graphics should be relevant, and not used as decoration.
 - (b) Icons should be simple, and should translate concrete meaning.
2. Text
 - (a) Changing the text’s position should be avoided.
 - (b) The main body of text should be written in *sentence case*.
 - (c) *Sans serif* fonts, such as Helvetica or Arial, should be used, and font types with effects should be avoided.
 - (d) The font size should be between 12 and 14 points.
3. Navigation
 - (a) Deep hierarchies should be avoided.
 - (b) Ample time should be provided for reading information.
 - (c) The repetition of actions should be avoided.
4. Screens
 - (a) Scroll bars should be avoided.
 - (b) Only one screen should be exhibited at a time; overlapping screens should be avoided.
5. Content
 - (a) Irrelevant information should be omitted from the screen.
 - (b) Important information should be concentrated at the center of screen.
 - (c) The screen’s layout and navigation should be simple, clear and consistent.
 - (d) The effort to recall should be reduced by showing as few options to the user as possible.
 - (e) It should be obvious which components are selectable (and vice-versa).

6. Color
 - (a) Colors should be employed in a conservative manner.
 - (b) Pure white color should be avoided for the background.
 - (c) When switching screens, brightness should not change abruptly.
7. Contrast
 - (a) The contrast between the elements of the foreground and the background should be strong.
8. Touch
 - (a) Multi-touch interactions should be avoided.
9. Space and size of buttons
 - (a) Touch targets should have a width and height greater than 14mm.
10. Remote Commands
 - (a) Group the buttons "Channel Up" and "Channel Down".
 - (b) Group the buttons "Volume Up" and "Volume Down".
11. Buttons Grouping
 - (a) For grouping buttons, the edge of the buttons should be used.
12. Feedback
 - (a) Feedback that eliminates the need to look at the remote control, such as a verbal response, should be preferred.

5 Interface Design

This section presents the design options followed in order to develop the Smart Remote Control. Firstly, the application requirements are presented. These were used in order to project and determine each screen of the remote control. With that in mind, several prototypes were built for each screen, which eventually lead to the final interface design. It is important to have in mind that the perception of the interface by the elders is quite different from the one of the general public. This is mainly related with the specifics of this particular age group.

5.1 Requirements

In order to better serve the purpose of the application, a list of functional and non-functional requirements was produced. Next, the most important functional requirements are presented.

1. The user must be able to: turn de SmartBox on and off; request an emergency call to the myPhone-OnTV application; change the channel on the remote myPhoneOnTV application; change the volume; and use context buttons to interact with the myPhoneOnTV application by touching the corresponding action button.
2. The user may change the channel of the remote application myPhoneOnTV by voice command.
3. The user must be able to access his contacts list.
4. The user must be able to perform a video call to any of the contacts present in his contacts list.
5. The user must be able to accept or decline incoming video calls.

The following list presents the most important non-functional requirements of the Smart Remote Control application.

1. The application must be able to operate in Android devices that run Android 2.2 or above [12].
2. The application must run on devices that have a minimum screen size of 3.2 inches or above.
3. The target public of the application possesses an age of 65 years or more.
4. The application must be ready to be operated by illiterate people.

5.2 Interface Design Specifications

When developing the interface, several aspects were taken in consideration for all of the screens. Almost all of the interface buttons use symbols that represent their actions, allowing an easier association between the symbol and its function. There are textual descriptions for the symbols in the screen and for describing the function of a button or a group of buttons. For the text information, a sans serif font is used. The size of text was also maximized; however, the size of the text may vary with the type of device

that is running the application. Regarding the buttons, several measures were taken to assure the best possible compromise in size and spacing. Despite the fact that the size of the buttons depends on the size of the device, the interface is designed for assuring that each button has at least 14 mm in height and width. The size of the buttons is also maximized in order to fit the available screen size. The spacing between buttons is never smaller than 1.5 mm, regardless of the size of the device. The Android guidelines [15] for defining button sizes and spacing according with the screen size of the device were also adopted. The shape of the buttons is rectangular, allowing a better use of the available space without compromising usability. By touching any button of the application, the device produces three different feedback signals: a small sound, a vibration and a change in the visual aspect of the button. This allows the user to perceive that an action is being performed.

Specifically with the elderly in mind, some of the design guidelines for touch-based interfaces for the elderly [16] were taken in consideration, namely those regarding symbols and images, text, navigation, content, colors and contrast, touch, buttons spacing and size, grouping buttons and feedback.

With the application requirements in mind, five different screens were built for operating the remote control. The specifications for each one of the screens are presented next.

Remote Control Main Screen. This screen contains all of the functionalities that allow controlling the remote myPhoneOnTV application and that provide access to the contacts list. It is also in this screen that it is possible to use voice recognition for remotely operating the myPhoneOnTV application. Fig. 1 shows the final version of this screen. The top four buttons allows changing the TV channels present in myPhoneOnTV. The group “CANAL” allows changing the TV channel number (zapping). In the same manner, the “VOLUME” group allows to increase or decrease the sound volume. There is a group of four buttons with different colors and no images that are named “service buttons”. These will depend on different services that can or not be active through the myPhoneOnTV application. The final group of buttons of the screen allows to perform a video call through the contact list (first button), to perform an emergency call to the myPhoneOnTV application (second button), to activate the voice control of the myPhoneOnTV application (third button), and the last button allows to turn off the SmartBox device.

Contact List Screen. This screen shows a contacts list. It also allows making a video call for any of the contacts present at the list. The navigation scheme of the contact list is organized in pages style. This screen also allows returning to the remote control main screen.

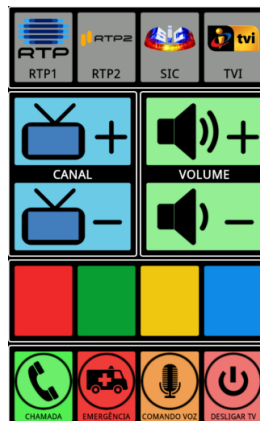


Fig. 3. Remote control main screen

Outgoing Video Call Screen. This screen is used whenever a user starts a video call from the contact list screen. It shows the name and picture of the contact and it allows turning off the current call. This screen switches to the Video Call screen when the contact answers the call, or switches to the Contact List screen if the call is refused or unanswered.

Incoming Video Call Screen. Whenever the user is requested to a video call, this screen is showed by the application. The screen shows the name and picture of the incoming call contact, and it allows receiv-

ing the call redirecting the user to the Video Call screen, or rejecting the call navigating to the previous screen.

Video Call Screen. Whenever a video call is established, this screen shows up. This screen shows the name and the video feed, in real time, of the other user that is communicating through the system. It also allows canceling the current call.

6 Testing and Results

This section presents the usability tests made to the Smart Remote Control application. It starts with the presentation of the users testing group as well as with the tests that were used to validate the application's ease of use. After that, the result analysis is made, presenting the identified strengths and weaknesses, as well as some observations made by the test group.

6.1 Test Scenario

In order to test the usability of the application, a group of senior people was selected for performing its evaluation. This group was composed of seven different users from a nursing home in Memória County, in Portugal, with ages between 77 and 91, and an average of 83 years old. All of the users were literate.

A task guide for performing when testing the Smart Remote Control and an evaluation questionnaire for registering the tasks' results (errors, execution times and the ability to perform the task) and user opinions was made. These were provided to the test group after a brief explanation on the Smart Remote Control's operation.

Table 1 presents the usability tests task guide. Each task represents one action that the remote control can perform for controlling the myPhoneOnTV application. The questionnaire used for obtaining the opinion and evaluating the satisfaction of the users with the application is presented in Table 2.

6.2 Test Results

Fig. 4 shows the results of the average execution time for the tasks presented in Table 1. We focus on the analysis of the tasks that present higher execution times. Task number 4 proved to be a challenge to the users. This task is related with the content currently available on the myPhoneOnTV, therefore the users were looking for a symbol on the remote control, but that symbol was only present on the TV display. Even though tasks 5 to 7 make use of the same strategy, the users were faster on their operation, since they were now aware of that particularity of the system. Tasks 10 and 11 were the ones where the users needed more time to perform the required operations. This was mainly due to two reasons: difficulty on understanding how the voice command operates and errors in audio recognition. Nevertheless, several of the tasks present an execution time fewer than 7 seconds which, considering that this was the first contact of the test group with the application, appears to be very reasonable.

In Fig. 5 the results of the questionnaire previously shown on Table 2 are shown. The Smart Remote Control has a very positive evaluation by the test group. The whole test group found that the remote control is useful in their daily life and it would use it again in the future. Questions 5 and 7 were mainly evaluated in a negative way. The majority of the test group thinks that the voice recognition system is not practical and they would rather use other tools that they are more familiar with for doing video calls (e.g., Skype or Google Hangouts). Concerning question 6, when the users that answered "yes" were asked what they would change on the remote, all of them focused on the fact that the context buttons of the remote should use a subtitle or symbol to indicate their function, instead of only showing it on the television's display.

Table 1. Usability tests task guide

Number	Task
1	Change to the next TV channel
2	Lower the volume of the TV broadcast
3	Change to the previous TV channel
4	Change to full screen (yellow context button)
5	Access the TV guide (green context button)
6	Answer incoming call (red context button)
7	List contacts (blue context button)
8	Press emergency button
9	Change to channel "SIC"
10	Change to channel "RTP1" using voice control
11	Change to channel "RTP2" using voice control
12	Perform a video call to a contact
13	Accept an incoming call
14	Stop a video call
15	Turn TV off

Table 2. Evaluation Questionnaire

Number	Question
1	The vibration on touch, was it useful?
2	The sound on touch, was it useful?
3	Do you prefer the direct channel access buttons over the zapping buttons?
4	Do you think that the remote control would be useful in your daily life?
5	Would you use the voice commands present in the remote control?
6	Would you change anything in the product?
7	Would you use the product for video calls?
8	Would you use the product again in the future?

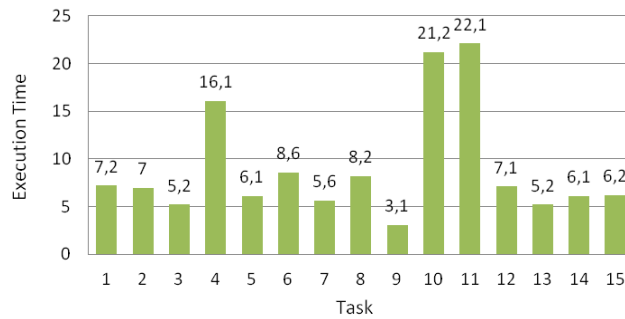


Fig. 4. Average execution times for the tasks presented in Table 1

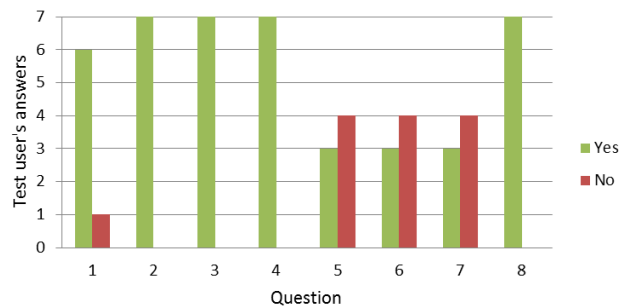


Fig. 5. Test user's answers to the questionnaire presented in Table 2.

7 Conclusions and Future Work

The Smart Remote Control for Seniors is an Android application that aims to allow the elderly to control the myPhoneOnTV application. It uses data from two different platforms that were previously developed for improving the quality of life of the senior population: HbbTV and +Social. This work is focused on the development and evaluation of a user interface for the senior population, which possesses particular characteristics and needs. A study of the existing literature on this subject was carried out for supporting the development of the interface; a prototype of the Smart Remote Control was built and tested in a nursing home, so as to allow drawing conclusions and gathering ideas for future developments.

There was very positive feedback from the test group, namely regarding: the pleasant appearance of the graphic user interface; the use of vibration and sound feedback when touching the command buttons; the usefulness of the system and the will to use it again in the future; and the usefulness of the buttons that enable direct access to television channels. It was nevertheless possible to observe that some of the execution times were excessively long, mainly due to two distinct situations: the use of context dependent buttons on the remote control; and the use of the voice commands for controlling the remote. These are two major issues that will be worthy of our attention in future developments.

Although some improvements are required to optimize the interface, we believe that this product is useful and that it responds to a current necessity of the elderly and, in particular, to the users of the myPhoneOnTV application.

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