Application for Older Adults to Ask for Help from Volunteers Through Television: Design and Evaluation of a High Visual-Fidelity Prototype

Tânia Ribeiro[1], Rita Santos[2,3(✉)], João Moura[1], Ana Isabel Martins[4,5], and Hilma Caravau[3,4]

[1] Communication and Art Department, University of Aveiro, Aveiro, Portugal
ribeirotania@ua.pt, moura.jps@gmail.com
[2] Águeda School of Technology and Management, University of Aveiro, Aveiro, Portugal
rita.santos@ua.pt
[3] CIC.DIGITAL/Digimedia, University of Aveiro, Aveiro, Portugal
hilmacaravau90@gmail.com
[4] National Association of Gerontologists, University of Aveiro, Aveiro, Portugal
anaisabelmartins@gmail.com
[5] Institute of Electronics and Telematics Engineering of Aveiro, Aveiro, Portugal

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 older adults. This article describes the design process and evaluation of an interactive high visual-fidelity prototype of an application for a TV set-top box, which aims to allow older adults to request, in a simple and quick way, help from a group of volunteers, in specific tasks such as small household maintenance. Concerning the user interface design, a set of specific guidelines were considered and applied in the development of a high visual-fidelity prototype. The result of this process was later evaluated in heuristic evaluation sessions and user testing. The former were supported by a list of heuristics, drawn from other lists used in recent research and adapted to the context of the study. The latter were conducted with potential users that tried to accomplish some tasks on the prototype. In a context in which several studies show that television is a highly privileged platform to provide information to the older adults population due to its high degree of use in this group, this project may present important contributions to better understand some of the challenges that are associated with the design and early evaluation of TV applications whose target audience is older adults and some good practices that should be followed to achieve a product that is easy and enjoyable for this public to use.

Keywords: Iterative design · User interface design · Heuristic evaluation
User testing · Application for set-top TV box · Volunteering

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1 Introduction

The aging process is often associated with dependency, financial difficulties, loneliness and isolation [1]. In Portugal, about 60% of the older adults 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 adults stay at home (which is commonly a sign of a good health situation), there are innumerable difficulties that they cannot overcome alone. Many 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 older adults. It is possible to notice that there are already several Information and Communication Technology 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 adults. In particular, it can be seen that the use of television (TV) as a platform to support requests to volunteers seems to 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].

It is against this background, and considering the results of a questionnaire to better know how key stakeholders see the relevance and some requirements of a TV application to support volunteering targeting older adults (topic not elaborated in this article), that arises the VoluntAge4Seniors project, a research project whose purpose is to develop an application to run in a specific TV set-top box that aims, in a simple and quick way, to allow older adults 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 will 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 [5]. It is important to note that voice interfaces are not yet common, despite their recognized potential to ease daily living for older adults [6]. The TV application will also allow older adults to evaluate the help they have been given.

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 recommended 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.

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, an

evaluation of the prototype's usability was carried out using heuristic evaluation and user testing. 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.

2 Considerations About the Design of TV Interfaces for Older Adults and Its Evaluation

When designing an application for older adults, it is important to take into consideration that older adults 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 [9]. Furthermore, it should be taken into account that some UI design guidelines for a standard laptop cannot be applied to the television [10].

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 [11, 12] to others that approach the design of interfaces for Interactive TV [13] or for older adults [14], or even specifically address the design of interfaces for TV UI for older adults [15].

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 [14]. 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 simple language, in order to give users time to read and focus on a single task at a time [14]. 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 [13]. Apart from the usage of simple and precise information, meaningful icons and labels also help in this task [11, 12]. 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 interface design 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 had even emerged from Nielsen's list of heuristics [11] to better recognize any potential issues. Besides the importance of carrying out heuristic evaluation, there is a widely recognized importance of involving the potential users of an application in early-and late-stage usability testing. This is particularly important in the case of users with age-related changes in hearing, vision, cognition, and mobility.

3 The High Visual-Fidelity Prototype

Besides the guidelines mentioned in the previous section, a set of practices pointed by the staff of the TV service company responsible for the development of the general environment provided by the set-top box 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. Considering this information, a nonfunctional high visual-fidelity prototype, with some content simulating the real one, was developed using a popular vector illustration tool (Adobe Illustrator).

At the end of a first version of the prototype, the result was discussed with two people of the TV service company with 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.

The final version of the high visual-fidelity prototype included the most important features: Selection of profile and Login; Home, area where the user could see potential pendent actions (such as evaluate a volunteer and/or confirm the help offered from a volunteer); Requests, area where the user could make a new request, see the requests scheduled (already accepted or not from a volunteer); New request: area where the user could start to choose the category of the request and, in subsequent steps, could choose the type of input (voice or TV remote control) and see information to help him to make the request by voice and: Profile, where user could see their personal data and statistics related with the use of the application.

Figure 1 shows the *Request* area, where the user decides to do a new volunteer request. After this, the user selects the category of the request as illustrated in Fig. 2.

Fig. 1. Request area: choice of new request.

The interface design, followed in almost all other interfaces, aimed to be minimalist, with short and meaningful information. Every menu option had its name, and a correspondent icon, to facilitate the memorization. It is also possible to see that the interface showed clearly the current location (in the left menu lighted in green) and that it had 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 was highlighted with color whereas the other elements were represented in gray.

Fig. 2. New request: category selection. (Color figure online)

The system triggered confirmation/alert messages in the final decision-making situations. These messages occupied the whole screen of the TV, which means the side menu did not appear, avoiding misinterpretations by the user. In addition, the user had to do some action on every message that appeared on the screen making sure he had time to read all the information presented. Figure 3 shows an example of the resume screen that appeared after making a request. The user had to validate or edit the request to continue using the application.

Fig. 3. Request feedback.

4 Evaluation Sessions

In the evaluation sessions, to make the prototype presented in the previous section to look and feel more like the end-product, some interactivity was added using Invision, a rapid prototyping cloud application that allows to transform a static design into a clickable and interactive prototype.

The prototype was evaluated in three heuristic evaluation sessions (described in Sect. 4.1) and two user tests (described in Sect. 4.2). The aim of these sessions was evaluating the UI design and recognizing any potential issues and usability problems.

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

4.1 Heuristic Evaluation Sessions

A list of heuristics was developed based on a set of heuristics suggested by [10, 17] where Nielsen's heuristics have an important role. At the end of a first version of the

list, an expert in TV applications development was asked to give feedback about the list and some changes were made.

Table 1 presents the final heuristics list that was used in the heuristic evaluation sessions.

For the evaluation, 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 three). 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, interface functionalities that were considered in the prototype and adopted heuristics; (2) the heuristic evaluation itself over the prototype. As recommended by Nielsen [17], 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 answered a questionnaire about his/her profile and, in open questions, pointed the interface strengths and limitations.

4.2 User Testing

Besides considering important to carry out a heuristic evaluation, the prototype assessment near potential end-users was also considered central to complement the heuristic evaluation inputs. Therefore, two user tests were conducted with the aim of collecting information concerning key aspects that should be improved, both in terms of visual design and features presented in the prototype.

As in the heuristic evaluation, a laptop was used to present the prototype. It was initially foreseen the use of a method resembling Wizard-of-Oz since when the user interacted with TV remote control the user's screen was controlled by one of the members of the team. Besides the responsible researcher making correspondence of the interface's screens with the movements and choices of the user, there was a member that assumed the role of coordinator (responsible for the interaction with the participant) and another researcher that played the observer role (responsible for registering the options taken by the user, comments and suggestions pronounced during on-going tasks and assuring the assembly of the test scenario).

The participants included in this study were selected by convenience among seniors related to the research team. The inclusion criteria considered were: being 60 years old or almost; watching television regularly; knowing how to read.

The tests took place under controlled conditions (laboratory). In the initial part of the test, the objectives of the test, the context of the application and the further use of data collected were explained in detail to each participant. The user also had the opportunity to request additional information and was aware that he could quit anytime. Additionally, an information sheet was given, and each participant was asked to sign an informed consent. Afterwards, the participant was invited to perform a list of eight tasks: (1) enter the application with a specific profile; (2) make a new request for help; (3)

change the date of previous request; (4) evaluate one specific volunteer; (5) accept help from one volunteer; (6) check profile information; (7) check his previous requests for help and; (8) exit the application. Following a thinking aloud method, it was requested that the user verbalize his thoughts as he moved through the user interface. Simultaneously, the observer registered the participants' actions and the observations considered relevant that occurred during each task. At the end of the test, a questionnaire was applied including questions about participants' TV consumption habits, level of satisfaction with the high-fidelity prototype tested, utility of the application and expected usefulness of the voice interaction.

5 Results and Discussion

The results from the evaluation session are presented according to the typology of evaluation carried out.

5.1 Heuristic Evaluation

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.* [10].

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

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.

The most frequently mentioned problems were related with the overuse of text using bullets, the selection area that moved 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 focused on a single action at a time, adequate font types and sizes and general navigation. The most critical weaknesses highlighted were about how older adults were asked to interact by voice and excessive density of information for a TV UI in some screens.

5.2 User Testing

Three participants were recruited to participate in the user tests, but one did not agree to provide some personal information to be used in the context of the study nor sign the informed consent. This person tried to accomplish the proposed set of tasks but after having some difficulties in the first two tasks decided not to continue the test. The two other participants took their involvement in the study very seriously and carried out the tests to the end. The first participant was 59, male, and the second was 82, female. Both had paid TV and the second participant referred to using the TV set-top box to schedule recordings, to see television programming and see past programs.

During the tests, the use of the technique resembling Wizard-of-Oz revealed not to be very functional and intuitive, with the mouse cursor being a distraction to the users. The problem was worsened by the fact that some network problems happened causing the restart of the application. Despite this, some major results emerged regarding the interface design and usability. These include: the relevance of replace the term “Help”, used in the application to provide more information about the application, since it was suggesting an option to start an ask for help; the choice of the green color in the context of a selected element seemed to work fine in the overall although more differentiation with other contents would be desired by using, for example, blinking; language expressions that were not completely intuitive to the users; the side menu became distractive in some tasks according to participant 2; the use of circles as a visual clue for showing the step in the task (Fig. 2) did not prove to be useful; participant 2 pointed out the lack of a return button in a certain screen and; the participant 2 mentioned two functionalities that, according to her, were not in proper locations.

In the final questionnaire, both participants that accomplished the given tasks said, using a 5-point Likert scale, to like the application experience and they agreed in classifying it as useful. One of the participants promptly classified the speech-to-text feature as useful while the other one showed to be reluctant concerning using this technology, admitting however that speech-to-text process is easier than using the TV remote control

keys. The former participant also admitted considering the use of the application in the future while the other one user-tester pointed that he would hardly use the application.

6 Conclusions and Future Work

This article presented the results of the design and evaluation of a high-visual fidelity prototype of a TV application that will support older adults to request help from a group of volunteers in daily living tasks. Both design guidelines and the two types of evaluation proved to be fruitful to design and assess problems, specially related with the visual part, of TV applications that will be used by older adults.

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 older adults 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. 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 before initiating the implementation of the application but also because the heuristics list that supported 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 considering not only a standard list of heuristics to support the development and evaluation of more specific products as the one here presented. Despite the low number of potential users, user testing with the two older adults in an early stage of design revealed to be an interesting method to complement heuristic evaluation and an essential step to develop a product that meets users' needs and expectations and with a high degree of acceptance. Nevertheless, it would have been useful to use co-design with older adults in the definition of the application UI, for example in the identification of language expressions to be used in the application since several issues showed that the language used was not completely intuitive to the users.

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. In terms of less positive aspects, the Wizard-of-Oz approach that was used as well as the use of a cloud solution to present the prototype proved not to be very adequate for doing tests with older adults causing interruptions in the interaction with the application.

As improvements, the authors recommend reducing the number of heuristics to become easier for evaluators to remember. Also, it would have been useful to perform the evaluation using a TV screen and remote control.

Regarding future work, it is aimed to continue the TV application development, considering the findings from the tests described in this article to improve the UI component. Another major step will be to better understand how the ask for help using voice

should be undertaken in the context of a TV application. It is aimed to undertake these actions by continuing to use an iterative design approach given its proven benefits to development lifecycle.

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