PhonAge: Adapted SmartPhone for Aging Population

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Abstract. SmartPhones can play a significant role in maintaining decent a Quality of Life for elderly people. There are numerous solutions available on SmartPhones that can assist the elderly in their activities of daily living, however these solutions are sometimes not welcomed in elderly community due to usability and accessibility factors. In this paper, we present PhonAge, an accessible & adaptable solution for SmartPhones that can host diverse useful services to elderly people. The first stage user evaluation results shows the usability of our solution.

Keywords: Elderly, Mobile Phone, SmartPhones, Human Machine Interaction, Accessibility, User Centered Design.

1 Introduction

Mobile technology can play a significant role in maintaining decent Quality of Life (QoL) for elderly people. It can promote active aging, active socialization, and independent living, while ensuring safety. The aging process is associated with progressive degradation of sensory, physical and/or cognitive abilities [5,8]. Elderly people want to keep their independence, remain active and maintain social relations while advancing in age. In a recent study, we sought to understand the technological need (including mobile technology) of elderly in modern society and to study the impact of technology use to promote active aging inside and outside the home [3]. The results of the study show that there is a real need for mobile assistive technologies that are adapted to elderly skills and needs, while providing them useful assistive services.

Recently, Smartphones have gained attention among elderly people [17] and many of them are starting to use them for various purposes (e.g. as a reminder). Numerous services are available on SmartPhones that can assist elderly (e.g. navigation, interactive diary, activity reminder, speed dial, SOS service), however these solutions are not much welcomed in elderly community, either, because of elderly resistance or rejection of technology, complex & tedious perception of technology, accessibility issues, and so forth. [3,20].

At present, the mobile industry is targeting young and a tech-savvy population [6,7] and does not always take into account the special needs and expectations of the elderly population when designing services or phone devices. The main

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difficulties in adapting Smartphones for elderly people are limited or lack of personalization, complexity of interface or a navigation menu, quantity of information arranged on screens, number of functions, language, etc. [9,20]. Consequently, mobile technology becomes more and more complex, and elderly people are confronted with devices and services that are not adapted to their needs.

In our experience while designing mHealthcare & social services on Smartphones for elderly people, we found that accessibility of phones is the major obstacle towards acceptance, usability and continuity of use. To address such issues, we designed and evaluated PhonAge, an accessible & adaptable solution for SmartPhones that is customized to the elderly profile and can host diverse services to assist them in their activity of daily living (ADL).

The rest of the paper is organized as follows, section 2 presents literature review focused on mobile phone based solutions to assist elderly people, section 3 describes PhonAge, section 4 shows the results of first phase evaluation and finally we conclude our work and discuss future work in section 5.

2 Related Work

A recent proliferation in mobile technology has given an opportunity to better deliver services to elderly people in their ADL. However, to the best of our knowledge very little work has been done to address the needs and difficulties of the elderly population while interacting with mobile phones. The proposed solutions are mainly available on either special devices or customized solutions on SmartPhones.

Special device solutions (such as Doro PhoneEasy[1], Mobi-click[2], Easy 5+[3], offer basic functionality of making calls and sending & receiving messages using accessible simple interfaces. Most of these devices also offer the functionally of speed/touch dial where some pre-assigned contacts numbers are stored that would help elderly (mainly those with cognitive disability) to call (e.g. family, caregivers, SOS services). These solutions have up to some extend address the cognitive and physical limitations of elderly, however these systems are not scalable and does not support implementation of mHealthcare services to assist elderly in their ADLs.

On the other hand, SmartPhone based solutions have been proposed to assist elderly in their ADLs (e.g. Fujitsu phone [14], silver line[4], Phonotto[5], Big Launcher [6], etc). The mobile User Interface (mUI) provided by these solutions are designed keeping in mind the elderly profile. The general idea of these mUI is to provide the most relevant information on the main screen while encapsulating the information and phone features. In contrast to special devices, cognitive, visual and

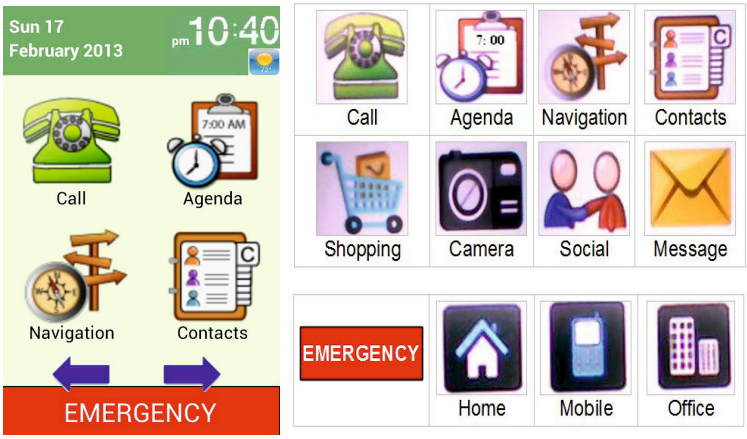
[1] www.doro.com/
[2] www.mobi-click.com/
[3] www.bctech.fr/telephonie/easy5.html
[4] www.igg.me/at/silverline
[5] www.phonotto.com/
[6] www.biglauncher.com/

physical limitation of elderly are addressed. For instance, Big launcher offers features for people with visual impairment to provide maximum readability and ease of use. It also provides the customization option where users can choose the color of their choice, size of the text and other features. Similarly, Fujitsu's RakuRaku offers an interface especially designed keeping elderly and their skill in mind. The hardware of the phone is able to distinguish between accidental touches and purposeful taps that make it intelligent in its group of solutions.

The solutions presented above (based on special devices and smart phones) have some pros and cons. Several studies have been conducted to evaluate the factors that contribute to affect the use of mobile phone among elderly [12,19,2,13,10,11]. Looking at these studies, we concluded that special device phones are not the optimum solution in case of elderly due to disability/frailness tags associated with them and limited functionality to provide assistive services. On the other hand, considering the touch screen feature in SmartPhones, there is a need to improve mUI so that it can satisfy & please elderly in their use, while providing a line of useful services related to the elderly population [4]. To the best of our knowledge, research in mUI design for elderly people has not been extensively explored and there are limited interface design guidelines available while designing for elderly (interested readers are refer to [7]). In the next section, we present our effort to address the issues presented above.

3 PhonAge: Adapted SmartPhone to Assist Elderly

PhonAge is an attempt to design an accessible phone to promote the use of smartphones among elderly people and to better assist them in their ADLs. As stated above, a key factor of usage success of mobile phones among elderly people is accessability of the mobile user interface (mUI). We designed and evaluated PhonAge, an accessible & adaptable android based solution for SmartPhones that can host diverse useful services to elderly people. PhonAge's interface is specially designed to meet the needs of elderly, according to their profile, taking into account cognitive degree (e.g. memory, attention, initiation, planning, time and spatial, and orientation impairments). PhonAge interface/screen is divided in three sections, namely **(1)** a spatiotemporal assistance section (Top section) (to continuously provide elderly people with spatiotemporal contextual information (date, time and weather)), **(2)** the main Activity and service area section (to provide accessible phone feature and services to assist elderly) and **(3)** an emergency section (to ensure safety of elderly people while moving (inside and outside)). PhonAge also provides a configuration of options that allow elderly people/caregiver/family to adapt phones according to elderly needs. For example, it enables them to change the text and icon size, choose among the icons from gallery, change the order of icons, etc. PhonAge's main screen and icons are shown in figure 1a. In the following section, we describe the design principles of PhonAge and its features.



(a) Main Screen (b) PhoneAge Icons

Fig. 1. PhonAge User Interface and Icons

3.1 Spatiotemporal Assistance Section (Top Section)

Temporal information is central to elderly people as our environments are organized on the basis of time and events are ordered by time of occurrence and duration [3]. Numerous eye-tracking studies have shown that the area where users look most is the top of the screens (e.g. [16,18]). Thus, we position spatiotemporal contextual information (time, date and weather) at the top section of the screen to allow users to access this information easily and quickly. Since Spatiotemporal information is central to elderly people, unlike traditional solutions we choose to display spatiotemporal values thought-out in all the navigation screen of system, so that elderly people will have access to this information every time they navigate in menus. The font size of spatiotemporal values are set according to the sensory needs of elderly (e.g. bigger font size for visual impaired). The configuration option of PhonAge allows users to choose the style of dates they like or are accustomed to i.e. dmy - European style, mdy - American style, ymd - Asian style, also to enable and disable weather information from the top screen.

3.2 Main Activity Section (Center Section)

The center section of PhonAge displays the main functions i.e. Call, Agenda, navigation shopping, etc. The functions are arranged in a grid of two rows and two columns. The number and position of icons are designed to facilitate visibility and learning, and not to exceed memory span (which in our case is 4 which is less than 7 ± 2 that the work memory can process at a time t [15]. In the first row, we placed two features of mobile devices that are mostly used by elderly people (i.e. Call and Agenda). These function icons are locked and cannot be moved. In the second row, users can choose among a list of function icons (e.g. contact, navigation, shopping) by flipping (right/left) or by using the navigation arrows.

The design of navigation arrow buttons is to facilitate the use of those who are not accustomed to Smartphone or scrolling features on touch screen phones. For consistency purpose and ease of use, similar arrows are placed in other screens where users need to navigate through screens.

PhonAge icons are specifically designed so that they give the look, feel and meaning to its user with labels available in their choice of language (to address cognitive abilities). These icons are available in four sizes so that a user can select the size of icon they feel comfortable with respecting screen density and spacing between the icons. The icons also provided the sense of feedback by audio, haptic and visual confirmation.

3.3 Emergency Section (Bottom Section)

Safety is one of the reason that keeps elderly people from being socially active outside of their homes (e.g. streets, malls and parks). In several situations, elderly people have a fear on being tagged as frail, attacked or abused, lost (wandering problem), or in a medical emergency situation (e.g. Fall). To address such situations, we choose to include a context-aware emergency service (based on the context-aware framework presented in [1]) enabled with an emergency button . The emergency button is placed on the bottom of the screen to make it accessible nearby the thumb in regular holding position of the phone. The button is available on all screens of PhonAge so that elderly people can access it any time in any operation. It is colored red to represent emergency (although the color can be changed according to user preferences through configuration function). Unlike emergency or SOS services in existing mobile phone based systems, the PhonAge's emergency service is context-aware and is triggered based on the predefined emergency protocol. PhonAge emergency service is triggered by pressing the emergency button once respecting the threshold of time t (in default setting t=3 sec, and can be changed in configuration function). In addition, in case of emergency services (e.g. Fall detection) automatic emergency response is invoked using environment context (e.g. those gathered with phone or wearable sensors). Here no interaction or confirmation is required from user.

4 Evaluation

To evaluate the usability and accessibility factor of PhonAge, we conducted first stage evaluation with elderly people. The goal of the evaluation was to explore usage and expectations of elderly people while using PhoneAge, and how elderly people understand and interact with PhonAge. Following, we present the method, and summary of results of the evaluation study.

Method. To evaluate the mUI of PhonAge, we compiled a semi-structured interview supported by a questionnaire of about 45-60 minutes composed of 18 questions divided in two parts. The interview is designed to be conducted in person (by examiner) and the feedback and remarks to be recorded by the examiner. Following we describe each of part of questionnaire:

Part. 1. Gathering User Information:
In this part, we ask questions related to participants profile, such as age, education level, living environment (independent or nursing home), etc. Participants are also informed about the purpose and procedure to evaluate PhonAge. The participants were asked to rate each item using a 5-point Likert scale.

Part. 2. Accessibility and Usability Test:
In this part, we ask questions about understandability, usage, utility and satisfaction of the PhonAge interface.

- **Icon Understandability Test:** (similar to that used by [3]) was run to evaluate the meaning which PhonAge icons give. Firstly, participants were asked to give the meaning of the 12 icons proposed in PhonAge (i.e. *According to you, what is the signification of these icons* ?). Secondly, we presented the icons with their respective labels (see figure 1b) and asked the following question: "*According to you which information do you consult if you touch the next icons*". The order of the icons is modified to avoid inferring with any meaning about next placed icons.
- **Use Test Method:** was used to evaluate the usability of PhonAge including usage difficulties encountered by elderly people while using PhonAge mUI. The evaluation was designed to assess difficulties in use, utility of the navigation arrows provided (to switch between screens), and utility of functions (e.g. emergency, organization of icons/functionality on main screen). Participants were asked to navigate through phone functions and perform four defined tasks i.e. call, search contact address & email and locate the camera function. Moreover, participants were asked to evaluate the PhonAge interface in terms of utility, facility of use and their preferences (i.e. interface structure, color of the wallpaper, services usefulness). We ask questions like (*According to you, it is easy to* ?; *According to you, it is useful for outside activities to*? *According to you, the background is*?.

4.1 Results and Discussion

The results presented in this paper are those conducted with twenty elderly persons aged 60 to 84 (Mean=70 years, standard deviation=8,2, 13 females and 7 males) who participated in this study. The results of evaluation were compiled according to the tests conducted. Following, we present the results:

4.2 Icons Understandability Test

Evaluation of the icon understandability showed, that common icons (e.g. phone, SOS) were easily understandable (meaning, purpose) by all participants, even without a label. However, none was able to understand the following two icons: "shopping" for shopping list and "home phone number" on contact screen. Figure 2 illustrates the results of the understandability of PhonAge icons. Labeling the icons helped participants to understand the icons (e.g. navigation, social).

In certain cases, participants could not recognize the icons even when labeled e.g. 20 participants inferred that the shopping icon is for on-line shopping and not a shopping list; similarly only one participant inferred that time shown on the agenda icon (7:00) referred to an appointment at 7:00 AM. These results confirm the compliance of 9 icons to the associated functions. They also provided us with valuable feedback to modify the icons of shopping list, home and office phone. e.g. Taking into account our observation that elderly people pay attention to details/indications of icons, adding a sheet to the "shopping" icon improved the understandability of the icon.

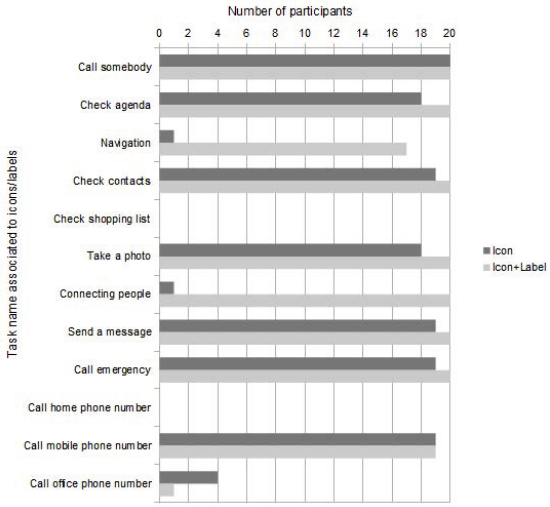


Fig. 2. Results of Icons Understandability Test

4.3 Use Test

Evaluation of PhonAge usage shows that the majority of participants (17/20) were able to easily execute the four proposed tasks. Only 3 people found these tasks difficult due to a visual impairment condition and their first time operating a mobile phone. During the first interaction with PhonAge, 17 participants used only the navigation arrows of the mUI to navigate through screen and icons selection. Only three used the touch scrolling, as they were already accustomed to it. After a demonstration time of the option (learning phase), 17/20 participants preferred to keep both in the mUI (i.e. navigation arrows and touch scrolling). After this learning phase, participants found touch scrolling very intuitive as most of them said "we flip pages like in magazine, moving finger/hand form right to left". sixteen participants faced a difficulty to return to home screen (while navigation between screens). In the current version of PhonAge, returning to home screen is done always using the back button provided by the device. Since these participants were all novice Smartphone users, they were not aware of

the presence of the button. One of the novice participants and the three who were already accustomed to touch screen devices had no problem returning to the home screen. After a learning phase of this option, the 20 participants were accustom to the use.

The overall evaluation results shows that participants appreciated the clear color (e.g. green, yellow, blue) of the wallpaper and they appreciated the readability (16/20), visibility (20/20), pleasant aspects (18/20) and contrast (20/20) of the interface. Eighteen participants preferred the portrait display contrary to landscape display as they found it more classic *like a book*. The position of the icons and information on the main screen are also very much appreciated, for instance, all participants (20/20) liked the access to the spatiotemporal values and emergency button on all screens. Seventeen participants reported that weather information is not necessary to accessible on all screens all time. Six participants also pointed, that one way to appropriate PhonAge is to personalize the label of the icons by adding the work "my" as *my contacts, my agenda, my shopping list* rather than *contacts, agenda, shopping*.

5 Conclusion

SmartPhones can play a significant role in maintaining decent Quality of Life for elderly people. However, a key factor in usage success of SmartPhones among elderly people is accessibility of the phone interface. In this paper,we presented PhonAge our solution for an accessible & adaptable SmartPhone that is customized to the elderly profile. Phonage offers personalization options for elderly/caregiver and family members. The evaluation results confirmed that PhonAge design complies to the expectations and perceptions of elderly people. Moveover, the feedback received by the evaluation helped to improve and modify the icons so that the elderly can have a better understanding of the functions they use. In future, we are working to develop services in the context of Age Friendly cities that would assist elderly to remain independent and maintain social interaction. The results of the studies and application are available on our Website site[7]. We encourage the research community to use PhonAge, and welcome an opportunity to work together. Our goal is to build a social prosthesis that promotes successful aging by use of PhonAge as a host that enables successful deployment of useful assistive services.

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