A Mobile Interface for the Older User

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Mobile phones are generally designed for the mass market, not for specific user demographics. The over 65s are a growing user group that is seldom accommodated by modern design. The side-effect is that senior mobile phone users, with their special needs, are left behind, unable to gain the full benefit of owning these devices. The literature suggests that the design of the interface is at fault so we designed and evaluated a prototype “senior” mobile phone, which does attempt to meet the needs of this demographic. We report on our evaluation and suggest directions for future work.

Mobile Phones, Interface Design, Older Users

1. INTRODUCTION

Modern society is increasingly dependent on technology. Mobile phones, as a prime example, have become almost indispensable. By 2014 mobile phone users exceeded 4.55 billion worldwide and there is an expectation that there will be 5.13 billion by 2017 (63.5% and 69.4% of the world population respectively)\(^1\). Having a mobile communication device in our pockets has changed the way we interact socially, how we coordinate our activities, and the ease with which we can access all kinds of information.

Technologically-facilitated social interaction has, unfortunately, not benefited all of society equally. The over 65s seem sometimes to be left behind, with industry pejoratively referring to them as laggards[1]. Seniors do have specific and unique needs [2] which have been neglected by mobile phone manufacturers [3].

One of the primary obstacles is the design of phone interfaces, which many older users find incomprehensible or unusable. Due to difficulties experienced by older users some manufacturers have simply reduced the functionality on their so-called senior phones. This reduction in functionality also seems to stem from an assumption that members of this user group cannot understand a rich feature-filled interface [4, 5] and have reduced functionality needs as compared to other user groups [4].

The consequence is an offering of impoverished phones that do not offer much value to any but the most infirm who might only want to make emergency calls. Mobile technology's potential to positively impact quality of life for seniors is thus not realised [2]. This sector of society is growing at an unprecedented rate and their buying power is increasing accordingly [6] so industry cannot afford to ignore them for much longer.

In this paper we report on a mobile phone interface designed specifically for senior users, with their needs and background experience of technology in mind. We report on a prototype, the evaluation thereof, and the lessons we learned from this experience. We hope our experience will serve to inform other designers wishing to accommodate the needs of this growing user group.

Section 2 presents an overview of the related work in terms of designing mobile phones for seniors. Section 3 outlines the development of the new Senior-friendly mobile phone interface. Section 4 reports on the evaluation. Section 5 discusses our findings and Sections 6 and 7 conclude and propose directions for future work.

2. BACKGROUND

Newton, Motte and Chittenden [7] defined *inertia* as the power of resistance by which everybody endeavours to preserve their present state. This tendency of the physical world seems to apply also in technology adoption when the subjects are seniors and it is referred to as “Status Quo Bias” [8].

\(^1\)http://www.emarketer.com/Article/Smartphone-Users-Worldwide-Will-Total-175-Billion-2014/1010536
This group instinctively resist the rapid advance of technology and society does not wait for them to conform. Hence, there is a need to motivate them to use the mobile technology and to gain experience with it. Otherwise, the inexorable advance of technology will further broaden the gap and leave them behind. The everyday problems the seniors face makes them dependent on others and thus decreases autonomy.

The research literature provides plenty of evidence of the difficulties experienced by seniors using mass market mobile phones. Abascal and Civit [9] were one of the first to write about the challenges experienced by older people (shared by those with disabilities) when using standard mobile phone interfaces. Zajicek [10] concludes that special interfaces should be designed for the seniors.

Perhaps in response, Kurniawan, Mahmud and Nugroho [11] carried out quantitative and qualitative analysis in order to find what could be improved in senior mobile phone design.

A number of researchers investigated the design of specific features of the interaction such as button size, number and spacing of targets, text-entry performance and typing patterns, icon feedback types, gestures etc. [12-16]. The upshot of those studies was the acknowledgement of a number of issues that need to be addressed in order for seniors to benefit fully from the functionality offered by mobile phones.

Other factors also have to be considered, in addition to the fine-grained interactional aspects. Mobile phone usage is also influenced by social, economic, educational, ethnic, cultural background and gender [17-19]. Another powerful influencer is the generational effect, described by Lim [1]. The author argues that the generation a senior comes from has a significant impact on their pre-existing mental models, and that these also make usage challenging since they do not align with modern interfaces.

A few researchers have built bespoke interfaces which build on the findings of researchers in this area. For example, [20] designed and implemented a mobile interface for seniors but unfortunately this work was not evaluated. Another interesting work, published by [2], is PhoneAge: a user interface, specially tailored for seniors. Unfortunately, even though evaluated, this study does not provide the statistical significance and thus the evaluation results cannot be generalized with confidence.

Another was built by Van Biljon and Renaud [21]. They used an action research approach in order to obtain the impressions of a group of older users. It was generally well received but some usability issues were identified that need to be addressed before senior phones can deliver true value to seniors. Industry has also produced some specially designed mobile phones for seniors, but most of these are not based on smartphone and touch-screen technology. Nonetheless, there are some companies producing senior smartphones such as Doro and Greatcall.

Even though such bespoke mobile phones provide special interfaces, they generally also mandate the use of one particular device provided by the company in question. Moreover, these products are not the ideal solution because they are promoted as “disability” or “frailness” devices and provide limited functionality [2]. Another interesting approach, in user-centric design, came from Motorola with “Moto Maker” [4]. Even though Motorola is trying to empower users by letting them design their own phone, the choices are limited to the appearance and materials of the phone and the cost is above average as compared to other smartphones.

The most comprehensive industrial effort so far is the Raku Raku phone [5]. Fujitsu used the experience gained throughout the Raku Raku [22] (meaning “easy” in Japanese) mobile phones, released in February 2013 an advanced smartphone for seniors named *Stylistic S01*. This smartphone is based on a customised Android 4.0.4 Ice Cream Sandwich specially tailored to enhance the interaction experience of senior users.

The Raku Raku smartphone is a well-engineered product that is specifically tailored to the needs of seniors. The design details and the features of this phone evince a spherical approach by Fujitsu, which is the first brand to address this market with any meaningful alternative to a regular smartphone. This device is unfortunately not available to the greater worldwide market of senior users, since it is available only in France and Japan. We are not aware of any usability evaluation of this phone.

As a consequence the present research aimed to develop an interface that would run on Android without the requirement of a bespoke device. Ergo, it would be universally accessible on widely available phones from all manufacturers.

The next section presents the design decisions and the development of the interface.

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2http://www.doro.co.uk/Products/Mobile-phones-and-accessories/
3http://www.greatcall.com/cell-phones/greatcall-touch

4 https://www.motorola.co.uk/moto-maker
3. DESIGN AND DEVELOPMENT

3.1 Target User Group

The term “seniors” is a vague and abstract term and can be interpreted in a variety of ways, since a distinctive clear-cut definition does not exist. The scientific community converges on the age of 65 [23]. Since it seems the most convenient choice [24], this study also uses the term “elderly” to refer to those over 65 years of age.

3.2 Qualitative Survey

After having specified the target group, there was also a need for a more tangible understanding of the way seniors perceive mobile phones. Hence, a qualitative survey was conducted in order to guide the design. For this survey, a semi-structured interview [25] methodology was used. During the interview the participants were encouraged to comment on mobile phones’ features and any problems they face.

All the participants were asked the following seven questions:

<table>
<thead>
<tr>
<th>Survey Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. For what purpose do you use your phone?</td>
</tr>
<tr>
<td>2. Which features of your phone do you use?</td>
</tr>
<tr>
<td>3. What do you find difficult on your phone?</td>
</tr>
<tr>
<td>4. Would you replace your phone with a more advanced one?</td>
</tr>
<tr>
<td>5. Have you ever used a touch screen phone?</td>
</tr>
<tr>
<td>6. What would you like to do with your mobile phone that you cannot do today?</td>
</tr>
<tr>
<td>7. Do you feel more secure when you are alone and have access to a mobile phone?</td>
</tr>
</tbody>
</table>

In total 5 senior mobile phone users (median age of 72) were interviewed.

Their profiles are shown on Table 1.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age</th>
<th>Education</th>
<th>S/P User</th>
<th>Living</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>70</td>
<td>Techn. School</td>
<td>No</td>
<td>Family</td>
</tr>
<tr>
<td>F</td>
<td>68</td>
<td>Elem. School</td>
<td>No</td>
<td>Alone</td>
</tr>
<tr>
<td>M</td>
<td>72</td>
<td>Elem. School</td>
<td>No</td>
<td>Alone</td>
</tr>
<tr>
<td>F</td>
<td>82</td>
<td>Elem. School</td>
<td>No</td>
<td>Alone</td>
</tr>
<tr>
<td>M</td>
<td>76</td>
<td>High School</td>
<td>No</td>
<td>Alone</td>
</tr>
</tbody>
</table>

3.3 Results

Despite the small number of participants the diversity of their profiles is broad. They have different educational backgrounds and social lives and yet they all seem to face the same problems with mobile phones. The only thing that homogenises them as a group, apart from their age, is their difficulty in using mobile phones.

All the users use their phones to enhance communication and to be able to deal with emergency situations. Moreover, they all use the basic functionality (calling and contacts). Only two use the phone for texting, which is considered advanced, and only one of the two is comfortably composing SMS messages.

One user blamed himself for the difficulties he experienced because he claimed that he had devoted little time and effort to master it. Another participant mentioned that everyday life worries and his tired brain made the learning process too difficult. The two female users focused on specific functionality. The last user, who possessed a smartphone, replied that all the features were wonderful and that he liked everything about his phone.

Five out of the six interviewees responded negatively when asked about replacing their phone with a more advanced one. Two participants replied that they wouldn’t change it because they were used to their current phone. Two mentioned that they did not need a new phone and another two that they did not have the money to replace it. One of the users who replied negatively said:

- “When my child brought me a new and fancy one, I investigated it and gave it back to him. I told him that I want a phone, not a television! They are offering us (the seniors) more than we can handle.”

Finally, the user who responded positively said:

- “Indeed I would replace it! Whenever I go to a sports cafe to watch football, all the young guys pop out all these huge devices and I feel inferior... I would have it just to show off, and at the same time in my pocket I would still have my current phone!”

Four users had never used a touch screen phone. When asked if they thought it would be difficult, they all agreed and said that their grandchildren would use it more efficiently.

The sixth question asked about what functionality the interviewees would like on their existing mobile phones. Four users were not interested in doing more than they already did with their phones.
One said that he would probably be interested in more functionality if he were younger. One interviewee was excited about capturing and editing photos and he said that he would love to exploit such features on his phone.

In the last question, about the feeling of security created by having a mobile phone, all the replies were the same. All users find themselves more vulnerable if they do not have their phones with them. They mentioned that they do not leave their place unless they have their phone with them, because it makes them feel more secure. More specifically one user mentioned:

- “Once, it was a luxury to possess a mobile phone, now it’s a necessity!”

## 3.4 Interpretation

The interviewees seemed largely unaware of the features provided by mobile phones and they considered most of the extra functionality useless. The interviewees seemed to be phobic about switching to something more advanced. They had negative perceptions about the ease of use of the newest mobile phones and thus tended to stick to what they already knew. Furthermore, they considered technologically advanced phones too difficult and complex, without having attempted to use them. This demonstrates a bias against smartphones. Only one participant was confident using his mobile phone and explained that the demand to use his phone for his job had made him, over the years, familiar with and dependent on it.

## 3.5 Design Requirements

The first prominent study into the requirements for senior mobile phones was conducted by Abascal and Civit [9]. Afterwards, many subsequent studies [2, 4, 5, 9, 11, 14, 17, 20, 21, 26-29] have extracted this user group’s requirements about the mobile phone usage which can be summarised as follows.

**Non-Functional:** Sense of security, Accessibility, Acceptability, Usability, Affordability.

**Functional:** Contact list, Alarm and reminders, Emergency Handling, Texting, Calling, Find my mobile number, Customisation.

## 3.6 Final Design

The senior audience is diverse in terms of needs and abilities. The interface needs to be simple, straightforward and cater for potential users’ minor disabilities, such as poor vision. Moreover, it needs to be simple, accessible, coherent and consistent.

**Visual representation:**
The visual aspect of a touch screen interface is the most important of all, for two reasons. Vision, as a sense, gives the richest information [30] and visual buttons delimit each input’s boundaries. Since seniors’ vision usually declines as years pass [31] graphic units should be large, clear and distinctly separated.

In order to make the visual units more accessible, every colour combination was evaluated based on WCAG2–Level AA accessibility specifications [32] by using an online “*Colour Accessibility Evaluator*” tool. With respect to size and spacing, the guidelines proposed by [15] were adopted.

**Visibility of the system status:**
The system status needs to be constantly visible [33]. This was achieved with the use of consistent colour coding, headings and icons.

**Feedback:**
Feedback is essential and reduces ambiguity about system state. Moreover, multiple types of feedback, when combined, can enhance the usability of a mobile touch-interface [34] [35]. Hence, the interaction is enhanced by visual (highlighting visual buttons when touched) and tactile feedback (vibration) to confirm performed actions.

**Navigation:**
The navigation of a mobile phone interface (the menu) is the most important issue for senior users [36]. The problems that the seniors face with menus are probably attributable to their lack of a menu-based mental model, since they are more experienced with linear rather than hierarchical menus. They also tend to have an abstract and vague representation of the structure in their minds and they struggle to perceive the functions that advanced terms are related to. As a result, their navigation performance is poorer as compared to younger users [37].

Therefore, the interface was designed to have the smallest possible hierarchical menu depth. According to that guiding rule, all tasks can be completed on the upper or second level in the navigation tree, as presented in *Figure 1*.

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Consistent navigation patterns:
The navigation should follow a straightforward and consistent pattern. Thus, buttons in the same location, with the same size and style are performing the same actions. A back button is navigating back one level each time. Moreover, there are no "hidden" screens (loaded by swiping horizontally) and scrolling is only performed vertically and this only when unavoidable.

Mis-click avoidance:
Mis-clicks are a common problem for inexperienced touch-screen users. Hence, clicking on this interface requires a long press in order to register the request, a technique also used by [21]. The hardware soft-keys were deactivated, because they could easily be touched accidentally [38].

Autonomy and Security
Autonomy and security are essential for seniors [39] and this can be enhanced by helping them in emergency situations and to inform their relatives in such occasions. Therefore, a “care centre” page is always accessible in the interface. This page handles emergency situations by allowing the user to call an ambulance or a relative. This is depicted as Level 0.5 in Figure 1.

The interface will also monitor daytime activity and if there is no activity for some time it will try to interact with the user. If the user does not respond a warning would be sent to a relative. This last feature is depicted in Figure 2.

4. EVALUATION

The interface was implemented on the Android 4.0 platform. It was tested using a controlled experiment contrasting elderly and young participants. In total, twenty-two users participated. The following two null-hypothesis were tested:

H0: "The older participants’ average completion time for all tasks will be the same as the average completion time of the younger adults for all tasks".
H1: "The older participants’ average completion time for Taski will be different from the average completion time of the younger adults for the same task", where i ε [1-12].

![Figure 2: The interface will try to interact with the user after a predefined period of time. The arrow represents the transition after the user's input. a) The interface will try to interact with the user b) The screen after a negative response](image)

The participants in the senior group were 3 females and 8 males with median age of 68; 10 were totally inexperienced with smart phones and 9 had a primary school education. On the other hand the young participants comprised 4 females and 7 males with median age of 29. All were smart-phone users and were university graduates. Participants in both groups were asked to carry out 12 tasks. For the evaluation, a Samsung Galaxy Ace 2, with a 3.8 inch display was used. The tasks to be carried out were:

**Evaluation Tasks:**
1. Dial a number
2. View call history
3. View messages
4. Delete a message
5. View the contact with name “Babis”
6. Add a new contact with photo
7. View the calendar events
8. Create a new event
9. View the new event
10. View your mobile phone number
11. Increase the Rington volume
12. Call an ambulance (fake call)
In order for the evaluation to be approached holistically, both quantitative and qualitative data were gathered. The quantitative data were related to the efficiency and consisted of completion times for each task. The qualitative data was related to the user experience [40] and consisted of verbal responses or comments about the interface (during an informal chat at the end of the evaluation) and their emotions when using the phone. The emotion was chosen from a graphically presented set of emotional states [41].

![Figure 3: The home screen of the interface.](image)

4.1 Quantitative Analysis

The completion times results are shown in Figures 4 and 5 (average time per user and average time per task).

![Figure 4: Average time for each user. The results are sorted.](image)

The small sample size does not facilitate normality tests and thus a nonparametric test (namely Mann-Whitney-Wilcoxon [42]) was chosen for comparing the two group means. Hypothesis 0 was rejected (p<0.05) and Hypothesis 1 was supported for all tasks (p>0.05), except for Tasks 6 and 8 which had a p-value of 0.2748 and 0.2929 respectively.

![Figure 5: Average time for each task.](image)

4.2 Qualitative Analysis

At the end of the evaluation the participants were asked to comment on the interface and state their opinion of its potential adoption. An informal chat took place and the comments were recorded. We used the requirements as categories to allocate the comments to. Only one negative comment was received "It is not guiding me enough". The others fell into one of the following three categories: accessibility, acceptance and usability. Examples of the comments are provided below and results from the emotion chart are shown in Figure 6.

Accessibility:
- "I like the fact that it has big letters."
- "Its strength are the large buttons"

Acceptability:
- "Unfortunately such phones are not available to buy!"
- "This phone is easy; better than the others!"
- "That's really good!" (the interface)

Usability:
- "It's easy if you read what it says; everything is explained."
- "I like the fact that each button refers to one letter. In those with hard buttons I am struggling with the multiple letters per button."
- "Corroborative, encouraging! It gives you the feeling that you are doing well."

![Figure 6: Users’ emotions while using the interface. The users were asked in the questionnaire to choose one of these graphical figures based on their emotions. Blue corresponds to elderly and red to younger users.](image)
5. DISCUSSION

Even though the evaluation was performed with a small number of participants, some interesting results, both qualitative and quantitative, were obtained. More specifically, it was made clear that the average time per user for the elderly will always be less than that of younger adults. This is as expected since understanding builds upon existing experience and knowledge [43]. The young participants were experienced with smart phones, whereas the test group consisted of people unfamiliar with smart phones and touch-screen technologies in general.

The most salient result of the quantitative analysis was the rejection of H1 for Tasks 6 and 8. The elderly in those tasks performed similarly as younger adults. Interestingly enough, those two tasks, for both groups, were the most time consuming and required the most steps to complete. The inter-group difference (avgt ime(eld) / avgt ime(youn)) was the smallest with 2.1 and 1.64 times for Task 6 and 8 respectively. Taking into account that the elderly become anxious when tasks are complex [44], the interface is efficient for cognitively intensive and multistep tasks, since the older and younger users demonstrate similar efficacy.

The qualitative data also provides tangible feedback about the perceived ease of use, acceptance and user experience in general. Almost all the comments were positive and demonstrated general acceptance. Most of the older participants did not expect such high levels of usability and some of them, after using it, considered the test interface to be easier to use than their current hard button phone.

Before the evaluation most of them expressed their disappointment with the current touch-screen smartphones. Most of them, when asked, said that they would purchase this phone (with the specific interface) if they could afford its price.

Moving on from usability, the emotions that the users experienced during the evaluation were generally positive. Most of the participants, from both groups, felt pleasant and none experienced unpleasantness or frustration. Positive emotions enhance the users’ perception of usability [41] and increase satisfaction, acceptance and may strongly impact intention to purchase [45].

6. CONCLUSION

Since technology for seniors is not a need but rather a solution, this research developed a tangible and effective tool that will be easier to use. The outcome of this research was an interface that could be used on any smartphone with an Android 4.0 (or higher) operating system. The prototype interface incorporated many features and functions, such as highlighting, tactile feedback, generally applied interface, visual accessibility, emergency handling, ease of navigation and many more, which would help seniors overcome their problems with mass market smartphones.

The interface was tested for usability and efficiency with the help of experienced young and inexperienced older smartphone users. The evaluation demonstrated that the interface, even if it could not deliver equal effectiveness for simple tasks, could help elderly users to reach similar levels of efficiency to younger adults in cognitively intensive and multi-step tasks. Moreover, the users expressed acceptance of the interface and perceived it to be useful.

7. FUTURE WORK

A great deal more work has to be carried out in order for such a senior-specific interface to be ready for release to the general public. A large-scale evaluation that compares it to an off-the-shelf standard interface must take place. Additionally, more functionality and features, to potentially further enhance usability, need to be added. Which features to add were elicited during the evaluation (while monitoring the usage), the literature review and the monitoring of modern smartphone trends7,8. The proposed additional features are the following:

1. Voice input and output [46] [47]
2. Smart search functionality
3. More customisability
4. Internet browsing and entertainment
5. Well-being and health monitoring functionality [48]
6. Remote access to device, by family members and doctors

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