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Accessibility to mobile interfaces for older people

José-Manuel Díaz-Bossini* and Lourdes Moreno

Computer Science Department, Universidad Carlos III de Madrid,Av. De la Universidad 30, 28911 Leganés(Madrid), Spain

Abstract: Accessibility is a major concern in our society nowadays. However, technology is always one step ahead and new devices appear before we can address the accessibility problems for the older ones. People with disabilities are not the only ones that are being excluded by technologies. Indeed, there is an exponential growth of the elderly population that suffers from age-related disabilities. Accessibility issues should be in mind for developers. Unfortunately, addressing these issues is even harder in new devices like mobile phones and tablets where there is not a proper set of guidelines focusing on this domain. This work provides: (1) a set of guidelines to keep in mind in order to achieve accessibility in mobile interfaces for older people. This checklist is the result of a review study of the literature, standards and best practices that are being performed in this area of knowledge, (2) use of this accessibility checklist aimed at elderly people, a survey of three mobile native Apps on android platform has been carried out, these Apps have as aim to modify the default interface for another more accessible one.

Keywords: Accessibility; Mobile Devices; Elderly people; Application Interfaces

* Corresponding author. Tel.: +34-637-432-694;
E-mail address: jbossini@di.uc3m.es (J.M. Diaz), lmoreno@inf.uc3m.es (L. Moreno)

1. Introduction

People with disabilities are at risk of being excluded from the use of Information Technologies but there is another group that could be affected by this exclusion: elderly people. As society ages, the likelihood of people suffering some disability grows. Whether this be temporary or not, there is an increasing correlation between age and disability. Today's developed societies face a demographic reality, they age progressively and rapidly. Therefore, some data should be mentioned since it is expected that the number of people over 60 in the world will triple by 2050 [1].

In fact, our elderly could be affected by sensorial, operable or understanding disabilities. The fast diffusion of mobile telephones is opening a vast diversity of new opportunities for people with different levels of physical restrictions, these due to disability or ageing [2].

According to Abascal [3], what older users expect from mobile communications is not very different from what the generic user expects from these services: mostly, fully reliable personal communications and services to improve, as much as possible, safety and quality of life.

Accessibility issues should be a requirement for developers. However, accessible web pages and applications for people with disabilities are not as extended as they should be. This problem is even bigger in the context of mobile phones due to the exponential growth that these devices have had. Mobile technology is evolving continuously so it is hard to address the accessibility issues due to the huge amount of different devices that come on the scene. The World Wide Web Consortium (W3C) is working on providing guidance to apply its Web Content Accessibility Guidelines (WCAG) [4] and they provide a set of Mobile Web Application Best Practices (MWABP) and Mobile Web Best Practices (MWBP) [5] but these are just an adaptation and a set of best practices, not a specific guideline.

This paper aims to collect set guidelines from best practices that are suitable to be applied in the mobile applications context. These guidelines will be taken into account in the accessibility study of three Apps that modify the default interface for another more accessible one. In fact, these applications could be helpful to address accessibility issues for older users without the need of a special device.

Section 2 shows the Accessibility issues for elderly people. In section 3, Accessibility guidelines for mobile applications are collected. The experimentation design of the survey of three Apps is provided in section 4. In section 5, the analysis of the Apps and their results are presented. Finally, Section 5 shows some conclusions and outlines future research perspectives.

2. Accessibility and older people

As people age, they experience a decline in a wide variety of abilities (vision, hearing, mobility and cognition) that impact on various aspects of their everyday lives. As a result, they often need a greater degree of support in carrying out tasks and activities [6] [7]. Research on Information Technologies and elderly people has been carried out in recent years, but this research is focused mainly on the use of Internet and the design of web sites for older people [8][9][10][11].

The evolution of mobile technologies has supposed an enormous social change. Unfortunately, this change has not been possible for all groups. Disabled people and elderly people experience several difficulties: devices were not properly designed for older people; developers didn't address accessibility issues on their application designs, and so on [12]. Fortunately, that trend is changing; more and more the devices are including assistive technologies by default like haptic interfaces and tools like the text to speech or speech to text interfaces and the W3C is working on the adaptation of their own guidelines, like WCAG, for the mobile context.

In [3], Abascal points out that the requirements that mobile communication systems for disabled and older people should meet can be classified under the following categories:

- Personal communication: for users with restricted movement, mobile technology enhances their chances of personal communication.
- Security: situations of illness, home accidents and so on, require a quick communication channel.

- Social Integration. Access to education and labour market: Services like tele-working and tele-education contributes to social inclusion and autonomy of user with disabilities.
- Autonomy: the combination of personal communication, security and access to integrative services gives to people with disabilities and older people more opportunities to carry out an independent way of life.

As we can see, by addressing accessibility, we could improve the quality of life of our elders in many ways.

3. Accessibility guidelines of mobile Apps for the elderly

There are several resources for Mobile Accessibility Guidelines (Native Apps and Web-Apps), some of them are generic resources and others are aimed at platform specific (Android, Blackberry, iOS, Nokia and Symbian and Windows Mobile) [13]. As we have said above, WAI of W3C is working on the adaptation of their existing generic guidelines for the mobile context (WCAG, UAAG, ATAG, WAI-ARIA) [14] but this work is still in progress. Some related work on accessibility guidelines for older people in mobile scenarios have been found [15][16][17][18], and these works were taken into account to adapt to the mobile context the accessibility guidelines that have been considered in this paper.

In this case, this paper is aimed at native App of Android platform and the study will be to focus on three different sources: the Barriers Common to Mobile Device Users and People with Disabilities, the Android Guidelines for developers [19] and the Web Design Guidelines by Panayiotis, Z. et al [20]. They will be used to analyze three applications downloaded in the Android Market that transforms the mobile interface into a friendly accessible one for elderly people.

3.1. World Wide Web Consortium (W3C) guidelines

The W3C collect a set of Barriers Common to Mobile Device Users and People with Disabilities that are focused in four different contexts: Perceivable, Operable, Understandable, and Robust [21] . The last one (Robust) is focused mainly on Web-based application than native mobile Apps, so it won't be considered in this study.

We have used this set of checkpoints or guidelines to analyze the Apps, but attending only to those guidelines that affect the mobile interfaces. Table 1 collects these checkpoints; it has been made based on the work [5]. The first column gives to each checkpoint a codename with the following nomenclature W3C+First character of the W3C principles (Perceivable, Operable and Understandable) + number to identify checkpoint inside each context, for example W3CP001 means the first perceivable checkpoint. The second column describes the content of each checkpoint. Third and forth columns point out the context for desktop and mobile devices respectively. The fifth column describes the experience that the user has if the checkpoint is not addressed. Finally, the last two columns relate the checkpoint with the point or points inside the Web Content Accessibility Guidelines (WCAG) 2.0, the Mobile Web Best Practices (MWBP) 1.0 and Mobile Web Application Best Practices (MWABP).

3.2. Android Accessibility Practices

Google Inc. provides a set of best practices to address accessibility for developers. The practices that will be used to analyze the applications are:

1. Add descriptive text to user interface controls.
2. Make sure that all user interface elements that can accept input (touches or typing) can be reached with a directional controller, such as a trackball, D-pad (physical or virtual) or navigation.
3. Make sure that audio prompts are always accompanied by another visual prompt or notification, to assist users who are deaf or hard of hearing.
4. Turn on TalkBack and Explore by Touch (these are the assistive technologies provide by default for all android devices), and then try using the application using only directional controls.

To use this checkpoint on the tables they will have the codename Android plus its checkpoint number, so for checkpoint one for example, we will have Android-001.

Code	Content	Disabilities context	Mobile Device Context	Experience	WCAG 2.0 Success Criteria	MWBP 1.0 Best Practice, MWABP Best Practice
			Perceivable			
W3CP001	Information conveyed using color (for example, "required material is shown in red") with no redundancy.	User who is blind or colorblind perceives color incorrectly or not at all.	Many screens have limited color palette and color difference is not presented. Device is used in poor lighting,so colors are not clearly perceived.	User perceives color incorrectly or not at all, and so misses or misunderstands information or makes mistakes.	1.4.1 Use of Color, 1.3.1 Info and Relationships, 1.4.3 Contrast (Minimum), 1.4.6 Contrast (Enhanced)	USE OF COLOR, COLOR CONTRAST
W3CP002	Non-text objects (images, sound, video) with no text alternative	User who is blind cannot perceive content that include non-text objects. Furthermore, information not available to user whose browser, assistive technology, other user agent doesn't support object.	User can be billed for download volume so images might be turned off to save costs. Some mobile user agents have limited support for non-text objects so user loses information. Some user agents also shrunk images in size to fit the device's screen which can make images meaningless.	User cannot perceive important information or loses information due to lack of alternative.	1.1.1 Non-text content	NON_TEXT_ALTERNATIVES, OBJECTS_OR_SCRIPT
			Operable			
W3CO001	Special plugin required.	Plugin turned off, or not installed, or not compatible with assistive technology. Plugin not operable with preferred input device.	Plugin turned off or not installed; not compatible with input device (for example, requires mouse).	User can not perceive content or cannot operate interface.	2.1.1 Keyboard, 2.1.3 Keyboard (No Exception)	OBJECTS OR SCRIPT
W3CO002	Inconsistency between focus (tab) order and logical document content sequence	User with motor disability uses keyboard for navigation not mouse. User who is blind also often use tab navigation to move from one element to another.	Mobile devices may not have a pointing device so the user may have to navigate elements serially.	User is unable to navigate content in logical sequence, becomes disoriented.	2.4.3 Focus order	TAB ORDER
			Understandable			
W3CU001	Long words, long and complex sentences, jargon	Users with some types of cognitive disabilities have difficulty processing information. Users who are deaf and whose native language is sign, have difficulty processing complex written language.	Text is displayed in small font, and user is often distracted by ambient conditions (background noise, conversations, moving objects in field of vision).	User has difficulty understanding information.	3.1.5 Reading level	SUITABLE, CLARITY
W3CU002	Content spawning new windows without warning user.	User with low vision, or restricted field of vision, or blindness, or cognitive disabilities doesn't realize active window is new.	Single window interface. Multiple stacked windows on small screen hide each other.	User becomes disoriented among windows; back button doesn't work. User closes window, not realizing it is last in stack, closing browser instance.	3.1.2 On focus, 3.2.2 On input, 3.2.5 Change on request	POP UPS
W3CU003	Blinking, moving, scrolling or auto-updating content	People with reading disabilities, cognitive limitations, and learning disabilities do not have sufficient time to read or comprehend information.	Reduced size of mobile viewport or poor ambient lighting makes it difficult to see content. Auto-refreshed pages may also have cost implications if they are left open or put unnoticed into the background.	User has difficulty reading and comprehending content.	2.2.2 Pause, Stop, Hide, 3.2.5 Change on request	AUTO REFRESH

Table 1 Barriers Common to Mobile Device Users and People with Disabilities

3.3. Age-centered Research-Based Design Guidelines

Panayiotis, Z. et al. established a set of 38 Senior Friendly Usability guidelines for web design. These guidelines are grouped in 11 different categories. Five of these categories were focused mainly on web pages so we erased them from our study because they didn't fit in well with the mobile context: Navigation, Links, Text Design, Search Engine, User Feedback & Support. The 6 remaining categories that fit the application mobile context are: Target design, Use of Graphics, Browser Window Features, Content Layout Design, User Cognitive Design, Use of Color and Background. Each category will have a codename so it can be used in result tables, this codename starts always with the acronym of Web Design Guidelines (WDG) plus the acronym of the specific dimension; for example, for Target Dimension, the codename will be WDG-TD . The criteria used on each category are:

Target Design (WDG-TD)

- Provide larger targets
- There should be clear confirmation of target capture, which should be visible to older adults who should not be expected to detect small changes
- The older adult should not be expected to double click

Use of Graphics (WDG-UG)

- Graphics should be relevant and not for decoration. No animation should be present.
- Images should have alt tags
- Icons should be simple and meaningful

Browser Window Features (WDG-BWF)

- Avoid scroll bars
- Provide only one open window eg. pop up/ animated advertisements or multiple overlapping windows should be avoided.

Content Layout Design (WDG-CLD)

- Language should be simple and clear
- Avoid irrelevant information on the screen
- Important information should be highlighted
- Information should be concentrated mainly in the centre.
- Screen layout, navigation and terminology used should be simple, clear and consistent

User Cognitive Design (WDG-UCD)

- Provide ample time to read information.
- Reduce the demand on working memory by supporting recognition rather than recall and provide fewer choices to the user.

Use of Color and BackGround (WDG-UCB)

- Colors should be used conservatively
- Blue and green tones should be avoided
- Background screens should not be pure white or change rapidly in brightness between screens. Also, a high contrast between the foreground and background should exist, for example, colored text on colored backgrounds should be avoided.
- Content should not all be in color alone (color here is denoted by all colors other than black and white)

4. Experimental Design

4.1. Object of study

The aim of this study is to analyse three different applications taking into account the above accessibility checklist. These applications transform the default interface into another more accessible one.

4.2. Experiment Context -

The device used to study the Apps has been a Nexus 4 Smartphone with Android 4.2.2. The TalkBack services and the Explore by Touch system feature will be enabled during testing:

- The TalkBack accessibility service works by speaking the contents of user interface controls as the user moves focus onto controls.
- The Explore by Touch system feature is available on devices running Android 4.0 and later, and works by enabling a special accessibility mode that allows users to drag a finger around the interface of an application and hear the contents of the screen spoken. This feature does not require screen elements to be focused using a directional controller, but listens for hover events over user interface controls.

4.3. Sample APP's

Apps under study have been Big Launcher [22], Frontillo [23] and Mobile Accesibility for Android (MAA) [24]. These Apps are applications that focus on make the mobile interfaces accessible for people with disabilities and/or to elderly people.

Apps have good acceptance by users, Google Play Score[†] is a score based on the users opinions; it could take values between 0 and 5 stars where 0 is the minimum. The score of Big Launcher App in the Google Play Store is 4,5 out of 5 stars, for Fontrillo its score is 4,5 out of 5 stars and MAA's score is 4,1 out of 5 stars.

4.4. Study parameters

The parameters that will be applied to our study are those described above in Section 3. That includes: the Barriers Common to Mobile Device Users and People with Disabilities addressed by the W3C and, collected in table 1; the Android Accessibility Practices and finally, the list of guidelines based on the Age-centered Research-Based Web Design Guidelines by Panayiotis, Z. et al.

Each application will be evaluated for each checkpoint individually from the accessibility checklist, and the final score will be the average between them, as we explain in next section.

4.5. Evaluation method

An expert on mobile accessibility has carried out the evaluation. He tested each checkpoint or guideline manually for each App. Each checkpoint was graded from 1 to 5, where 1 means checkpoint not at all addressed and 5 means checkpoint completely implemented. The results are presented for each set of checkpoints and the final result will be the average between them.

5. Analysis and Results

This section shows the results obtained from test each checkpoint over each application. The main goals of our study are first to test if the checkpoints and guidelines collected are suitable to address accessibility issues on mobile devices for elderly people. Secondly, the application of these checkpoints allows us to make a ranking of the most accessible App of the three.

5.1. Big Launcher Application

The Big Launcher App has been evaluated on its 2.3.1 Free version. Big Launcher fared well with many of the checkpoints collected in section 3. Its strengths being completely compatible with TalkBack and the Explore by Touch system features. The iconography is completely understandable and it has the perfect size that allows users

[†] https://play.google.com

to interact with the different options in the home screen (see Figure 1). Its weakness; it loses some functionality without the TalkBack accessibility service enabled, for example, if the user receives messages, the icon starts to blink but blind people can lose this information without the voice service enabled.

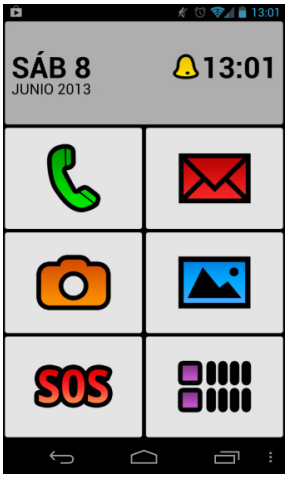

Figure 1 Big Launcher Main Screen

5.2. App Fontrillo

Fontrillo App, as does Big Launcher, complies with many of the checkpoints established above. The analysis has been performed on its 1.0.10 version. Its strengths are that it converts the phone interface into one easy to use, each operation has its own screen so users do not get lost in multiple menu options. Its weakness were that it is not 100 % compatible with TalkBack service, and there are not any non-text alternatives for every image or menu screen; in addition, the other applications installed on the smartphone are not integrated inside Fontrillo so you have to stop it if you want to access to them. Fontrillo is aimed at elderly people, and it achieves its goal, but it transforms the smartphone into a classic phone with limited functionality. In Figure 2, screenshot is showed.

Figure 2 Fontrillo Main Screen

5.3. Mobile Accessibility for Android

This application focuses mainly on blind people however, it could be used to simplify the mobile interface for elderly people too. The analysis has been performed over the 2.05 version (first 30 days evaluation free). Its strengths are that this application provides its own voice service that speaks the content of the interface without the need of additional assistive technology. As a weakness, this voice service cannot be disabled so elderly people could reject it because the App could cause the user to feel different from other users [25]. In Figure 3, screenshot is showed.

Figure 3 The Mobile Accessibility for Android Main Screen

This application is designed mainly for blind people, so it is not appropriated to be used by our elders. Elderly people that have needs other than visual disabilities will be more comfortable with Big Launcher or Fontrillo application.

5.4. Comparative Table

Table 2 shows the partial scores for each checkpoint and the global score obtained as the average of the scores. As Table 2 shows Big Launcher has the higher score of the three applications under study. The second one is Fontrillo and finally the Mobile Accessibility for Android.

All applications address accessibility issues, but Big Launcher is the one most accessible to elderly people. Fontrillo is a good application but it needs to solve problems like the use of text alternatives for images that allow Talkback or other assistive technologies to work fine.

Finally, the MAA application has the lowest score, but it doesn't mean it doesn't address accessibility issues. As we can see for the W3C checkpoints it has the highest qualifications; it's an application that focuses mainly on blind people and it implements with success these guidelines. However, it does not comply with some accessibility requirements to provide support for other special needs of the elderly people.

Last but not least, there are other considerations that should be taken into account like prizes and personalization. Again, Big Launcher and Fontrillo are the winners attending to these checkpoints. Big Launcher Free Demo is 100 % operable, but with commercial advertising that can be removed buying its paid version. Fontrillo is 100 % free and it does not have any advertising. On the other hand, The Mobile Accessibility for Android is fully operational only for 30 days, after that, you should buy its paid version.

Both, Big Launcher and MAA allows you to customize its default options, but Big Launcher again is more flexible allowing customization of buttons, theme changing, and so on. Customization for Fontrillo App, however, is limited; you can configure things like the SOS call but, you cannot customize the interface itself.

Table 2 Application under Analysis Scores

CHECKPOINT	BIG LAUNCHER	FONTRILLO	THE MOBILE ACCESSIBILITY FOR ANDROID
W3CP001	5	5	5
W3CP002	5	2	4
W3CO001	2	2	5
W3CO002	3	4	4
W3CU001	5	5	4
W3CU002	4	3	4
W3CO003	4	5	4
Android001	5	2	5
Android002	3	3	3
Android003	4	3	4
Android004	5	3	3
WDG-TD	5	5	2
WDG-UG	5	4	2
WDG-BWF	2	2	2
WDG-CLD	4	4	2
WDG-UCD	5	4	3
WDG-UCB	4	5	3
Final Score	**4,11**	**3,58**	**3,47**

6. Conclusions and future work

This paper has reviewed the literature, best practices and guidelines that addressed accessibility for elderly people in the mobile context. From this study, a checklist of accessibility guidelines have been elaborated and this resource has been used to analyse and evaluate three mobile native Apps that modify the default interface, turning it into a more accessible and friendly one for elderly people.

The mobile native Apps under study were Big Launcher, Fontrillo and the Mobile Accessibility for Android. The results of study indicate Big Launcher is the most accessible for older people of the three applications.

Accessibility issues should be a goal for developers. Accessibility requirements should be addressed early on the design phase in the development process. But developers cannot make the travel alone; they should have a set of useful guidelines and practices to follow and the tools that helps them to properly address accessibility issues. For the moment, there is a lack of specific rules for mobile applications context, the W3C is working on the adaptation of their guides but there remains a lot of research work to do.

All Apps should be accessible in order to prevent social exclusion and to encourage the access of elderly and disabled people to the technologies. But, there are not many accessible applications on the market. Today, accessibility issues are a warning, but tomorrow they could be more alarming as long as society is getting older and the number of disabilities continues to increase with age.

This paper focuses only on native app android. As future work, it could be interesting to study the problem from the iOS perspective. Another set of features would be also interesting to analyse like those that are task-oriented like call or info search or those that are context-dependent like videophone or desktop application.

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