Guidelines to Design Smartphone Applications for People with Intellectual Disability: A Practical Experience

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Abstract. Applications for smartphones have a great potential to facilitate the lives of people with intellectual disability. In fact, it is possible to design specific applications adapted to their needs. But even in this case, users may experience accessibility issues with some structural elements of smartphones. In this study, we have identified these elements through a 2-month test period with some people with intellectual disability. They used a simple smartphone application that met some needs identified by their caregivers. Through this practical experience, problems with the notification bar and the home, back, menu, search, volume and power buttons have been detected. Potential solutions to overcome these issues have also been proposed.

1 Introduction

People with intellectual disability are characterized by significant limitations both in intellectual functioning and in adaptive behaviour, which covers many everyday social and practical skills [1]. Research has shown that assistive technology can facilitate learning, increase access, and serve as a tool to compensate for specific challenges associated with a disability [2].

In this sense, traditional mobile phones have evolved into modern "smart" phones which combine the communication facilities of cellular phones with the potential of handheld computers [3]. Regarding their use, a recurring theme is the diversity across subjects [4]. Bryen et al. [5] reported that the mobile phone usage rate of adults with intellectual disabilities was much lower than expected. Many mobile phones still lack features that would reduce the level of difficulty and improve access to them. Furthermore, the complexity of some mobile handsets and services can represent barriers to use [6].

Some studies have focused on identifying the features that make the use a complex process. Urturi Breton et al. [7] examined the problems intellectually challenged users might experience when using touch screen mobile phones. They identified issues

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regarding buttons (too small), menus (too many), text size (too small), multi-touch events (too complex) and feedback (not provided). Interfaces should be clear and concise. Other studies also point in the same direction [8][9].

Most authors admit that it is not possible to face people with intellectual disability to smartphones as they were initially conceived [7][8], and we concur with this opinion. However, we cannot renounce using such powerful devices since they have great potential in the field of ambient intelligence. Smartphones, like computers, also run a hardware operating system, which allows for the development of supplemental software applications to be run on the phone [3]. We should take advantage of this potential to make them accessible to people with intellectual disability. It is possible to design specific applications adapted to their needs, with reduced functions, improved usability and enhanced accessibility. But even if an application is adapted, there are structural elements of the smartphones that could hinder its use. These elements are common to all applications and inherent to the mobile devices. In this study, we present a practical experience that has enabled us to identify these elements. The results presented here are general and aim to be of interest to researchers developing smartphone applications for the disabled.

2 Subjects

Three people with intellectual disability were recruited for this study. They were members of the *Agrupacion Turolense de Asociaciones de personas con Discapacidad Intelectual (ATADI)*. The study was approved by the board of the organization and two of their caregivers were involved in the 2-month test period. None of the three participants had used a smartphone before. During the tests, they should interact with a smartphone running an application for people with intellectual disability. Each of the three subjects wore the phone for two months. The tests were performed in the subjects' living environment and they used an application designed according to the needs identified by their caregivers [10] (section 3). Therefore, we did not force interaction with the mobile phones. In fact, this is one of the strengths of this study; we avoided scheduling sessions where users are often asked to perform some predefined actions under the supervision of the researchers. Instead, the subjects handled the phones in their living environment as they considered, without receiving specific instructions. This long real-world evaluation allowed some problems emerge that, in a supervised context, would have rarely been detected. The application with which users interacted is briefly explained in section 3.

3 Methods

The application is intuitive and quite simple. It consists of a button to be pressed in case of emergency. Simultaneously, it locates and stores the position of the phone. In this sense, caregivers can visualize the routes performed by users through their PCs (Figure 1). This last task is accomplished in a transparent way, that is, users' intervention is not required. Their interaction with the phones occurs if they leave some predefined security areas, in which case they are alerted through a message sent to their phones. An alarm tone rings and simultaneously the phone starts vibrating. Users can view the content of the message by switching on the phone screen.

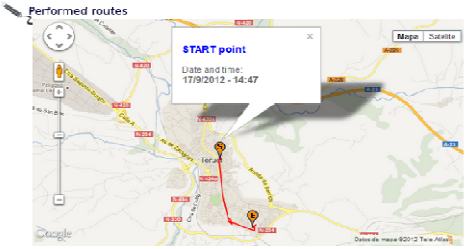

Fig. 1. Screen to visualize the routes performed by the subjects

4 Guidelines to Design Applications for Smartphones

Through this practical experience we could identify which smartphone elements interfere in the use of an application by people with intellectual disability. These elements are represented in Figure 2. This section explains how they affected the operation of the phone during the 2-month test period, describing the actions that can be undertaken.

Fig. 2. Structural elements of a smartphone that could hinder its use

The structural elements of the smartphones that hinder their use are:

- Back, Home and Search Buttons: Users often push these buttons unintentionally. If the back button is pressed, the application is destroyed. When this occurred, none the participants were able to launch it again. In fact, they did not even notice that the application was not running, so they thought it was still active. By contrast, the home button makes the application running on the background and, as in the previous case, users were unable to open it again, so although the location function still worked, the help button was no longer accessible since the application main screen was not displayed.
- Menu Button: By pressing this button a list of commands or facilities is displayed on the screen. It is highly prone to errors, since it requires the interaction with two elements; first, the button itself and second, the option within the menu. None of the 3 subjects involved in the study were able to perform these actions.

- Volume Button: The volume should be controlled internally by the application. Two of the participants accidentally used to switch to vibrate or silent mode which affected the operation of the phone, for example, when receiving a call.
- Notification Area: It can cause confusion since notifications are displayed in a small area (up to 64 density-independent pixels tall). The characteristics of this area make it inappropriate to be managed by people with very low technological skills.
- Power: By long-pressing this button a menu with three options (power off, airplane mode and restart) is displayed. Participants often accessed this menu accidentally due to the need of short-pressing the power button to switch on the screen. None of the three subjects were able to distinguish between a short click and a long click.

To overcome the problems encountered, some design guidelines concerning each one of these elements are provided in table 1. An extra column has been added, reporting on the degree of complexity in carrying out the proposed solutions in an Android device.

Table 1. Solutions proposed to overcome the problems encountered

Structural element	Solution proposed	Degree of complexity
Back button Home button Search button	The normal behaviour of these elements should be overridden, preventing the application from being destroyed (back button), from returning to the main screen (home button) or from accessing to the search option that can cause confusion in the users.	Low. The Android operating system has functions to override the normal operation of these buttons.
Menu button	The menu button should be discarded, and all options included in the main screen of the application. Obviously, this screen should be designed according to the international accessibility standards [11].	None. It is a designer's choice whether to include a menu or not.
Volume button	The volume should be controlled internally by the application. That means, caregivers should decide whether to enable or disable the volume settings, since users may inadvertently change the configuration.	Low. The Android operating system has functions to control the volume settings.
Notification area	The notification area should not be present, filling the whole screen with the content of the application.	None. It is a designer's choice whether to include the notification area or not.
Power	At best, the functionality of the power button should be overridden and a password required for turning off the phone. Since this is a hard task, strategies to prevent the use of the power button are needed. This necessarily leads to the search for alternative ways of switching on the screen. The volume button is a good candidate for this function.	Very high. The power button is a structural hardware element of the phone, and changing its operation, if possible, is a hard task.

Most of the design guidelines given in this paper can be easily implemented. In fact, we have developed a preliminary application with the back, home, search, menu and volume buttons overridden and the notification area removed. As this application lacks of functionality, it should be seen as a framework through which any type of adapted application could be implemented. Thereby, future applications should be contained inside this "framework" application in such a way that if they are designed following the accessibility standards, the whole system will be usable, not being compromised by the structural elements of the smartphones.

5 Conclusion

This study identifies the structural elements of a smartphone that may hinder its use by people with intellectual disability. These elements are the notification bar and the back, home, search, menu, volume and power buttons. When an adapted smartphone application is developed, the functions of these buttons should be overridden to make the system usable. Furthermore, all options within the application should be made accessible from the main screen, designing the interface according to the international accessibility standards [11].

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