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Research Article

Problems Facing by Visually Impaired People during Interaction with Mobile Applications

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Abstract

In order to improve the quality of life for Visually Impaired People (VIP), these mobile applications have paly an important role. VIP can independently live their lives with the help of advanced mobile technology. There are many assistive mobile applications that facilitate the VIP to perform their daily tasks. But when VIP interacts with these mobile applications there are many accessibility issues. This paper focused on the accessibility of mobile phone applications by VIP. This paper observed the activities of VIP during using mobile applications. In this paper, a total of 10 VIP people have participated with a different type of visual impairment. In order to find out the problems in accessibilities, the participants completed the given task. In a result of observation and accessibility of mobile phone applications, there were found many problems of accessibilities and usability. The representation of problems during interaction of mobile applications with VIP is the main contribution of this paper.

Keywords: *Visually Impaired People; Human-Computer Interaction; Mobile Applications; Usability; Accessibility*

Introduction

World Health Organization (WHO) estimated in the year 2018 that worldwide there are approximately 1.3 billion people have affected by near and distance vision impairment. From this estimation, around 188.5 million people have visually impaired called mild vision impairment, moderate to severe vision impairment is around 217 million people and 36 million people are blind [1]. In order to near vision impairment, there are approximately 826 million people live with it [2]. Over the age of 50 years, there are about 65% of people have undergone visual impairment in developing countries. Glaucoma, refractive errors, and cataracts are the main reason for visual impairments [3]. Research shows that the prevalence of nearsightedness will increase to around half the population of the world in 2050 [4]. The quality of life has suffered from visual impairments. Sometimes they have problems in their ability to work and establish in their personal relationships. Due to visual impairment, there are about 48% of people completely or moderately cut off from the people and things around them.

Visual impairment

A functional restriction of eyes or visual system [5] and can definite as visual field loss, reduce visual acuity, contrast sensitivity, visual distortion, visual-perceptual difficulties, diplopia, or any combination from them is defined as Visual Impairment. These functional restrictions can result from acquired conditions (e.g. age- related changes, systemic disease, trauma, and ocular infection), hereditary (e.g. Stargardt's macular degeneration or retinitis pigmentosa) or congenital (e.g. development abnormalities or genetics, postnatal or prenatal trauma). Visual impairment can produce abnormalities by the outstanding influence with one's capability of independent function. There are some particular problems involve loss of capacity to read the print of standard size, restriction or lack of ability with respect to driving, difficulty or lack of ability in face- recognizing of similar persons, performing leisure activities with difficulties. A visual disability exists when these impairments restrict personal freedom [5].

Description and classification of visual impairment

The International Classification of Impairment, Disabilities, and Handicaps (ICIDH) system is used to classify disorders (diseases), impairments, disabilities, and handicaps by World Health Organization (WHO).

A condition that describes as or could describe serious harm to people is known as disease. It is also a medical condition or illness.

Any type of irregularity or loss in a psychological or anatomical or a physiological function is known as impairment.

A lack of ability or limitation to do work in the normal range or manner that considered to be a normal human being is known as a disability.

A person's underprivileged situation in culture as the result of impairments or disabilities is known as a handicap [6].

The functional restriction of a visual system [5] or eyes due to a disease or disorder in the result of a visual handicap or a visual disability is referred to like the term "visual impairment". For example, reduce visual acuity can be a reason for macular degeneration. Worldwide the categories of visual impairment are different [7]. The classification of levels for visual impairment is based on visual field limitation or visual acuity according to WHO [4].

The World Health Organization uses the following classifications of visual impairment:

- **Near-normal vision:** 20/30 to 20/60 is considered mild vision loss.
- **Moderate low vision:** 20/70 to 20/160 is considered moderate visual impairment.
- **Severe low vision:** 20/200 to 20/400 is considered severe visual impairment. In the United States, a person with 20/200 in the BETTER eye is considered legally blind.
- **Profound low vision:** 20/500 to 20/1,000 is considered profound visual impairment.
- **Near-total blindness:** less than 20/1,000 is considered near-total visual impairment.
- **Total blindness:** no light perception is considered total visual impairment.

Mobile devices

Mobile phones are the devices that used as a part of daily life, but sometimes the usage is so much tricky. If take a simple view of the previous era, featured mobile phone was introduced at the end of the 90s. They had many new features like mobile games, wallpaper, ringtones that are customizable and mobile cameras. In the year 2002, the era of smartphones started. They included all the previous era phone's features. The only changes was having a bigger screen size. In the year 2007, the most recent era starts when the iPhone launched by Apple. The multitouch simple display was introduced with mobile interaction. The Android operating system was introduced as a competitor to the iPhone a couple of years later. These mobile phones have many cost-effective technologies for visually impaired people. These mobile phones were used frequently for visually impaired people and suitable software is needed for them.

In order to improve the quality of life of VIP, these mobile devices can play an important role. These mobile devices make easier the performance of tasks for VIP like indoor and outdoor moving [13-15] object recognization [16,17] understanding the text documents structure [10], product identifications [12] and communication through the social network [11]. In these mobile devices, there are many accessibility tools available to interaction with VIP. These tools are a magnifying glass, high contrast screens, and screen readers [18]. Magnifier magnifies the graphical components of a mobile screen, the color of user interface elements reverses with higher contrast, and the auditory response of interface focused elements is provided by a screen reader. There are some problems that create difficulties for VIP when they interact with mobile applications such as restriction of accessibility tools [18,20] these devices are with high prices [19], with touch screen devices there is a lack of physical buttons [20]. The accessibility problems are remains even with an adaptation of device software. These problems include a keyboard with small keys for text entry [21] and in modern smartphones nonappearance of screen reader [23]. In touch screen mobile phones there are many other problems that create the difficulties for VIP like non-touch- sensitive edges of a mobile screen [22]. In order to interact with a touch gesture, there is a need for training [23]. The aim of this paper is to point out the accessibility problems faced by VIP during using mobile applications. These problems have described with the help of VIP and observation during their task completion.

The remaining part of this paper is organized as follows: Section 4 describes the background and literature review. Section 5 describes the methodology of the experiment. The results of experiments are discussed in Section 6. Problem Facing by VIP during using the mobile phone applications in Section 7. The conclusion and feature direction are described in Section 8.

Background and Literature Review

In this paper accessibility of daily task through mobile applications by VIP have focused. The directional control components and physical keyboards found in the mobile devices of previous generations. These tools allowed the VIP to use the system in order to get haptic feedback. Thinyane and Thinyane [25], Strumillo., *et al*. [24] and Kane., *et al*. [26] described tools that were provided as a subordinate for VIP to use the mobile applications. They did not give enough sufficient resources to use these mobile applications. The drawbacks of these tools have been conveyed in the recent few years and try to develop their alternatives. For VIP, there were developed particular menus and many different types of text inputs. In order to improve text entry for VIP NavTap is introduced. This technique provides the VIP to enter the text with the help of a device's directional controls [27].

The physical elements like direction control and keyboards have vanished with the arrival of touchscreen technology. The interaction and accessibility of mobile applications with VIP led to reduced, due to the nature of a new form of mobiles. There are non-touch-sensitive edges of a screen, lack of physical buttons and problems in software like need help form a virtual keyboard text input, touches and gestures are difficult to identify [28].

In order to improve the tactile response of graphical components in these devices, different solutions have been studies. NoLook Notes is another example of text entry in which on small screen size, a group of characters in a menu can make easier the use of a virtual keyboard [29].

Kane., *et al*. [30] described that when they compared the normal person performance with VIP in order to use a gesture. They found very much difference in both of them. The touch gesture of VIP take extensive time, take up more area on the screen, and focus on the corners. Some suggestions have proposed using other forms of interaction in some studies like a gyroscope and movement gesture [31,32].

The use of modern mobile applications are feasible for VIP nowadays because of many accessible tools are available like a magnifier, contrast control, voice commands, and screen reader. Kane., *et al*. [30] described that VIP has frustrated by the use of mobile applications due to the tactile response form mobile phone applications and the deficiency of physical buttons [28] and gesture acting with special characteristics.

Methodology

The problems of VIP during interaction with mobile phone applications were identified with the help of observation and usability during their works. In this paper, a focus was on the usage of mobile applications by VIP. The evaluation of usability and accessibility problems identification of VIP was done with the help of different tasks.

Participants

In this experiment, there were a total of 10 VIP participated. There are 7 males and 3 females with 33.5 years of average age. All the participants more than one and years of experience using smart mobile phones. The participants have a different type of visual impairment. The standard of visual impairment was according to World Health Organization (WHO). The education level of five participants was higher than secondary, three participants passed middle school, and two participants passed primary. The introductory guideline of the tasks was introduced with all participants.

Task design

The latest technology smartphones are used for this experiment. In order to fulfill the tasks, the interactive mobile interface was provided. The experimental stimulus was an android smartphone having multiple functions and a 5.5-inch screen. Every participant performed six tasks on the provided mobile phones. Task 1. switch the power on Task 2. adding the contact Task 3. text message sending Task 4. media playing Task 5. text message-deleting Task 6. doing/ending a call.

The screenplay was demonstrated for each task. In order to complete the task five minutes was given to complete each task. In order to determine the accessibility and problem of VIP during using mobile applications, all participants completed all the tasks. On the completion of each task, an assessment of a task's success and failure was noted. For each task, a success rate was calculated across all participants.

Results and Discussion

The measurement of Task Completed % depends on the task fulfilled by the participants. This measurement is based on simple binary values if a task is completed successfully its value is 1 otherwise the value is 0. The task completed % is shown in figure 1.

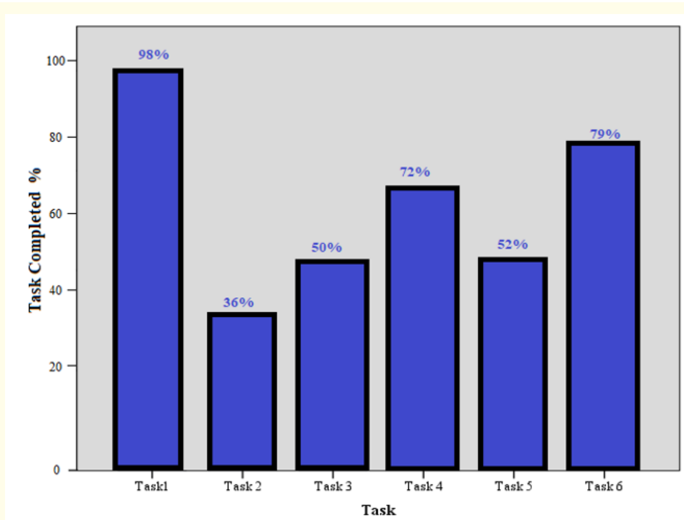

Figure 1: *Task Completion % by VIP.*
Task 1: switch the power on Task 2: adding the contact Task 3: text message sending Task 4: media playing Task 5: text message-deleting Task 6: doing/ending a call.

The results show for Task 1 the completion rate is 98%. In Task 2 the completion rate is 36%. In Task 3 the completion rate is 50%. In Task 4 the completion rate is 72%. In Task 5 the completion rate is 52% and in Task 6 the completion rate is 79%. One of the highest-rated tasks is Task 1 every participant done this easily, due to the task is related to switch the power on of mobile phone, every participant finds the physical power button. On the other side, the lowest-rated task is Task 2. In this participant has faced many difficulties due to entering the data form soft keyboard. Most of the participants used the voice tactile but they also have difficulties in adding the contact. In Task 3 almost half of participant completed this task. One thing is observed in this task that the participants who have used the voice input method easily done this task. In Task 4 some participants have faced difficulties in searching the specific media type. In Task 5 mostly participants have done this easily but some participants did not find the inbox icon form menu bar and they took advise from researcher. In Task 6 some participants use voice communication to perform this, and some have faced difficulties in dialing numbers due to soft keys.

The problems have been indicated in pressing some particular softkeys. In smart mobile phones, there are multiple characters are represented by a single key. It needs to press that key many time to enter the required character. This makes the typing speed slow [23,32]. Sometimes it is required to see the character before entering, it takes time and reducing the speed [31].

Problem facing by VIP during using the mobile phone applications

1. There is a restriction of communication because of the small size of physical buttons
2. On the softkey board, an excessive quantity of keys produced the restriction of interaction.
3. There is a minimum tactile sensitivity of virtual buttons.
4. In virtual QWERTY keyboards slow in the input of text
5. There is a restriction of interaction in the virtual keyboard due to its concentration of keys.
6. Every character typed from a virtual keyboard there is a need to confirm it.
7. In screen reader there is a problem for VIP due it is linear in nature, it takes time to make the whole perception of the interface.
8. In screen reader, there is difficulty in listening to the words due to ascent of speaking.
9. Voice in screen reader is artificial.
10. The slow output of the screen reader.
11. The dimension of a touch-sensitive edge is wide.
12. In screen edges, there are no tactile distinctions.
13. There is a difficulty for VIP to search out the elements due to a large screen size.
14. Due to a lack of user feedback different forms of vibrations are difficult to recognize.
15. In noisy surroundings, it is difficult to recognize auditory feedback.
16. The auditory feedback is not enough for VIP.
17. Inactivating the voice commands there is a difficulty for VIP.
18. There is no privacy when VIP using the voice commands.
19. The recognization performance of voice command is decreased in noisy surroundings.

Conclusion and Future Work

This paper follows through a procedure during the evaluation of tasks but still, there are some limitations. In this study focus only on problems facing by VIP during using mobile applications. In this study, the data of participants background information such as their history, the cause of visual impairment does not include. In this paper, there is no specific visual impairment is discussed. The task evaluation in this paper did not consider the effects of diverse environments, due to this testing conducted in the lab environment. In the usage of smartphones, the situational effects like walking, time effects, and crowded spaces can greatly influence the ability of visually impaired people.

VIP has their own unique experience of interaction when they are using mobile applications. That experience creates a huge distance between the need for VIP and the creative ideas of mobile application designers. In developing the new mobile application for VIP, this distance has a challenge for all mobile application developers. If VIP considered a part of mobile application development then maybe we can overcome this distance. This paper analyzed the problems and interactions of VIP with the different tasks of mobile applications. The problems and expectations of users were also investigated regarding tasks on touchscreen-based mobile phones. The results of this study will also help and facilitate the touchscreen- based mobile phone application developers for VIP. The future work will focus on improving the current mobile application for VIP and need to define a user-centric standardization of mobile application for VIP.

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