ASSISTIVE INTERFACE FOR PEOPLE WITH VISUAL IMPAIRMENTS

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Abstract

Although technology is rapidly developing, mobile applications are difficult to use for visually impaired people. The potential of technology to give invaluable support for people with visual impairments remains unexplored especially accessing the advanced functions of a smart phone is not a trivial task for them. Currently, visually impaired users rely on screen readers and voice commands to discover and execute functions on smartphones. Despite its common use, screen readers are not convenient in public places because of continuous read out functions. Also, voice commands are difficult for a system to recognize in noisy environments. Therefore, visually impaired people are unable to fully access advanced smartphone functions until now. In this paper, to increase the accessible rate, marking menu is implemented as an assistive interface for visually impaired people.

Keywords: Visual Impairments, Assistive Interface, Marking Menus

Introduction

According to the statistics, the population of blind people is increasing around the world. This population encounter difficulties for safe and independent mobility. Furthermore, they face more problems related to communication and access to information. Nowadays, there are a variety of assistive technologies helping to reduce many of these barriers. The use of technology for tasks such as reading, writing, communicating, navigating, and searching for information would enable blind people to perform a wide range of activities independently.

However, disabled population continue to face barriers in many situations. Specifically, modern devices such as smartphones that require visual clues presents challenges for people with visual impairments to access the advanced functions in it. Because of these challenges, persons with visual impairments can't get fully access and difficult to use touch screen.

In this research, a survey was conducted with thirty participants at Kyi-Myin-Daing and Kha-Wae-Chan Blind Schools. They all used smart phones for call. Thirteen people used for social media (facebook, viber, messenger, youtube etc) and fourteen people used map application to navigate their way. They give comments and several feedbacks on using smart phone. Motivated by user comments and available technologies, we developed marking menus that can provide eye-free access. This assistive interface will provide users to access smartphones' functionality easily. After developing the system, we conducted a preliminary study with users.

The following sections will present the literature reviews, usability studies, discussion of design guidelines drawn from user feedback during the user studies, and conclusion.

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Assistive Interfaces for People with Visual Impairments

There may be several different ways of using the device to perform an interaction task. An interaction technique is a way of using a physical device to perform an interaction task. Assistive interfaces for people with visual impairments based on two main aspects: (1) inputs, and (2) outputs.

Inputs

- **Hands**

Hand gestures on surface screens are a way of common today interaction. Surface gestures were used as input in tactile graphs, media player and other touchscreen devices. Especially modern devices nowadays mostly rely on hand gestures performed on touchscreens. The use of hand gestures for eyes-free input on a mobile touch screen was demonstrated by some researchers (Kane et al. 2008).

- **Body movements**

Hand position, foot position, head position, and even the direction of gaze of the eyes are also usable as computer inputs. Another way of interaction is motion gestures where users interact with a device, in 3D space by translating or rotating the device, or by moving the body parts without holding any devices. Bauer et al. (2013) implemented motion gestures for menu selections on large wall-mounted displays.

- **Voice**

Another natural way of interaction is speech that can be used with unrecognized speech discrete word recognition, or continuous speech recognition. Even if the computer could recognize all the user's words in continuous speech, the problem of understanding natural language is a significant and unsolved one.

- **Braille**

Braille inputs are where users perform inputs to systems using braille tactile buttons. Braille was the primary assistive input technique for blind people before (Caleb et al. 2012).

Outputs

Output modalities are classified into four categories.

- **Braille displays**

Braille displays are where system responds are displayed through tactile braille.

- **Sound**

Sound outputs are where the system responds to users through non-verbal sounds such as beeps.

- **Speech**

Speech outputs are where users receive system responses through verbal speech Vibration outputs are where users receive system response through vibrations which encode information in different patterns.

- **Vibration**

Vibration is a non-intrusive eyes-free output. They are used to convey a variety of information to users non-visually. Various information can be encoded in different temporal and spatial patterns of vibration.

Current technologies and interfaces are limitedly accessible and less engaging to visually impaired users. This is due to the need of better understanding of users, which will guide to designing and developing more efficient and engaging technologies for them. In another word, not a single existing interface can work perfect for this group of users in all situations. There is a pressing need of supplement or alternative interaction technique to make technologies more accessible to them. This research will propose new interaction technique for visually impaired users which are based on close studies and understanding users.

Survey Development

Preliminary Interview

We developed the survey to explore the current use of mobile devices and apps for people with visual impairments, as well as their perceptions of the apps. The survey consisted of information (such as age, gender, education and occupation), use of mobile devices and apps in general (device type, years of using a mobile device, the number of apps downloaded in a month, apps in use, frequently used apps, and usability and accessibility of apps), and use of apps specifically designed for people who are visually impaired (usability, accessibility). Based on their feedback, survey items were revised for clarity and accessibility. The survey took no more than fifteen minutes to complete. The participants' responses to survey items were saved and analyzed by Microsoft spreadsheet.

Formative Interview

In order to identify usability issues with mobile devices and touch screens, we conducted formative interviews with thirty blind mobile device users from Kyi-Myin-Daing and Kha-Wae-Chan Blind School. Studies have been conducted with persons with visual impairments for smart phone usage. Questionnaires were used to examine how smart phones play a role in their daily lives and how they can get benefits or assist from them and how they face difficulties in using smartphones. The participants strongly agreed that they need smart phone to assist them in their daily lives. They all use smartphones' technology to contact people, send message and use entertainments. The usage of smart phone for people with visual impairments is shown in Figure1.

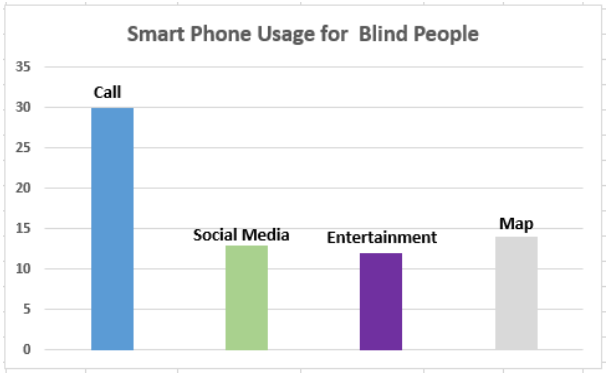

Figure 1 Survey for Smart Phone's Usability for Blind People

But, they are less accessible than enabled people. They have problems to use smartphones in public places because of screen reading functions and also the reader doesn't also recognize in public places. So, they can't use smartphone effectively and efficiently as shown in Figure 2.

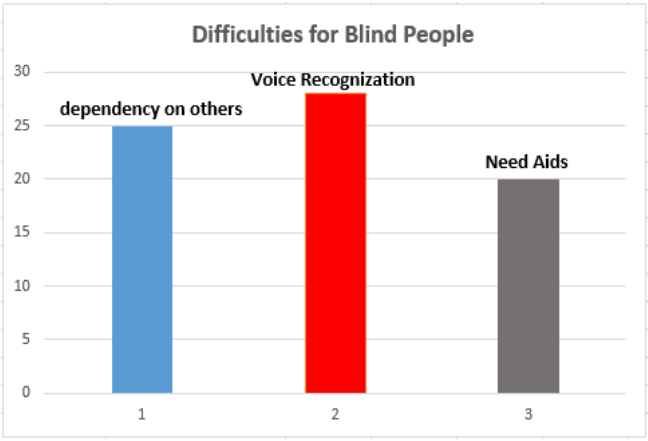

Figure 2 Survey for Difficulties for Smart Phone's for Blind People

Based on the user comments and qualitative analyses, we will provide design implications and guidelines for development of assistive interface for people with visual impairments.

Menu System

A menu is a list of options or commands presented to the user of a computer or mobile phone or communication system. A user chooses an option from a menu by using an input device. Some of the input devices used in the menu interfaces are touchscreens, keyboards, mice, remote controls, and microphones. In a voice-activated system, such as interactive voice response, a microphone sends a recording of the user's voice to a speech recognition system, which translates it to a command. Menus are used extensively in human computer interfaces. They provide critical information on what commands are available and a way to invoke commands.

Marking Menu Method

A marking menu is an interaction technique that allows a user to select from a menu of items. It supports to make interactions more efficient and easier to learn. There are two basic ways (or modes) in which a selection can be performed:

Menu mode In this mode a user makes a selection by displaying a menu. A user enters this mode by pressing the pen against the display. A menu of items is then displayed centered around the pen tip. A user can select a menu item by moving the pen tip into the sector of the desired item. The selected item is highlighted and the selection is confirmed when the pen is lifted from the display. (See Figure 2.1)

Mark mode In this mode, a user makes a selection by drawing a mark. A user enters this mode by pressing the pen against the display and immediately moving in the direction of the desired menu item. Rather than displaying a menu, the system draws an ink-trail following the pen tip. When the pen is lifted, the item that corresponds to the direction of movement is selected. (See Figure 3)

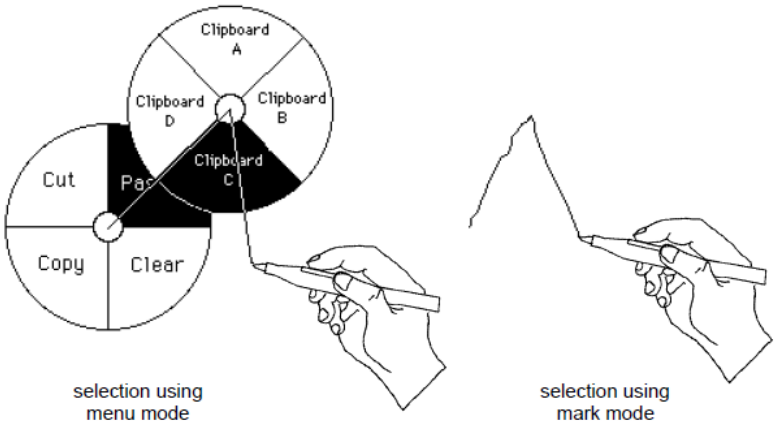

Figure 3 The two basic ways of selecting from a marking menu.

Advantages of Marking Menu

Marking menu support advantages over the traditional menus. With these types of menus, selection is performed by popping up the menu and selecting items by pointing with the mouse. Menu items can also be selected by pressing an accelerator key associated with a menu item. There are several specific advantages marking menus have over these traditional menus:

Keyboard less acceleration

Marking menus allow menu selection acceleration without a keyboard. With traditional linear menus, key presses must be used to accelerate selection. Marking menus provide a method of accelerating menu selections when no keyboard is available. With marking menu, the selection of all items can be accelerated by the user marking a mark.

Ease of drawing

Marking menus use a very simple set of marks consisting of straight and zig-zag marks. Marks are easy and fast to draw and are therefore suitable for accelerated performance. Ease of drawing is especially important when drawing precision is hampered by imperfect pen/display technology.

Eyes-free selection

Selection by a distinct physical movement with a marking menu lends itself to "eyes-free" selection. For example, we can draw the directions of a desired items without looking. Eyes-free selection is useful in situations where a user's visual attention must be on something other than the selection process. An eyes-free selection technique is also extremely valuable to the visually impaired.

Marking Menu Design

In our research, the following making menu was implemented on android OS by understanding the analysis of the user survey as shown in Figure 4. We will conduct the experiment on later.

Figure 4 Marking Menu Layout based on User Survey

Results and Discussion

Thirty participants from Kyi-Myin-Daing and Kha-Wae-Chan Blind School are included to complete the survey. According to the survey results, our findings are that all participants are currently using smart phone. They all use smartphones' technology to contact people and use social media and entertainment. But they have problems to use smartphones in public places because of continuous screen reading functions. We have to provide making menu as an effective input technique to carry out their desire work. Our major finding that voice recognition is needed to use smartphone more effectively and efficiently. But this system can't work exactly in public places because of the noise.

Therefore, we developed a making menu as an effective input based on user centered approach to get fully access and make their desire thing effectively and efficiently. After the system was implemented, we conducted a preliminary study to investigate the usability of our system with five blind-folded users. The purpose of the study was to validate the performance of our proposed system in terms of errors and task completion time. Results from the preliminary study indicates that marking menus were desirable eyes-free menus on smartphones with error rates less than 4% and approximate task completion time of 077 second.

Conclusions

The number of all ages with visual impairments has been increasing throughout the world. They face several challenges in their daily lives. Nowadays, mobile devices are widely used by people with disabilities. They cannot benefit from these devices e.g. current smart phone with rich functions. To satisfy their lives and productive livings assistive interfaces or technologies are needed to provide people with visual impairments (blind or low vision).So, assistive interfaces are need to provide their satisfactory and productive livings. They complained that screen reading function is not convenient in public places. Therefore, we proposed marking menus as effective input methods for blind people. Our finding confirms that marking menus are promising assistive interface for people with visual impairments.

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