Mobile Braille Touch : Improving The Accessibility Of Touchscreen-Based Mobile Devices For The Visually Impaired Person As One Of Learning Media

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***Abstract*— Mobile Braille Touch (MBT) is an eyes-free text touch screen entry based application for mobile devices. The emergence of touch screen devices poses a new set of challenges regarding text-entry. Now a days touch screen mobiles are becoming more popular amongst sighted as well visually impaired people due to its simple interface and efficient interaction techniques. Most of the touch screen devices designed for visually impaired users based on screen readers, haptic and different user interface (UI). We present the Mobile Braille Touch, a text-entry method based on the Braille alphabet with an accessible keyboard for blind users on touchscreen smartphones as tools of learning media to improve their capability on Braille alphabet. Based on the standard Perkins Braille, the MBT implement a six-key chorded braille soft keyboard, with the specifications ; 1) Braille touch on a smartphone; 2) a soft braille keyboard on a touchscreen tablet; and 3) a commercial braille keyboard with physical keys. In this research we overview the MBT learning media that consist of six-part module based on braille chorded input. Our proposed framework is built on several previous works carried out for develop mobile touchscreen for the visually impaired, with four parameters of measurement including : speed of braille text entry, depth error analysis, and the lesson and learned for the design of learning media, and evaluation of accessible of eyes-free soft keyboards.**

Keywords*— *component; Mobile Braille Touch, Soft keyboard, User Interface

I. Introduction

Touchscreen intended for the operation of graphical user interfaces are increasingly common in mobile devices and computers both used privately and made available to the public. Such solutions are hardly accessible to the blind: it is difficult for them to locate and select items visualized on the screen. [7]. As mobile touch screen devices become increasingly ubiquitous, they are also becoming more accessible to people with visual impairments. Both Apple and Google have developed screen readers that are pre-installed on their devices, but Apple's iPhone seems to be the most popular touch screen phone among blind people. The iPhone is the only touch screen phone recommended by the National Federation of the Blind (NFB) [9], the American Foundation for the Blind [1], and the Royal National Institute of Blind People [13]. Meanwhile, Android's accessibility features require a complex setup process [1].

Although advancements in touch screen accessibility have been made, the fundamental task of text entry remains slow and error prone. Much work has recently arisen in this area
[3][4][10][11][12], highlighting the compelling need for a better input method. Bonner et al. [3] found that the mean text entry rate on an iPhone with VoiceOver was only 0.66 words per minute (WPM) and Oliveira et al. [11] [12] report a mean speed of 2.1WPM with a VoiceOver-like input method. Clearly, a better text entry method is needed for blind and eyes-free text input.

While Voice Over interaction involves selection of virtual keys, we propose a novel multi-touch technique based on signal detection theory called Input Finger Detection (IFD). In this technique, a signal is input by touching the screen with several fingers where each finger represents one bit, either touching the screen or not. A user sets reference points anywhere on the screen at any time to indicate initial finger positions, and we use maximum likelihood to decide which fingers were used to input the touch points based on the reference points. We then track the reference points to ensure they accurately represent the "true" locations of the fingers. Using IFD, we developed Perkinput, a nonvisual text entry method that uses the 6-bit Braille character encoding. To enter a character with two hands, a user taps the screen with up to 3 fingers from each hand. The fingers contacting the screen correspond to dots in the Braille character. When using one hand, a user enters 3 bits of a character at a time, performing multi point touches to enter one character.

In this paper, we proposed Mobile Braille Touch : Improving The Accessibility Of Touchscreen-Based Mobile Devices For The Visually Impaired Person As One Of Learning Media. With the proposed system, present the Mobile Braille Touch, a text-entry method based on the Braille alphabet with an accessible keyboard for blind users on touchscreen smartphones as tools of learning media to improve their capability on Braille alphabet. Based on the standard Perkins Braille, the MBT implement a six-key chorded braille soft keyboard, with the specifications ; 1) Braille touch on a smartphone; 2) a soft braille keyboard on a touchscreen tablet; and 3) a commercial braille keyboard with physical keys. In this research we overview the MBT learning media that consist of six-part module based on braille chorded input.

II. Related Work

Generally touchscreen has two main attributes: first, one directly interacts with what is displayed on screen, rather than using mouse or touchpad; secondly, that does not require any intermediate device that would need to be held in hand (other than stylus). On the other side vision impairment is a term experts use to describe any kind of **vision** loss, whether it's someone who cannot see at all or someone who has partial vision loss. Some people are completely blind, but many others have what's called legal blindness (kidshealth.org).

Several research related with touchscreen mobile devices for the visual impaired users. **Telephone Keypad Based** : *Guerreiro et al.* [5] using 1) Twelve medium size buttons representing set of character 2) Split or double tap used to enter character. 3) Offers a more direct mapping between input and desired output. *Aakar Gupta and Navkar Samdaria* [6] with feature 1) Vibrotactile technique is used. 2) Swipe, pause, circle, hand -waving, audio and vibrotactile feedback is used. 3) Increases speed and accuracy.

Stroke Based Keypad : *Goldberg and Richardson* [2] using 1) Unistrokes alphabets are entered with stylus. 2) strokes are simple. 3) Provide audio feedback. *Tinwala and Mackenzi* [14], with 1) Graffiti strokes are entered by stylus. 2) Strokes are for number, punctuations, symbolic characters and mode switches. 3) Feedbacks are given by speech, sounds and vibrations.

Qwerty Keypad : *Kane et al.* [8], 1) Vision less keypad 2) Designed specifically for list-based application like music player and phonebook. 3) Use four basic gesture interactions for navigating and selecting characters. *Apple co. ltd.* using 1) Screen displays QWERTY keyboard layout 2) Offer a function to correct an error. 3) Give audio output. 4) Speed can be adjusted depending upon preference. 5) Offers a more direct mapping between input and desired output. Olieria et al [12] and Azenkot et al.[2], 1) Provide soft QWERTY keyboard. 2) Use split-tap interaction.

Braille based keypad, *joao oilveria* [2], 1) screen displays 6 dots as braille cells. 2) double tap is used to accept braille character. 3) audio feedback is given , 1) provide soft qwerty keyboard. 2) use split-tap interaction. Here *Anik Nur Handayani et all (2015),* we proposed to develop soft braille type with 1) virtual Braille keypad divided as 3x2 biner matriks, and 2) using narator as audio feedback to assist the process.

III. Proposed System

Generally touchscreen has two main attributes: first, one directly interacts with what is displayed on screen, rather than using mouse or touchpad; secondly, that does not require any intermediate device that would need to be held in hand (other than stylus).

1) Single-touch based strategies:

Basic touch screen functionality is single-touch, where you touch the screen like mouse moving around the screen and „tap" the screen like a mouse click. In this strategy a finger or any pointing device (gesture) is used to enter the text

2) Multi touch-based strategies:

Multi-touch refers to ability of touch sensing surface to recognize the presence of two or more points of contacts on the surface. This dual point awareness is used for pinch to zoom or activating predefined programs.

Problems faced by vision impaired in size which causes inconvenience in handling the device and some have too small to select only one letter at a time.

- ***Button size***: Some devices have too small buttons that either do not click when pressed or adjacent other button is clicked. Thus provide wrong feedback.
- ***Keypad layouts***: Every device provides different layouts of keypads. Novice users have to spend more time on learning and being familiar to it.
- ***Menus***: Large number of menus causes difficulties in understanding and selecting.
- ***Text size***: Small text size is unable to read.
- ***Feedback***: Some sound and tactile feedbacks are not clear to easily understand.
- ***Text entry rate***: Low text entry rate causes obstacles in fast typing and response.
- ***Time Delay***: Some approaches have more time laps between key touch and recognition which causes irritation and unwanted time loss of expert users.
- ***Cost****:* Disabled users either have to purchase mobile devices developed or them or have to download various application required making the device accessible by paying large mount. Every user can not afford it.

In this research we overview the MBT learning media that consist of six-part module based on braille chorded input. Our proposed framework is built on several previous works carried out for develop mobile touchscreen for the visually impaired, with four parameters of measurement including : speed of braille text entry, depth error analysis, and the lesson and learned for the design of learning media, and evaluation of accessible of eyes-free soft keyboards. Fig. 1 expressing the MBT learning media.

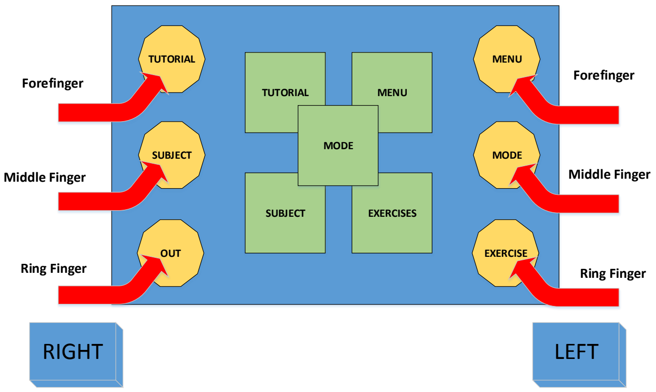
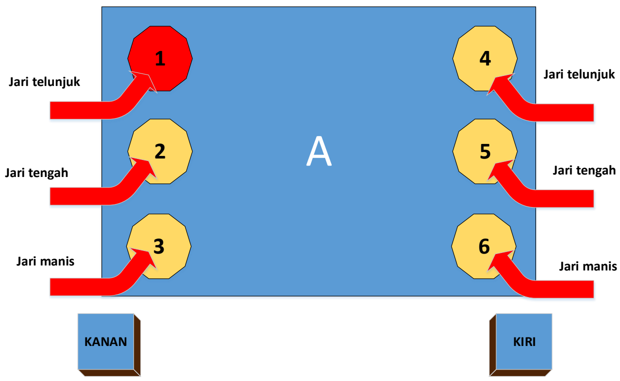


Fig. 1. Diagram Block of MBT



(a) MBT Interfacing with User

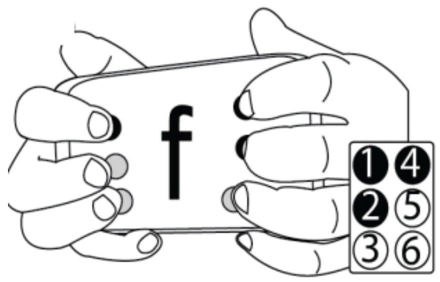


Fig. 2. (b) MBT Interfacing Illustration

Here we using,

a. For the button size, Iphone Human Interface Guidelines using 11 mm for the length and wide. Windows Phone UI design, 9 mm for the length and 7 mm for the wide. Nokia's developer source used 8x8 mm, and MIT Touch Lab.Study using 10 -14 mm for the button size. Here is we using MIT Touch Lab. Study for the our button size.

b. Virtual Braille keypad divided as 3x2 biner matriks as keypad layouts.

c. There fifth part of the menu, tutorial menu contains narrator voice in guiding the use of MBT. Material unit, combining letter, word, sentences and numeral based Braille input. Assist unit, contains series explanation and the buttons of soft keypad.
   Mode unit, consisting of two modes. Splash screen and check user. And packet unit for the assessment unit.

d. Text size, we using it to somewhere between 18-24pt. To reduce small text that unable to read.

e. We using Annotators for the tactile feedback

III. EXPERIMENT

According to the method described above and the structure of the mobile braille touch, we build an implementation and experimental system.

A. *Text Entry Evaluation*

1) The analysis of keypad design can be performed by measuring the metrics of text entry and effectiveness of keypad layout. A. Text Entry Metrics For evaluation of text entry two metrics are used. These are Speed and Accuracy [15].

a) Speed

Text entry speed is number of characters entered per second. To calculate speed in Word Per Minute (WPM) following formula is used:

$$\frac{(Transcribed\ text\ -\ 1) * (60seconds\ time\ in\ seconds)}{5\ characters\ per\ word} \quad (1)$$

b) Accuracy

Accuracy of text entry depends on number of error occurred during entering text. There are two method used to analyse text entry error: MSD error rate and KSPC.

c) a) MSD error rate

The Minimum String Distance (MSD) between the strings is number of primitives (insertion, deletion or substitution) to transfer one string to other . It is calculated by,

$$MSDerrorrate = \frac{MSD\ (P,T)}{Max\ |P|,|T|} * 100 \quad (2)$$

Where P and T are the presented and transcribed text strings, and the vertical bars | | represent the length of the strings.

d) Key Stroke Per Character (KSPC)

There are two classes of errors:

1. those are not corrected, and
2. those are corrected. MSD error rate measures not corrected error. To measure corrected error KSPC is used. KSPC is calculated as:

$$KSPC = \frac{|Input\ Stream|}{|Transcribed\ Text|} \quad (3)$$

IV. Conclusions

In this research we overview the MBT learning media that consist of six-part module based on braille chorded input. Our proposed framework is built on several previous works carried out for develop mobile touchscreen for the visually impaired, with four parameters of measurement including : speed of braille text entry, depth error analysis, and the lesson and learned for the design of learning media, and evaluation of accessible of eyes-free soft keyboards.

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