Designing A Tactile Display for Braille and Non-Braille Users

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ABSTRACT

Research is ongoing for cost effective tactile readers which incorporate relative motion between the finger pad and the text. Here, a novel method of tactile sequential reading using the designed prototype reader is presented. The accuracy of reading words using this prototype was evaluated with 17 visually challenged users who know braille. The results showed no significant difference in accuracy when reading words using this prototype compared to braille reading on paper. After incorporating a slight modification in the design to benefit non-braille users, 10 blind-folded sighted individuals and 12 late-blind visually challenged users were also evaluated in reading words using the prototype. Overall, a good accuracy rate in reading words for the 39 users (98.62 % for blind braille readers, 90 % for blindfolded sighted users and 96.8 % for blind non-braille users) was obtained. These results form the basis in the development of a cost-effective tactile reader which can potentially benefit both groups of visually challenged users- those who know braille and those who do not. This work has been published in the journal Technology and Disability[1].

Keywords: Braille users, non-braille users, tactile reading

1 INTRODUCTION

A visually impaired user can read material from a PC using a refreshable braille display (RBD) that actuates dots of braille which can then be felt by the user. The main drawback of refreshable braille displays is the high cost particularly due to the large number of actuators needed to display text to the user. Researchers look to decreasing the price of braille displays by limiting the number of cells presented to the user. Prior literature has shown that the pressing of pins up and down into the finger pad cause numbness due to the adaptation of mechanoreceptors further leading to inaccuracies in reading [1]. An effective tactile display will allow sliding movements between the reading finger and displayed text similar to the movement of a reading finger over paper braille [2]. It must also be noted that there is a diversity amongst those who are visually impaired. Based on whether they have had visual experience, they can be classified into early-blind or late-blind. It is seen that individuals who are late-blind have a difficulty in learning braille and therefore many of them do not learn braille at all but rely on screen readers or family to read out text to them [3]. The prototype has been designed to serve three purposes- to decrease the cost of tactile displays, to incorporate sliding movement between the text and the reading fingers and thirdly, to be usable by those who do not know braille.

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2 2. METHODOLOGY

The prototype consists mainly of two parts-an embossed disc placed on the shaft of a stepper motor and the associated electronics housed in an enclosure as seen in Fig.1. The discs are detachable and embossed with 12 braille (Fig.2.) or raised print characters (Fig.3.) at every 28.8º depending on whether the user requires braille or not. The stepper motor allows precise positioning of the tactile cell beneath the users' finger pad. The speed of the stepper motor is 150 rpm and at this speed it takes 400msec to display a character separated by 360º. Embossed characters that are less than 360º apart can be displayed faster. Therefore, this design introduces varying refresh rates of character presentation to the user based on the position of the embossed character to be read. Words formed by 2,3,4 and 5 letters were presented to the user to be read within a timeframe of 1 minute. Similar words were embossed in braille on paper and this was used as a standard of comparison when reading on the prototype by 17 users who were visually challenged and who knew braille.

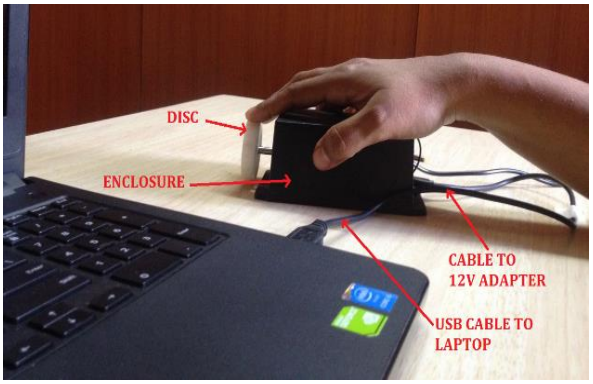

Fig. 1. Prototype

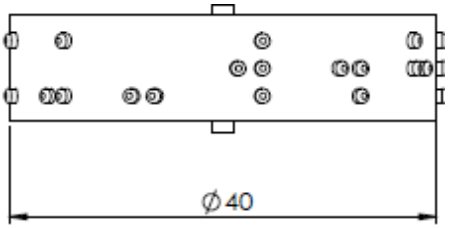

Fig.2. Embossed braille disc

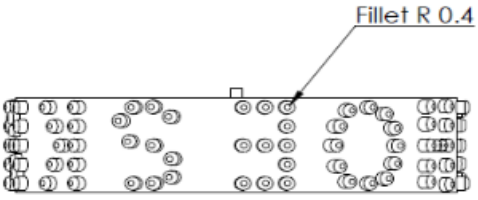

Fig.3. Embossed print disc

3 RESULTS

The mean accuracy of reading simple words was found to be 98.62%(SD=3.84) with 17 visually challenged users (who know braille). A statistical analysis of the results for visually challenged braille participants using a t-test between accuracy with the prototype and on paper braille showed no significant difference (p= 0.092) indicating similar accuracy in reading words using paper braille and the prototype.

An accuracy of 96.6% (SD= 6.8) with 12 non- braille visually challenged users and 90% (SD=13.96) for 10 blind folded sighted users. Blind folded sighted participants using the printed disc could read at a speed of 6-7 wpm with a training session of about 30 minutes. These results are encouraging in comparison to the results

obtained in [4] where blindfolded sighted users after 9 months of training read braille at the rate of 6-7 WPM. It is reasonable to infer that the memory of the shapes of the letters have contributed to the reduction in training time needed to read tactually.

4 CONCLUSION

The results with the prototype show that it is a viable method of reading for early blind users who know braille and late blind users who do not know braille. The study here explored whether reading words with letters presented at varying refresh rates was possible. The study also explored whether the passage of non sensical characters beneath the user's finger pad would hinder reading. The results obtained indicate viability of the design as both the features were not a hindrance in reading. In this phase of development, the cost of making this prototype is Rs 4700. The cost of making each 3D printed disc is Rs 916. The prototype needs to be developed further to include all the characters of the alphabet in braille and in the print alphabet and be further customized to benefit the users.

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