Deshi: A Shape-Changing Haptic Interface that Provides Cursor Feedback for Low-Vision Computer Users

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I. Introduction

As the world become progressively digital, the ability to access online information and services becomes increasingly important for independent living. Vision-impaired people (VIPs) often use screen-reader software to navigate electronic documents and websites. Screen-reader software uses a computerized voice to sequentially read out the text of a website. To interact with the webpages, it is often still necessary to use a mouse/trackpad to control a cursor, whose position on the webpage can be difficult to interpret without vision. One popular screen-reader software, NVDA [1], represents cursor position via audio beeps. Meaning that both text and cursor position are delivered via the same sensory channel. Furthermore, a major frustration of screen reader users is a webpage's layout causing confusing feedback, given that 2D layouts are converted into 1D spoken text [2].

To better communicate spatial text layout and address audio overloading we have developed a new haptic device, Deshi (DEsktop SHape changing Interface). Shape-changing haptic interfaces are an emerging topic that have shown great promise in providing spatial guidance efficiently, with less cognitive loading, distraction and annoyance, compared to other stimuli [3]. Deshi is a mostly 3D printed cube-shape XY-stage, which rests on a desk and may be held in a user's non-dominant hand whenever they wish to know the cursor's position (while their dominant hand uses a mouse or trackpad). Deshi's dimensions are 66×66×54mm. It can move its 'crown' in X by 10.1mm and Y by 6.1mm (Fig 1).

II. Methods

11 sighted users (3 female, mean age 22.4) took part in a study where a mouse was used to locate and click on a series of square targets (90x70 pixels) on a computer screen (1920 × 1080 pixels), that was hidden from view. Error to the current target was either provided by the Deshi haptic device or audio feedback that emulated the NVDA method of continuous beeps, whose pitch related to vertical error while left-right headphone balance related to horizontal error [1].

III. Results

Fig 2 shows four cursor-to-target paths for the sound and haptic feedback conditions for participant 1. Sound feedback appeared to provide more straight paths in cardinal directions, as users focused on the decoupled X or Y audio feedback individually. Though boxplots show slightly inferior performance for audio feedback on distance and time, unpaired t-tests provided no significant differences between the modalities. Likert surveys described haptic feedback as less confusing, less mentally tiring, and less annoying compared to the audio feedback.

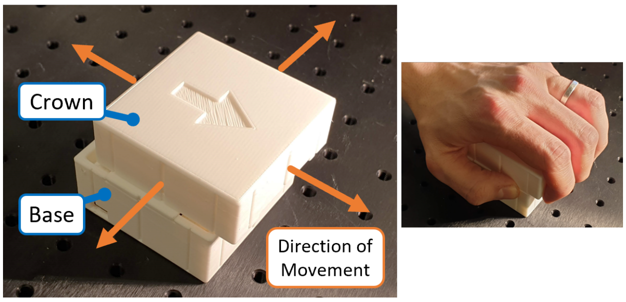

Figure 1: Deshi is a desktop shape-changing interface that resembles a cube. Deshi operates like an XY stage, with positive and negative linear motion of the crown two dimensions. The device is held by the user from above, with their non-dominant (non-mouse/trackpad) hand.

IV. Conclusions

Initial results show promise in user opinion of Deshi, but with scope for improving device performance prior to further tests, which are planned with vision-impaired individuals.

References

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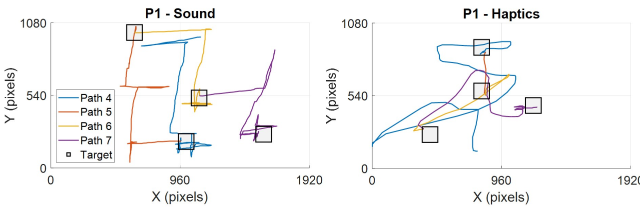

Figure 2: Four mouse paths between unseen targets taken by participant 1.

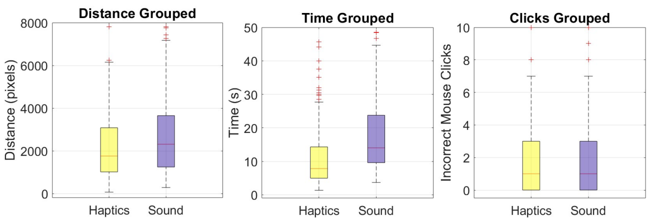

Figure 3: Distance, time and clicks results per target for all participants.

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