Comparing Skin-Stretch and Shape-Changing 2D Haptic Feedback

Hassaan-Ul Huda and Adam J. Spiers

I. Introduction

While haptic interface research has been largely dominated by force-feedback and vibrotactile interfaces, the lesser explored modalities of skin-stretch and shape-change have shown promising results via mechanotactile stimulation. Both interface methods have been shown as effective for communicating 2D spatial information [1], [2] but, to our knowledge, have never been empirically compared.

As various resources and social interactions progressively move to online platforms, we feel that ensuring better digital access for visually impaired people is of paramount importance. Vision-impaired people (VIPs) often use screen-reader software to navigate electronic documents and websites. Screen-readers use a computerized voice to sequentially read out the text of a website. We are currently investigating technologies for augmenting screen-reader audio feedback, by representing spatial cursor position via touch. This can hopefully alleviate a commonly reported problem of confusion due to a screen-reader's interpretation of 2D webpage layout into a 1D stream of spoken text [3].

Prior to screen-reader integration, we first wish to evaluate which haptic feedback modality would be most effective for communicating cursor position, initially via 2D psychophysical experiments. Skin stretch (SS) and shape-change (SC) have been selected as candidate interfaces due to their low distraction and cognitive loading effects compared to vibrotactile interfaces. Furthermore, these interfaces have significantly lower cost than force feedback systems. Due to a lack of commercial SS and SC devices, we have developed our own prototypes for comparative testing (Fig 1). The SS device is actuated by a five-bar linkage onto which a Lenovo 'Trackpoint' cap is mounted. Its workspace is a 2.5mm radius circle. The SC device (called Deshi) has dimensions of 66×66×54mm. It can move the 'crown' of its body in X by 10.1mm and Y by 6.1mm and is held from overhead.

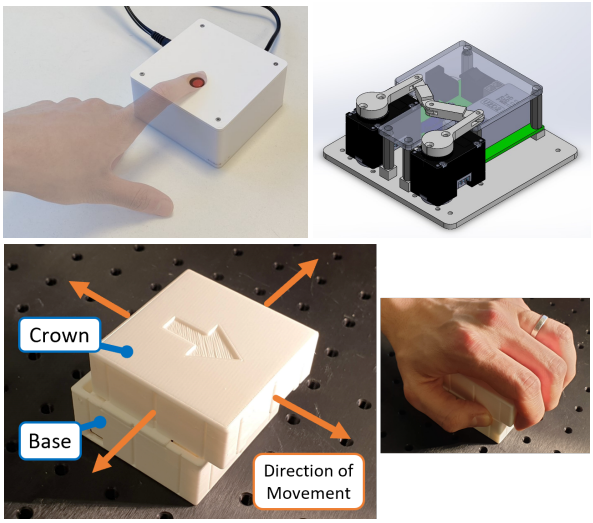

Figure 1: Our fingertip-skin stretch interface (top-left) achieves high precision and stiffness via the use of parrallel actuation (top-right). Our shape-changing interface, Deshi (bottom-left) acts like an XY stage and is gripped from aboe (bottom-right).

*Research supported by Imperial College London

All authors are with the Manipulation and Touch Lab, Dept. Electrical and Electronic Engineering, Imperial College London, London, SW7 2AZ, UK. Corresponding author e-mail: a.spiers@imperial.ac.uk

Table 1: Psychometric results

	JND	Weber Fraction
X-axis (both)	0.259	0.104
Y-axis (skin stretch)	0.256	0.103
Y-axis (shape-change)	0.269	0.108

II. Experiment

To initially compare interface perception, we conducted a *method of constant stimuli* study, with 40 device displacements per axis, with the range of the axis split into ±4 magnitudes. For this proof-of-concept work only 3 participants were recruited. Results are shown in Table 1. X axis performance was identical, while minor differences were observed in Y (Fig 2).

III. Conclusions

The test showed comparative interface performance, indicating promise for both. Further testing will determine if the observed minor differences are statistically significant.

References

[1] A. J. Spiers, J. Van Der Linden, S. Wiseman, and M. Oshodi, "Testing a Shape-Changing Haptic Navigation Device with Vision-Impaired and Sighted Audiences in an Immersive Theater Setting," *IEEE Trans. Human-Machine Syst.*, 2018

[2] L. T. Gwilliam, a. J. Doxon, and W. R. Provancher, "Haptic matching of directional force and skin stretch feedback cues," *2013 World Haptics Conf.*, 2013.

[3] J. Lazar, A. Allen, J. Kleinman, and C. Malarkey, "What Frustrates Screen Reader Users on the Web: A Study of 100 Blind Users," *Int. J. Human–Computer Interact.*, 2007.

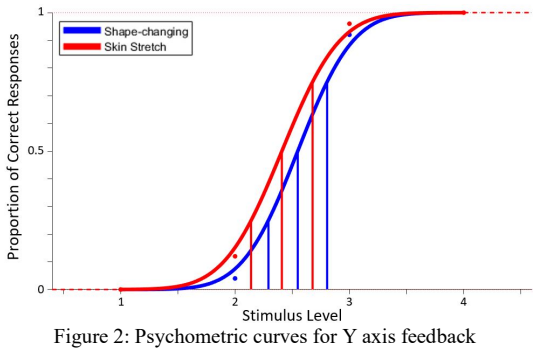

Figure 2: Psychometric curves for Y axis feedback