Concept of haptic device for user interface navigation and guidance

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Introduction

From HCI perspective, there are multiple I/O channels for the interaction with computer system that are bound to human senses. Since it is very difficult for a computer to address senses of smell and taste, HCI has recently been exploring combinations of remaining three senses. Visual feedback has always been predominant, often coupled with audio feedback, however this can be confusing considering desktop applications. On the other hand, haptic channel seems to be more suitable (as a proof, imagine computer keyboard without haptic feedback).

Haptic feedback

Haptic device can be described as an interface capable of providing sense of force or touch to the user. Such device is controlled with specialized haptic rendering software in order to create meaningful feedback, also called haptic cue. There are two types of haptic cues - tactile and kinesthetic. We perceive tactile cues by our skin receptors (mechanoreceptors, thermoreceptors and nociceptors) and they provide us with information about surface texture, pressure and pain. Kinesthetic cues are perceived by the receptors in muscles, joints and tendons and help to determine movement, position and torque of different parts of our body [Bowman et al., 2004].

As shown in Figure 1, there is direct analogy between 2D visual and 2D haptic feedback, and so they can team up to augment each other and facilitate improved interaction for the user. Two dimensional (directional) haptic feedback was described by [Choi and Kim, 2009], where tactile cues have been used.

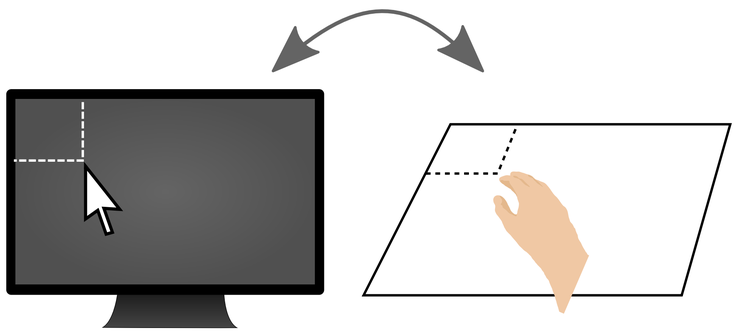

Figure 1: *Analogy between 2D visual feedback and 2D haptic feedback*

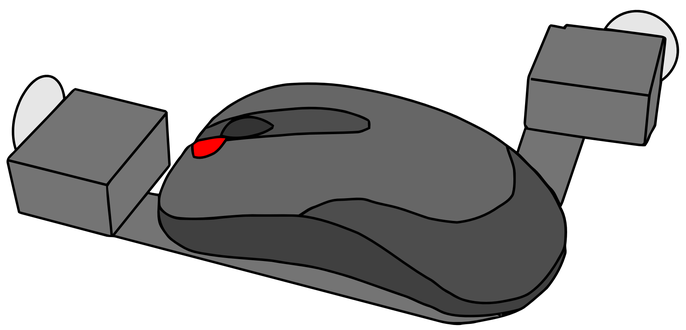

Figure 2: *First prototype of haptic mouse*

Kinesthetic Haptic Device

We have been exploring the usage of kinesthetic haptic cues in order to navigate a user throughout the user interface. Our first prototype (Figure 2) was created adapting ordinary computer mouse by attaching motors in order to provide directional haptic feedback. Motors are controlled by Phidgets Advanced Servo Controller to deliver passive kinesthetic cues (perceived by receptors in muscles of user's hand). We believe there are two possibilities for user navigation with haptic feedback:

- driving user's hand to the target by applying force with the motors
- constraining user's movement in wrong direction by applying resistance

Combination of these feedbacks should enable users to create more precise mental models of application interface, which is critical for design performance and error proneness.

As a future research we will experiment with four motors, exploring and testing more precise haptic cues. Using Fitt's law, we intend to measure the improvement in user performance using several prototype applications such as GIS, e-learning in desktop environment and assistance to visually impaired and children.

References

[Bowman et al., 2004] Bowman, D. A., Kruijff, E., LaViola, J. J., and Poupyrev, I. (2004). *3D User Interfaces: Theory and Practice*. Addison Wesley Longman Publishing Co., Inc., Redwood City, CA, USA.

[Choi and Kim, 2009] Choi, M. and Kim, G. J. (2009). Touchball: a design and evaluation of a hand-held trackball based touch-haptic interface. In *CHI '09: Proceedings of the 27th international conference on Human factors in computing systems*, pages 1535–1538, New York, NY, USA. ACM.