

A Vibrotactile System for Feeling the Depth of Digital Images

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Abstract

This sketch presents a coordinated pointing/tactile output device and image markup system that adds a tactile representation of depth to any digital image, enhancing data visualization and image disambiguation.

1 Introduction

We have developed a new system that uses a custom vibrotactile-enabled pointing device to add a tactile representation of depth to a digital image. The human perceptual apparatus is optimized for integrating multiple sources of complimentary sensory information when interpreting and disambiguating percepts [Massaro 1998], but complex data representations and digital images are typically purely visual. Our innovation is the combination of a familiar but augmented pointing device in conjunction with a tactile texture “overlay” that allows a user to feel continuously varying depth information in an image as a changing texture when moving the mouse cursor across the image.

2 System Construction

Our system consists of the Tactile Trackpoint (hereafter referred to as TT), an integrated isometric pointing and tactile output device developed at IBM [Campbell et al. 1999], and an image markup system designed to function in concert with the device. The TT is a modified trackpoint controller [Rutledge & Selker, 1990] featuring a small coil and magnet inside which can produce a vibrotactile stimulus of up to 30Hz directly to the user’s fingertip. Despite its tactile functionality, the appearance and pointing behavior of the TT is identical to the ubiquitous trackpoint pointing device (fig. 1). The tactile texture overlay uses a secondary image buffer to store a pixel-for-pixel “height map” of the visual image. Our height-maps are created manually, but could also be generated automatically for 3D rendered images. When the user moves the mouse pointer across the visual image, she receives tactile pulses at a spatial frequency proportional to the height data from the associated overlay buffer.

3 Discussion

Previous related work has focused on encoding a visual image entirely via a tactile, haptic, and/or audio representation, obviating the need for the visual image itself. These systems have been typically designed for blind users. Roth et al. developed an “audio-haptic tool for non-visual image representation” in which manual 2-dimensional markup of scene objects and the use of a force feedback interface coupled with audio cues allowed blind users to explore the 2-dimensional shapes or edges in a picture [Roth et al. 2001]. Other work has utilized the PHANToM force-feedback device or a force-feedback enabled mouse to allow blind computer users to experience data visualizations [Fritz et al. 2001].

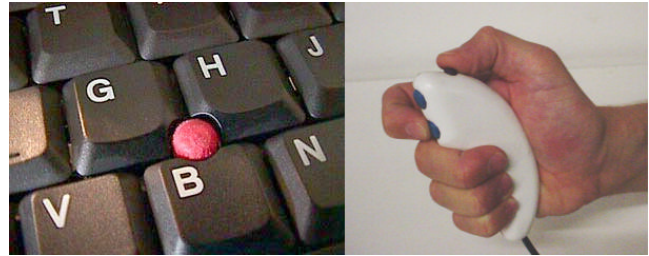


Figure 1. The traditional trackpoint controller, and handheld version of the tactile trackpoint.

The first aspect of our system which sets it apart from earlier work is that it augments rather than supplants the visual image, creating an enhanced multimodal experience for sighted users. In addition, since the TT is also a fully-functional pointing device, it seamlessly integrates tactile output with everyday GUI usage, unlike the bulky and expensive PHANToM. A handheld version of the TT makes it appropriate for use with wearable computers. (fig. 1) Finally, rather than simply giving a 2-dimensional texture to shapes or edges in the image, the continuously-varying depth overlay adds a third dimension to *each pixel* in the image (fig. 2).



Figure 2. (a) Classic example of a confusing visual image and (b) a simple depth map to disambiguate it. On the far right (c) is a sample algorithmically-generated depth map.

References

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