A Malleable Surface Touch Interface

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1. Introduction

Many conventional whole-hand input devices capture interaction by means of non-contact methods or through some physical medium. Such physical interfaces often involve contact of the hands and fingers with a hard, unyielding surface. In this sketch, we propose an input device that captures whole-hand input through a malleable medium. Its deformability and inherent feedback characteristics make it suitable for sculpting and molding applications.

2. System Overview and Related Work

Our malleable input surface is made of a cut garden-variety rubber glove. This rubber sheet is stretched tautly over a rigid frame to form a flat interaction surface. A video camera is positioned underneath to capture input information applied to the rubber sheet (fig.1).

By applying the hands and fingers onto the interaction surface, deformations are made that can be appropriately lit and captured using a video camera. By patterning the surface underneath with dots, position and depth tracking can be performed through computing the changes in displacement and area for each dot. The video capture and processing is done with ImageJ plugins.

Our input device exhibits two attributes of whole-hand surface-based interfaces: multi-point sensitivity and depth/pressure sensing. These are made possible through computer vision. Our interface also offers passive haptic feedback from the malleable nature of the surface.

Multi-point and pressure sensing are found in various combinations in other input technologies. SmartSkin [Rekimoto 2002] and Fingerworks [Westerman and Elias 2001] are examples of multi-point interfaces; the MTC Express [Chen et al. 2002] offers multi-point pressure sensing. An interface providing passive haptic feedback is shown in Liquid Haptics [White 1998], using a fluid-filled medical bladder.

3. Application and Evaluation

To demonstrate an application of our device, a virtual simulation of a spring-mass model was used. This simulation is derived from the KineticsKit python module (fig.2). Since a plane best corresponds to the input topology of our device, we chose a planar grid of masses connected by springs to comprise the interactive domain.

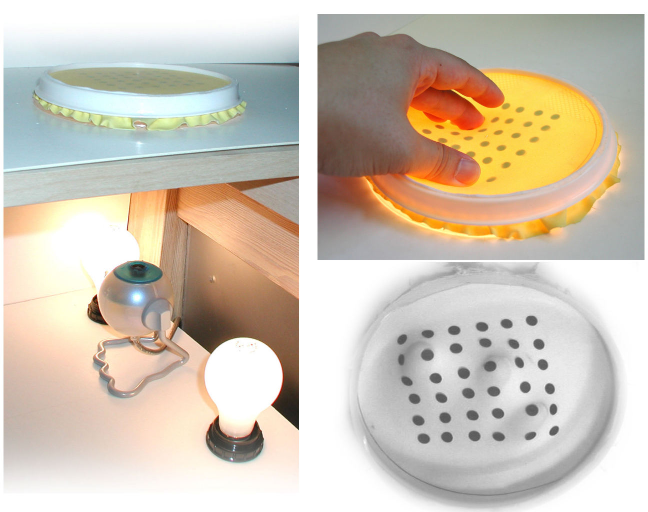

Figure 1: Interface architecture, video camera at bottom (left); interaction with surface (upper right); view as seen from camera (bottom right)

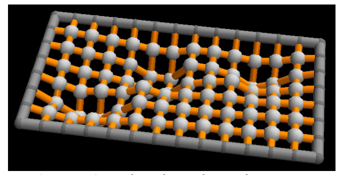

Figure 2: KineticsKit spring mass model

A whole-hand input device can be used to manipulate multiple masses simultaneously, something that would be difficult with a mouse. Squeezing and stretching (fig.3) actions are also possible, enabling types of manipulation of the virtual grid that simple downward pressure cannot provide.

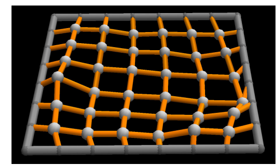

Figure 3: Simulation under a stretched condition

Although position tracking of multiple points can detect such movement-based actions as a stretch, only a malleable surface can actually provide an analogous passive haptic feedback. For example, lateral translation of the input domain by means of stretching the surface material can be mapped to x- and y-translations of the system objects in the simulation.

As a comparison, this spring-mass simulation was interfaced with the MTC Express. It was only sensible to map the applied pressure to the downward movement of the masses. The lack of a malleable surface does not provide much useful haptic feedback; the semantics to produce xy-plane movement would also be different, requiring tracking of fingers sliding across the surface.

4. Conclusion and Future Work

A malleable surface interface can be used in applications that require the physical manipulation of surfaces intuitively performed by the human hands, such as sculpting and massage. While other interfaces using a rigid surface can capture hand input adequately, a malleable surface can provide that extra passive haptic feedback that can be helpful for effective manipulation, in addition to supporting many in-place manipulation actions due to the highly deformable property of the surface.

We have demonstrated a simple application that clearly shows the advantages of a malleable surface interface when compared to a conventional hard surface touch pad. Its usage of commodity video technology could make it an inexpensive alternative touch device. We will continue improve the input processing methods and develop applications that make use of this interface.

5. References

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