ClaytricSurface:An Interactive Surface with Dynamic Softness Control Capability

Yasushi Matoba * Toshiki Sato † Nobuhiro Takahashi ‡ Hideki Koike §
The University of Electro-Communications (UEC Tokyo)

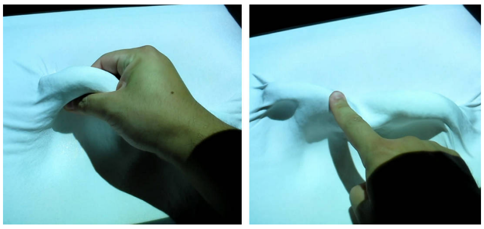

Figure 1: *Surface in a Soft State(left) and Hard State(right)*

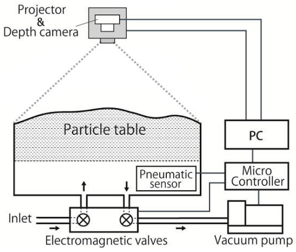

Figure 2: *System Hardware*

Figure 3: *Pen-based Interaction*

1 INTRODUCTION

For a long time, solid planar surfaces have been commonly used for computer displays. Recently, there have been many attempts to provide a flexible element with the display surface to extend possibilities of interaction by utilizing many flexible materials, such as elastomer, sand or clay [Piper et al. 2002]. However, in many traditional flexible display to date, this softness element has been considered as a static element and thus unchangeable. Thus, traditional flexible surface limits the possible interaction that is supported on each surface due to the interactive element being strongly dependent on the physical/chemical properties of display material.

In order to address this problem, we proposed the idea of“ Dynamic Flexibility ”for the display medium and developed a novel interactive surface with the capability of dynamic flexibility control. The main features of this surface are as follows: First, the user can use the display as both a traditional rigid/planar display and also a flexible/non-planar display. Second, the surface of the display is able to present the gradual dynamic translation of its properties from soft to hard and vice versa. In addition, the user or the system can quickly switch the surface softness state at anytime.

2 DYNAMIC SOFTNESS CONTROL

In order to develop the surface that has such dynamically changing softness properties, we looked into the application of small particle materials together with a particle density control technique. Polystyrene particles exhibit liquid-like behavior due to its lightweight and low friction characteristics. However, if you seal these particles into an airtight plastic bag and extract the air from the bag, the particles trapped within are compressed and the bag will gradually harden. If the pressure approaches vacuum pressure levels, the surface container (the plastic bag) will become completely hard.

Based on this technique, we developed an tabletop system named “ClaytricSurface” (Figure.2). Figure4 shows the relationship between internal particle density and softness of the surface. At first, when the pressure of the table is at atmospheric pressure, the surface behaves as a soft surface. In this state, the surface provides soft touch sensation like sand or clothing, and enables the user to change the shape easily with simple hand manipulation or with tools. Once the pressure starts to decrease by the vacuum pump, the surface gradually becomes harder. In the median state, the user can deform the surface with his/her hands like clay(Figure.1(left)). Furthermore, once the internal pressure approaches the maximum level determined by the degree of vacuum, the surface becomes hardened and its current shape is fixed(Figure.1(right)).

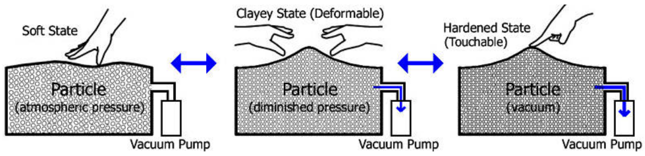

Figure 4: *Particle Density Control Using Pressure Manipulation*

3 APPLICATIONS

Firstly, we have developed a novel 2.5-dimensional modeling application. The user can form a 2.5D model by using variety of hand movement such as “gathering with both hands” or “pulling and tugging” while experiencing the touch sensation of a dynamically-changing material. In this application, user’s touch input is detected by the depth camera above the table and the surface softness can be controlled by a simple GUI slider or button. Additionally, once the model is in a fixed state, he/she can instantaneously paint a texture with direct touch input. We also developed a “handy modeling support device” by using a vacuum forming technique that enables the user to easily create a pre-prepared 2.5D shape. Furthermore, we developed a entertainment application that allows user interaction with characters that he/she has made via modeling application through direct touch input.

We have also developed another application augments pen-based interaction. In this application, the user’s pen input is detected by electromagnetic fields produced from under the table. The user can dynamically change the shape of the surface and tactile sensation, moreover, adjust the friction resistance between pen tip and the surface(Figure.3).

References

PIPER, B., RATTI, C., AND ISHII, H. 2002. Illuminating clay: a 3-d tangible interface for landscape analysis. In *Proc. of the SIGCHI conference on Human factors in computing systems*, ACM, New York, NY, USA, CHI ’02, 355–362.

*e-mail:matoba@vogue.is.uec.ac.jp
†e-mail:den@atsuage.net
‡e-mail:novriki@acm.org
§e-mail:koike@acm.org

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