Volflex

Hiroo Iwata*
University of Tsukuba

Hiroaki Yano†
University of Tsukuba

Naoto Ono‡
University of Tsukuba

Abstract

Volflex is a volumetric haptic display. It is composed of a group of air balloons controlled by computer-controlled air cylinders. Each air cylinder is equipped with a pressure sensor that detects force applied by the user. Deformation occurs according with hardness of the virtual clay.

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1 Introduction

Shape design of 3D object requires good sensation of haptics. Volflex is a new haptic interface that provides the user to physical 3D surface for interaction. Digital tools for 2D paint are mature technology. On the other hand, tools for 3D shape manipulation are at preliminary state. Shape design of 3D object is one of the major application areas of haptic interface. The Volflex is a new haptic interface that provides a physical surface like clay. Clay is a very popular tool for shape design or plastic art. The Volflex enhances these activities by computer-controlled surface for haptic interaction.

The device is composed of a group of air balloons. Volume of each balloon is controlled by an air cylinder. Each air cylinder is equipped with a pressure sensor that detects force applied by the user. Deformation occurs according with hardness of the virtual clay. Unlike real clay the Volflex allows the user to "Undo" operation.

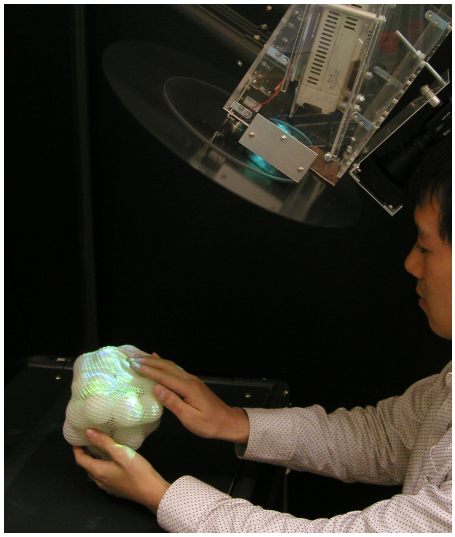

Figure 1: Overall view of the Volflex.

*e-mail: iwata@kz.tsukuba.ac.jp
†e-mail:yano@iit.tsukuba.ac.jp
‡e-mail:nono@vrlab.esys.tsukuba.ac.jp

2 Technical Innovation of the Project

The project aims at development of a haptic interface for digital clay. The major goals are:

(1) to provide a volumetric interface device that enables users to feel virtual objects using the whole palm.

(2) to provide visual image on the surface of the device.

We fabricated a new haptic interface by the use of a group of computer-controlled air balloons. The balloons fulfill the interaction surface. They are arranged in a body-centered cubic lattice. A tube is connected to each balloon. Volume of each balloon is controlled by an air cylinder. The tubes are connected each other by springs. This mechanical flexibility enables arbitrary shape of the interaction surface.

Each air cylinder is equipped with a pressure sensor that detects force applied by the user. According with the pressure data, the device is programmed to perform like clay.

A projector is set above the balloons. Image is projected on the surface of the device, not on the user's hand. We developed a mechanical rotary shutter that separates the projector and camera. The camera captures the user's hand, which is eliminated from the projected image.

Figure 2: Examples of deformation.

3 Larger implications of the project beyond this demonstration phase

Virtual clay is one of the ultimate goals of interactive technique of 3D graphics. The Volflex provides effective interface device for manipulation of virtual clay by using lattice of air balloons. 2D paint tools have been popular and digital picture is easy to draw. The Volflex is a new digital tool for making 3D shape. It has potential to make revolution in methods for industrial design. Designers use their palm or the joints of their fingers to deform a clay model when carrying out rough design tasks. The Volflex has the ability to support such natural manipulation.

The Volflex is not only a tool for 3D shape design but also an interactive artwork. Physical property of the virtual object can be designed by programming controllers of the balloons. Projected image can be also designed. The combination of haptic/visual display provides a new platform for interactive sculpture.