Cloth Handling in Virtual Space

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Abstract. Cloth is used for design and production of clothing and virtualization of cloth is beneficial. In this study cloth handling is virtualized. Cloth is mechanically formulated and modeled. The motion of the position of human hand in the real world is captured using Kinect that is a sensor of game-machine. The motion of the position of human hand to the cloth model and handling of cloth is simulated in the virtual world. Handled cloth interferes with other object in the virtual space because collision detection and reaction are defined for the cloth model. Three-dimensional shape of hand is extracted from the depth image of Kinect and the motion of the shape of the hand in the virtual space is displayed.

Keywords: Cloth Handling, Simulation, Kinect.

1 Introduction

In the real world, cloth is touched and handled in the process of apparel design or production. Designer touch cloth to determine which cloth is suitable for designed clothing. Cloth is also touched and handled to design or make clothing. “Draping ” is one of the methods to make clothing pattern. While making a garment, cloth is pinned, cut away, and marked. If the pinned cloth matches the designer's ideas, dress patterns are made from the marked cloth. However, Draping is a costly, troublesome, time-consuming task. Although draping better enables garments to be made that reflect the designer’s vision and better fit the wearer’s shape, the time the process takes can be long and expensive. With today’s information and communication technology, virtualized draping reduces time and cost, as well as enabling mass customization from remote places.

Some systems for making dress patterns in virtual space have been developed. It is important to develop techniques for real-time virtual draping because this has certain advantages, one being the sensation that the real-time operations offer more realism than other methods. The position to pin or cut is not determined in advance while cloth is manipulated. The position of cuts or starting point of pinning can be decided interactively through automated program interface protocols. If the shape of the cloth can be calculated from its mechanical properties in real-time, it then becomes possible to manipulate the cloth and watch how the shape of the cloth changes.

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Real-time simulation of cloth handling has also been conducted. Dummy is dressed in simulation by handling garment patterns [1]. Cloth is pinned on a doll by marking the cloth and the doll, then the pinned cloth can be moved [2]. In these studies, mouse is used to manipulate cloth although the feeling differs from actual cloth handling. Handling by gesturing would be more realistic than mouse manipulations. In addition, most of the time the methods are able to perform only one manipulation.

We proposed a method in which controlling cloth handling follows the hand gestures in the real world. However, manipulating cloth is not all that cloth handling entails. Other manipulations, such as choosing fabrics, attaching and releasing cloth, are also needed. Among those operations, cloth cutting is also included.

2 Cloth Handling

In the handling of the cloth model, the model in virtual space is moved according to the motion of hand in the real world. The cloth model follows the motion of hands in the real world in the handling in this model.

Kinect (Micorsoft) is utilized for a sensor to detect human motion for our study. It is a game-machine sensor that controls game software through body motion or voice inputs without the need of a controller. A software program designed for human-motion capture and in particular hand gesturing can be utilized for Kinect. Three-dimensional coordinates of various parts of the body are tracked. In adapting to cloth handling, hand coordinates and hand gestures can be obtained by Kinect.

For simulation, cloth has to be formulated as a model. The cloth model here is based on a two-dimension lattice of particle-spring nodes. This model consists of particles arranged on grid with springs connecting nearest and next-to-nearest particles. Thus, a particle is connected by springs to eight others to represent the forces of fabric's warp, weft, and bias directions. Given masses and spring constants, the modeling of the dynamic response of cloth is calculated using the leap-frog method in the numerical integration of the discretized equation of motion [3-5]. Gravitational force and spring forces are applied to each particle. For each iteration in the numerical integration, the position of each particle in the next step is calculated from the present position of each particle and the forces applied to each particle.

In the virtual space, collision detection and reaction are defined between cloth and objects, such as a dress dummy, created in the computational domain. A virtual object consists of point cloud. Collision detection [3-5] involves calculating the distance between each particle in the cloth model and object. If the shortest distance is smaller than a predefined constant, collision between cloth model and object is signaled. If collision is detected, a repulsive force is applied to the colliding particle in the cloth model.

3 Results and Discussions

Handling of cloth in the virtual space was tried with the model described above. BacBook Pro (Core i7 2.4GHz, GeForce 650M (GPGPU is utilized), Windows 8, VisualStudio 2010) was used for the simulation. As an example, it was virtualized to handle a cloth by picking up two corers of a square cloth. For this simulation, to detect the position of hand and to apply the position to two corners of a cloth are needed.

Motion of both hands is captured by Kinect which is originally designed for a sensor of game-machine. A camera to take images and a sensor to capture depth are equipped, and the depth for each pixel of depth image can be acquired. It also has a function designed to extract the coordinate of skeletal joints form the depth image. The coordinate of the left and right hand skeletal joints are tracked form all the joints in real-time.

The virtual cloth model follows the motion of both hands in the real world. The cloth consists of 10 by 10 nodes. The left-hand coordinate is given to the particle at the upper left edge of the cloth, and that of the right hand to the particle at the upper right edge. Subsequently, numerical integration, performed after a predefined time interval, calculates the motion of the cloth.

Figure 1. shows the results of the simulation. In the figures, vertical cloth and horizontal plate are shown. The position of the plate is fixed, and collision detection and reaction are defined between the cloth and the plate. In the right side figure, the lower half of the cloth is laid on the plate. It was succeeded to handle the virtual cloth in real-time. The density of the nodes for the cloth and the plate has to be tuned because it is observed that sometimes a part of the cloth goes through the plate.

The dynamic shape of hand in the real world is recognized and reproduced in the virtual space. The coordinate of the right hand skeletal joint is picked up form all the joints to detect the motion of hand. A domain that contains the right hand is set, and the depth image points that are included in the three-dimensional domain are picked up. Approximate three-dimensional shape of the right hand can be recognized and extracted by the method. As this is processed in real time, the movement of three-dimensional shape of the right hand can be extracted in real time. Figure. 2 shows the results of extraction, rock, scissors and paper of right hand respectively. It was succeeded to reproduce dynamic three-dimensional shape of the right hand in the virtual space in real-time. It is expected to react the shape of the virtual cloth according to the motion of the fingers of the right hand.

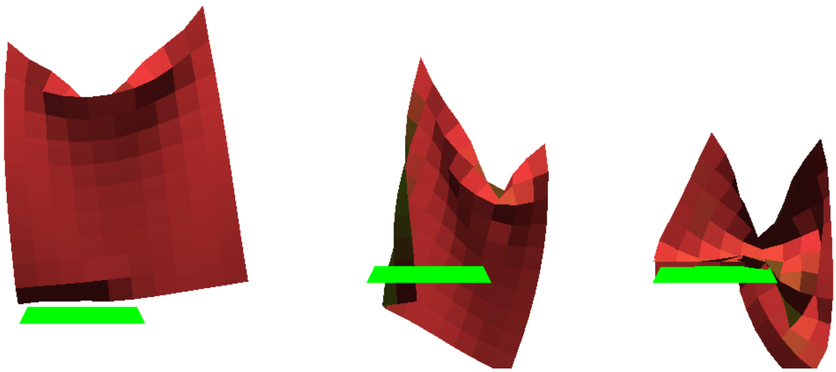

Fig. 1. The results of real-time cloth handling simulation

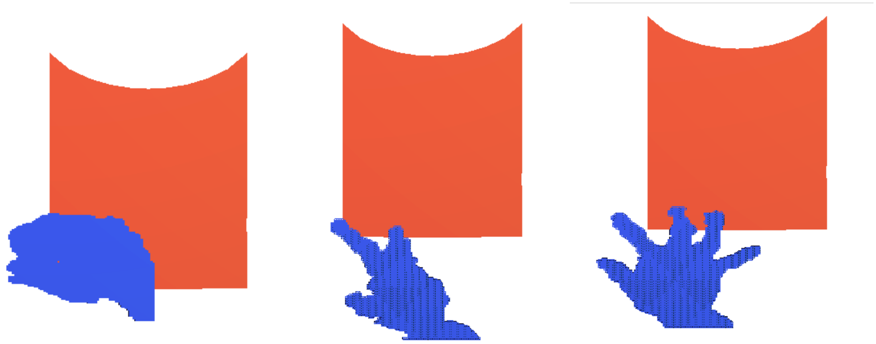

Fig. 2. The results of extraction of the shape of the right hand in the shape of rock, scissors and paper

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