A Virtual Cloth Manipulation System for Clothing Design

Shgeru Inui[1(✉)], Yuko Mesuda[2], and Yosuke Horiba[3]

[1] International Cluster for Cutting Edge Research Institute for Fiber Engineering, Shinshu University, 3-15-1 Tokita, Ueda, Nagano 386-8567, Japan
inui@shinshu-u.ac.jp

[2] Interdisciplinary Graduate School of Science and Technology, Shinshu University, 3-15-1 Tokita, Ueda, Nagano 386-8567, Japan
l2stll5c@shinshu-u.ac.jp

[3] Faculty of Textile Science and Technology, Shinshu University, 3-15-1 Tokita, Ueda, Nagano 386-8567, Japan
horiba@shinshu-u.ac.jp

Abstract. We have been studied virtualization of draping which is one of a design method for clothing. It is desirable to adopt a man-machine interface in the same way as the real world for virtual draping. For this purpose, motion of hand is detected by Leap Motion as a sensor. This sensor can detect not only the motion of hand but the motion of fingers. According to the motion of hand or fingers in the real world, hand model in the virtual world is moved. Cloth is modeled with simple particles and springs, and dynamical change of cloth model form is obtained by numerical integration of motion equation. The interaction between the hand model and the cloth model is enabled, and then it is possible to grab the cloth model by the hand model in the virtual world.

Keywords: Draping · Leap motion · Cloth model · Hand model · Simulation

1 Introduction

In the processes to design clothing, paper patterns are made from a design drawing. Draping is one of the methods to make paper patterns from a design drawing. In draping method, paper patterns are made to apply cloth to a dummy and cutting unnecessary part of cloth. Though draping is a suitable method to make clothing fit to each person, it takes more time and cost than other methods. It is expected that the efficiency to design clothing is improved tremendously by virtualization of draping method. In the virtualized draping, natural man-machine interface is required.

We have been studied the virtualization of draping [1, 2]. Our method to make patterns for clothing is to map virtual cloth model on a virtual dummy model. After that, darts are made and the unnecessary part of cloth model is cut as in the real world. Another types of virtual draping systems have been studied. Cho et al. [3] made patterns to develop the surface shape of a measured dummy body. Wang et al. [4] presented a method to make patterns using contour curves and style curves. Huang et al. [5] made a wireframe model from characteristic points of human body, and made

C. Stephanidis (Ed.): HCII 2015 Posters, Part I, CCIS 528, pp. 185–189, 2015.
DOI: 10.1007/978-3-319-21380-4_33

patterns from the deformed wireframe. Au et al. [6] inserted planes into human body model, and then made patterns by development. Some studies are interactive. The study of Meng et al. [7] is not about draping. In this study, patterns and three-dimensional shape of clothing is correlated. When a user change the shape of the patters, the three-dimensional shape of clothing changes accordingly, and a user is able to adjust the patterns interactively. Wibowo et al. [8] studied virtual draping method with a instrument to trace the surface of a dummy in the real world. The cloth manipulation in those studies are completely different from that in the real world. The experiences in the real world is very important, and only our method can provide the same feeling in cloth manipulation as in the real world.

On the other hand, online trade becomes more and more popular than now. But it is difficult to feel the characteristics of cloth because it is impossible to touch cloth in the online trading system. When cloth handling is virtualized, it is possible to touch cloth in the virtual world. The virtual cloth is deformed according to the movement of real fingers in the virtual world. It may be possible to feel characteristics of cloth to show the appearance of the cloth deformation. We have been manipulated cloth in the virtual world by detecting the movement of hand. The purpose of this study is to manipulate virtual cloth by detecting the movement of fingers.

2 Virtual Cloth Manipulation System

2.1 Detection of the Movements of Fingers

We have been studied man-machine interface not by mouse but the method to manipulate virtual cloth naturally by hand [9–11]. Microsoft Kinect has been utilized as the sensor to detect the movement of hand. The coordinate of skeletal joints can be detected by Kinect. The coordinate of hand joint is extracted, and the coordinate is set to a node of a cloth model to manipulate the cloth model. In the real world, cloth is manipulated by the movement of fingers. Therefor, it is important to detect the movement of fingers to manipulate virtual cloth. It is not impossible to detect movement of fingers by Kinect, but it takes time to process the detection. In this study, Leap Motion sensor is utilized. With Leap Motion, it is possible to detect the movement of both fingers, and the detected movement is used as the movement of the virtual hand model.

2.2 Models

Cloth and Objects are modeled for virtualization. Cloth is modeled by particles and springs with which particles are connected. Gravity force is acted on the particles. The cloth model is simple because mechanical calculation can be processed at high speed. The coordinate of each particle is obtained from the integration of motion equation. The cloth shape can be predicted from the coordinate of each particle. The objects beside the cloth is supposed to be rigid bodies. Each object is modeled as a set of particles. Collision detection and reaction are defined between the virtual cloth and objects. For each particle of the virtual cloth and object, a radius is set and the collision is detected from the comparison between the radius and the distance of particles. When

collision is detected, repulsive force acts to make the distance between particles is more than two times of the radius as reaction. The simple method is adopted for collision detection and reaction to calculate at high speed.

2.3 Processes

The coordinate of each finger joint is detected by Leap Motion. The virtual hand is also modeled as a set of particles. The detected coordinates are set to the virtual finger joints, and the fingers are moved in the virtual world according to the movement of the fingers in the real world. The virtual cloth is deformed by the interaction of the finger movements because the collision detection and reaction are defined between the virtual cloth and fingers. An explicit method, computation load of which is light, is adopted for this study to integrate motion equation of each particle. The calculation is upgraded by using GPGPU. The force acted to each particle of the cloth model can be calculated from the shape of the cloth model of the previous step. This process is suitable for parallel computation because the calculation can be processed independently for each particle.

3 Results and Discussions

The virtual cloth model is hanging with the fixed four corners in the initial state, as shown in Fig. 1. In this state, the virtual hands and fingers are moved according to the movement of the hands and fingers in the real world. The virtual cloth model can be touched to move the virtual hands and fingers in the region where the hands and fingers can contact with the cloth model, as shown in Fig. 2. When the fixations at the four corners of the cloth model are released, the cloth model falls onto the hand model and then the cloth model can be grabbed. There are some future studies as follows. Though the movement obtained by Leap Motion is more or less stable, sometimes the movement jumps. Some processes are necessary to smooth the movement. As an explicit method is adopted for high speed integration of the motion equation, sometime the calculation becomes unstable. It is necessary to stabilize the calculation so long as the

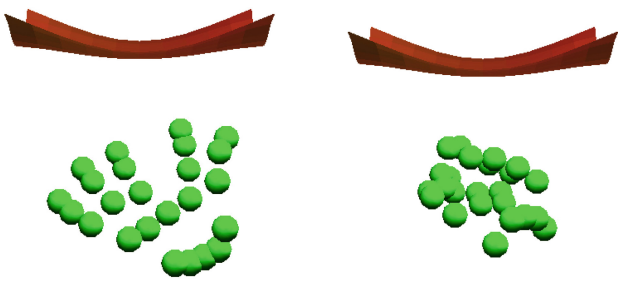

Fig. 1. The red object is the cloth model and the green object is the hand model. The cloth model is hanging with the fixed four corners. The left hand side image shows the opened hand model, and the right hand side shows the closed hand model (Color figure online).

Fig. 2. The left hand side image shows that the cloth model is pushed up by the hand model, and the right hand side image shows that the cloth model is freed and the hand model grab it.

calculation speed is not so much sacrificed. As friction is not defined, it is difficult to keep the cloth model fall into the virtual hand. Friction between virtual cloth and fingers should be defined. In the processes of draping, cloth is applied to dummy and rest part of the cloth is picked for dart. From the point of view of draping, the association between the finger movements and the deformation of cloth should be considered.

Acknowledgments. This work was partly supported by Grants-in-Aid for Scientific Research (No. 23240100, 24220012) from the Ministry of Education, Science, Sports and Culture of Japan.

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