KEER2014, LINKÖPING | JUNE 11-13 2014
INTERNATIONAL CONFERENCE ON KANSEI ENGINEERING AND EMOTION RESEARCH

Cloth Model Handling by The Combination of Some Manipulations for Draping

Yuko mesuda[1], Shigeru Inui[2], Yosuke Horiba[3]

[1] *Graduate School of Science and Technology, Shinshu University, 3-15-1 Tokida, Ueda City, Nagano 386-8567, Japan*

[2] *Faculty of Textile Science and Technology Division, Shinshu University, 3-15-1 Tokida, Ueda City, Nagano 386-8567, Japan, inui@shinshu-u.ac.jp*

[3] *Faculty of Textile Science and Technology Division, Shinshu University, 3-15-1 Tokida, Ueda City, Nagano 386-8567, Japan*

Abstract: In this study, manipulation of a cloth model for virtual draping in real-time is performed using hand gesture. The manipulations are holding, releasing, attaching and mapping. And, the cloth model is manipulated by using the manipulations in combination. A cloth model and an object model consist of particles. The holding is performed by fixing the particle nearest to the hand in the loth model to the hand. This manipulation is started if a distance between the particle and the hand is shorter than a threshold. The releasing is demonstrated by releasing a fixed particle. The attaching is performed after the cloth model is held, and the held particle is fixed to the particle nearest to hand in the object model. These manipulations except the holding are performed by pressing keys on the keyboard. The manipulations are combined by pressing the execution keys. As the results, we succeeded in performing each manipulation and using the manipulations in combination. The results suggest the possibility of performing virtual draping by using this algorithm.

Keywords: virtual draping, real-time, hand gesture, cloth manipulation, combination of manipulation.

1. INTRODUCTION

Draping is one of making pattern for garments. In draping, a designer attaches cloth to dummy and makes garment form to make the pattern. The draping has advantages, such as it can make a garment which is a perfect fit. However, it takes cost and time. Virtual draping methods are suggested in order to reduce cost and time. Especially real-time draping can demonstrate more realistic draping.

The studies including virtual draping for making customized virtual garment and garment simulation have been conducted. Interactive system and simulation for garments have been developed to make fitted garments. Yasseen Z. et al. create a garment reflected a user's image by drawing line on the dummy body in virtual space (Yasseen et al., 2013). And, dynamic behavior of

the garment is simulated in moving the body. Wibowo, A. et al. develop a method which makes garment pattern by drawing garment outline with special tools on mannequin (Wibowo et al., 2012). In addition, they make actual garments from the obtained garment patterns. A cloth model and mesh manipulation are important for interactive virtual draping. The study, which the cloth model attached to an object model is moved by mouse, has already been conducted (Igarashi and Hughes, 2003). In these studies, the cloth model is often manipulated by using mouse.

However, virtual cloth manipulation using gesture is more realistic than the mouse manipulation. Therefore, we suggested method of cloth manipulations for the virtual draping according to hand gesture in the real world (Inui et al., 2012; Mesuda et al., 2013). However, the method needs other manipulations for draping because the method can performed only two type manipulation: moving and cutting. In addition, some manipulations have to be used in combination. In this study, we suggest four manipulation methods: hold, release, attaching and mapping. And we demonstrate some manipulations in combination.

2. THE MODEL AND THE DEVICE

In this study, a cloth model is particle model, and an object model such as dummy body is also represented by particles. And, cloth mechanical characteristic and the reaction of collisions between cloth model and object model are defined. A sensor is used to get hands motion. The model, the calculations and the sensor are discussed in the following.

2.1. The cloth model and the object model

The cloth model consists of particles and springs. Particles arranged on grid are connected by springs. The springs connect nearest particles and next-nearest particles (Figure 1).

The object model also consists of particles. However, the particles are not connected by springs. In dummy model, it consists of 80 cross-sections and 32 particles are arranged evenly in a circumference of the cross-sections. A radius and a height of the cross-section in which a particle is arranged are obtained from data of dummy model. The data are used in mapping. Other manipulations are performed by using three dimensional coordinates of each particle.

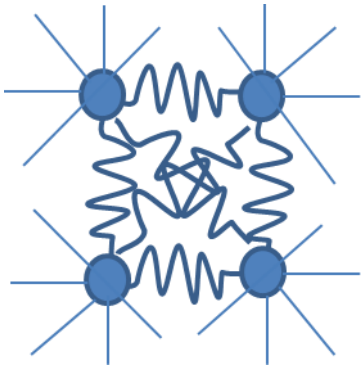


Figure 1: The cloth model

2.2. Dynamic calculation

In this study, dynamic behavior of cloth model is demonstrated by integrating forces acting on the particle (Harada T. & Koshizuka S., 2007). Forces of spring, collision reaction and gravity act on each particle. These forces are summed and position of each particle in the next step is calculated

by integrating the total force. In the integration, leap-frog method is used.

2.3. Collision reaction and collision detection

Collision detection and collision reaction are also defined (Harada & Koshizuka, 2007; Fuhmann, 2003; Fuhmann, 2003; Zhao, 2004). In collision detection, if a distance between the cloth model and the object model is shorter than a threshold, this algorithm judges that the cloth model touches the object model. If the cloth model collides, a repulsive force acts on the collided particle in the cloth model. The repulsive force does not act on the object model because the form of the object model does not change. This repulsive force is calculated by distance between collided particles. The distance is extended to the threshold by the repulsive force. Therefore, there are spaces between the cloth model and the object model.

A part of the cloth model often cuts into the object model. In this case, the particle cutting into the object model is moved to nearest particle in the object model, and then the collision reaction is performed.

2.4. Kinet

Kinect, it is sensor, is used to obtain hands motion in the real world in real-time. Kinect can get part positions of user's body by sensor and camera. Each part is obtained as three dimensional coordinate. The positions are updated every 1/30 seconds. User's motion is obtained by this update.

3. MANIPULATIONS OF THE CLOTH MODEL

In this study, the cloth model is manipulated according to hand gesture. User watches a screen on which the cloth model, the object model and hands position are displayed and manipulates the cloth model. We demonstrate four manipulations: holding, releasing, attaching and mapping. And, these manipulations are used in combination.

3.1. Holding and releasing

The holding is performed by moving a hand in fixing the particle of the cloth model to the hand. The user can watch the closest particle in different color to the hand. And when a distance between the hand and the particle is shorter than a threshold, the particle is fixed to the hand. This is, the user moves their hand to change the color of the particle in which they want to hold. And then they move their hand close to Kinect if the particle color changes.

The releasing is performed by releasing a fixed particle. The releasing particle is decided in the preparatory stages. This manipulation is started by pressing a key on a keyboard.

3.2. Attaching method

The attaching is performed after the cloth model is held because the particle fixed to the hand is attached to the object model. The particle in the cloth model fixed to the hand is fixed to the particle of the object mode nearest to the hand by pressing the key. The place, which the particle is fixed, changes from the hand to the nearest particle in the object model. The color of the nearest particle changes because the user can check the attaching position. The color of a particle in which they want to attach changes by moving their hand. And then they press the key to attach the cloth model. When the cloth model is attached, collision reaction has to be considered. Because there are spaces between the cloth model and the object model by collision reaction. Thus, collision detection and reaction are performed after the particle in the cloth model is moved to the particle in the object model. And then the cloth mode particle is fixed.

3.3. Mapping and stabilizing method

In draping, grain is often attached to guideline of the dummy such as center line. Attaching by mapping and stabilizing the cloth model to the object model is performed to attach exactly. The cloth model is mapped along the dummy model and stabilized by the dynamic calculation and collision reaction. In the calculations, parts of the cloth model are fixed. Thus, the attaching form is made. The mapping method is detailed below.

First, a height of the dummy model mapping the particle of the cloth model is calculated. Top of the cloth model is attached to the highest position of the dummy model mapping the particle, the height is decided in advance, and a height mapping each particle is calculated based in the highest position. At this time, top and bottom cross-sections of the height are calculated.

Next, lateral position mapping of the particle is calculated. Length of the cloth model particle in lateral direction is compared with arc length from the centerline in the top cross-section obtained in the previous step. And, right and left particle of the dummy model of the mapped particle on the circle are calculated. And then, angle and radius of the particles in the dummy model is obtained. Angle and radius in which the particle is mapped in the cross-section is calculated by interpolating the angle and the radii. The calculated radius is extended to the threshold because there are spaces between the cloth model and the dummy model by collision reaction.

After mapping, top and left of the cloth model are fixed and then dynamic calculation and collision calculation are performed.

3.4. Combination manipulation

These manipulations are used in combination. Each manipulation is switched by pressing a key. However, the holding is performed by the distance between the hand and the particle in the cloth model. And, the attaching can be performed after the holding manipulation. The mapping cannot be used in combination. However, the mapping is started by pressing the key because it will be used in combination in future study. Each manipulation can be used once.

4. RESULT AND DISCUSSION

In the holding, the releasing and the combination manipulation, their initial state is that both or one of upper edge of the cloth model are fixed. Table 1 shows a combination of the manipulations. Figure 2-6 show results of each manipulation. Figure 7-9 show results of combination manipulation.

From Figure 2, we succeeded in holding any positions in the cloth model. This algorithm can keep fixing the position in the cloth model after holding. In the Figure 3, in either two positions or a position are fixed, the fixed particle can be released. This algorithm can simulate how the fixed area of the cloth model falls. From Figure 4, the cloth model can be attached to the object model. The spaces between the cloth model and the object model are considered. However, the attached point is often a little different. This cause is calculation time in dynamic calculation and collision reaction. The particle is moved to a position stabilizing the particle by calculating these calculations several times. Therefore, the particle can be attached to a closer position by increasing the calculation time. Figure 5 shows the result of increasing the calculation time. As the result, this problem is improved.

In the mapping, left side and top of the loth model are attached to center line and above the level of the waist of the dummy model. From Figure 6, we succeeded in mapping along the center line. The cloth model is wavy a little in the first time after mapping. The cloth model is stabilized and its form changes along form of the dummy body by repeating the calculations. However, a part of the cloth mode does not change along the dummy model form. This cause is the influence which the

top and the left side of the wavy cloth model are fixed and it affects other areas of the cloth model. This problem is solved by increasing particle number of the cloth model and dummy model.

As shown Figure 7-9, the cloth model can be manipulated by some manipulations in combination. In both of combination 1 and combination 2, the cloth model can be held and released. However, in combination 1, the form of the cloth model is unstable if the particle fixed to the hand is released. This cause is that the calculated result vibrates. In combination 3, we can confirm clearly the cloth model is attached to the object model. In combination 4, the cloth model often vibrates faintly and is attached to different point a little, but this algorithm can demonstrate the cloth model colliding and attached to the object model. This faintly vibration is also generated by the calculated result vibrating. This problem is solved by changing this integration method.

This combination manipulation has some problem, but this algorithm can manipulate the cloth model in combination regardless of sequence and type of the manipulations. Therefore, it is fully possible to perform the draping by using the manipulations in combination in this algorithm using the hand motion in the real world.

Table 1: Combination of the manipulations

Combination name	**Manipulations**
Combination 1	Holding -> Releasing
Combination 2	Releasing -> Holding
Combination 3	Holding -> Attaching -> Releasing
Combination 4	Holding -> Releasing -> Attaching

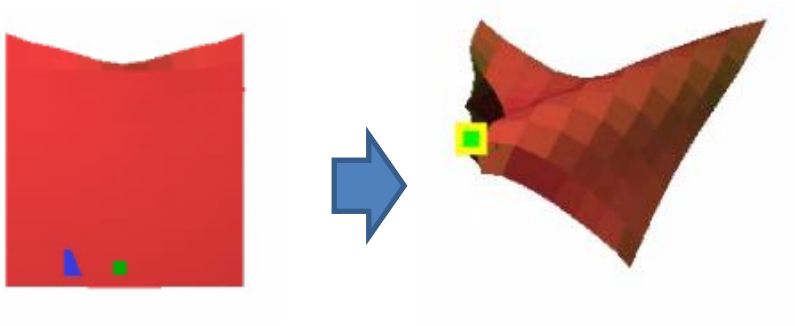


Figure 2: Result of the holding the cloth model. The initial state is that two particles in the top of the cloth model are fixed.

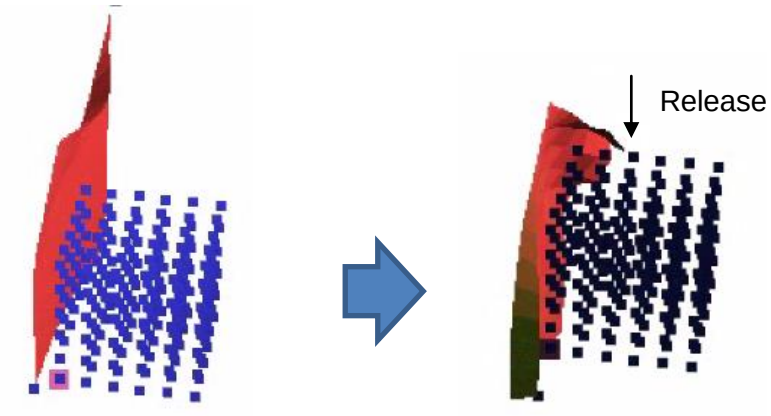


Figure 3: Result of the releasing. The initial state is that two particles in the top of the cloth model are fixed. The right of the fixed position is released.

Figure 4: Result of attaching. The initial state is that one particle in the top of the cloth model is fixed.

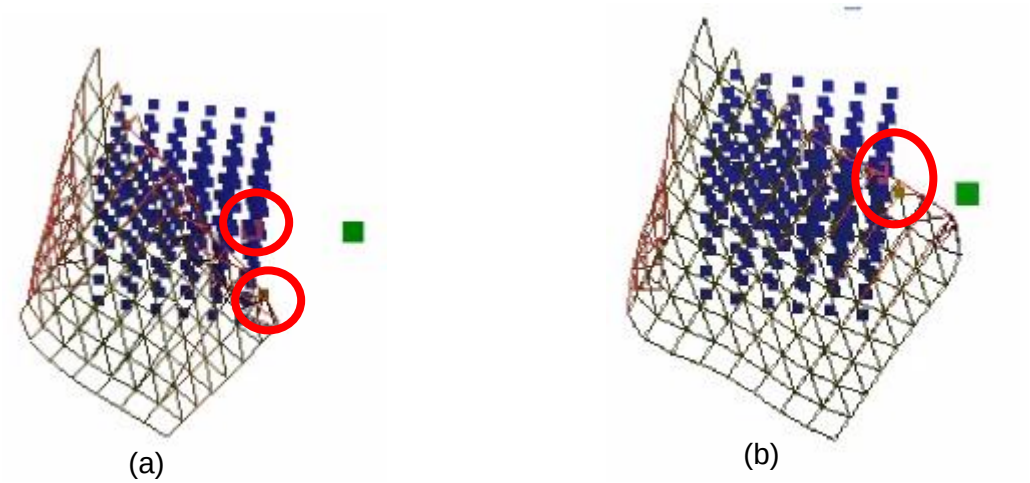
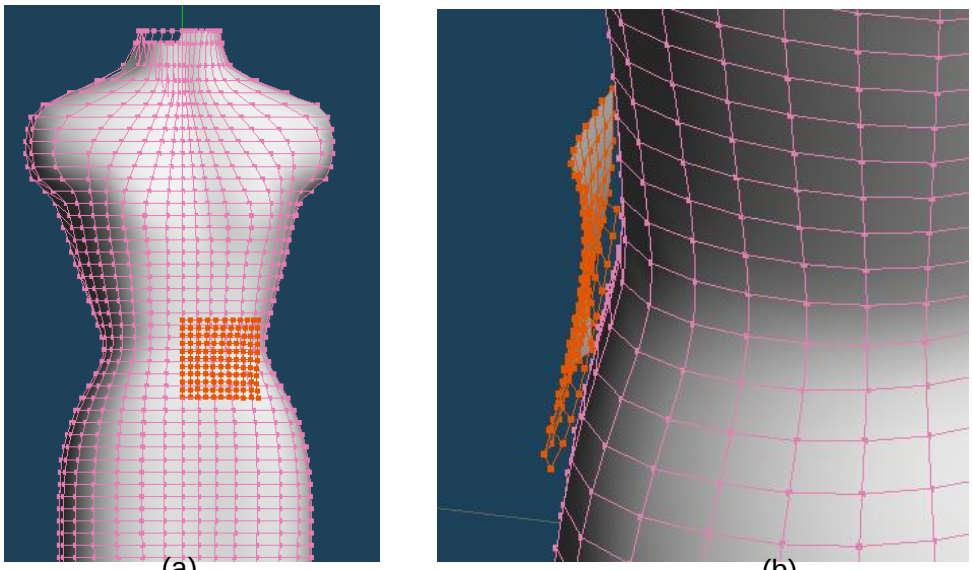


Figure 5: Figure 5: Comparison of different calculation time. The circles in this figure are at attaching point and the nearest object particle. (a): The calculation time is 50. (b): The calculation time is 100.



(a) (b)

Figure 6: Result of mapping. (a): The front view of dummy model. (b): The side view of the dummy model.

Figure 7: Result of Combination 1. The initial state is that one particle in the top of the cloth model is fixed.

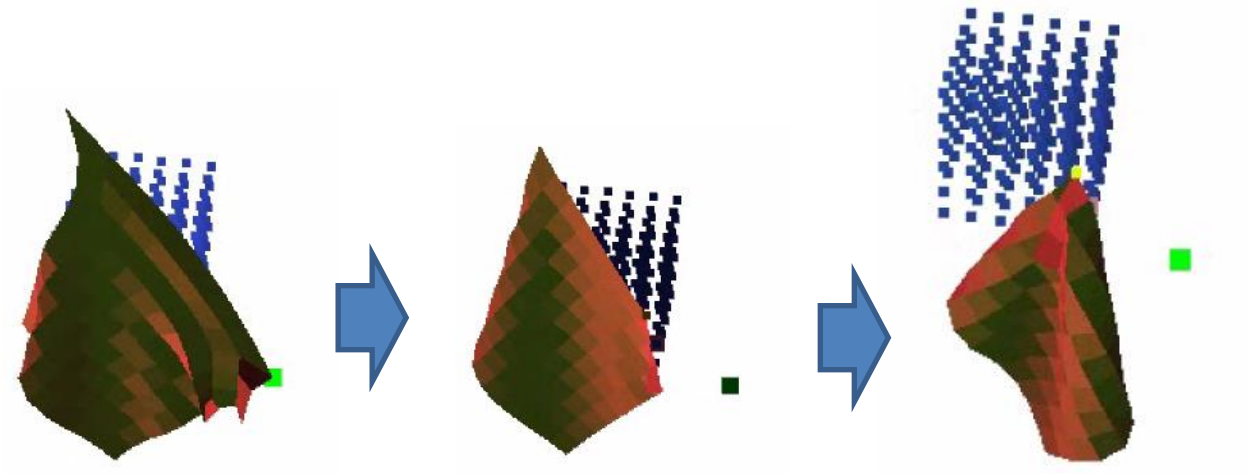


Figure 8: Result of combination 3. The initial state is that one particle in the top of the cloth model is fixed.

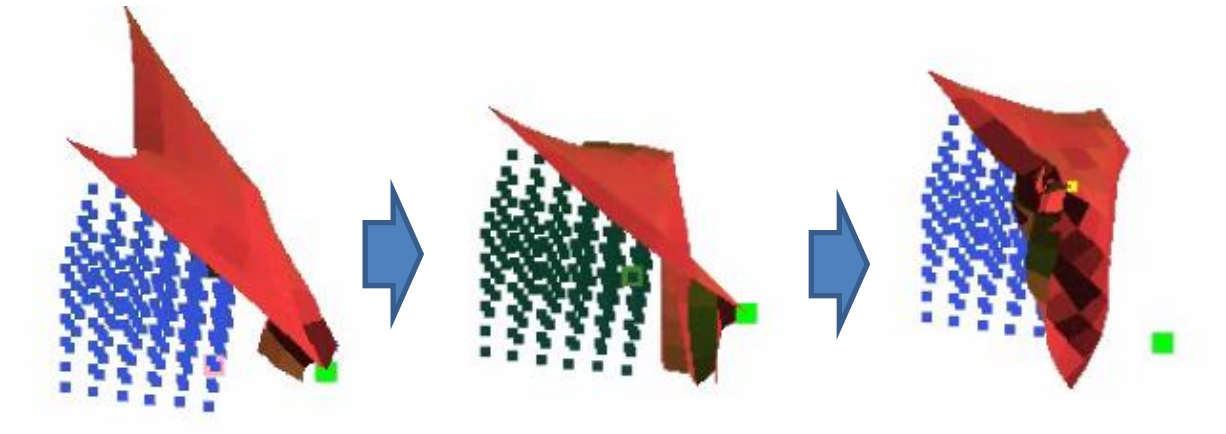


Figure 9: Result of Combination 4. The initial state is that two particles in the top of the cloth model are fixed.

5. CONCLUSION

In this study, cloth model manipulations, holding, releasing, attaching and mapping, are performed by using a hand motion in the real world in real-time. And, the cloth model is manipulated by using some manipulations in combination. The hand motion in the real world is obtained by using Kinect. The cloth model is particle model and the object model also consists of particles. Dynamic calculation, collision detection and collision reaction are defined.

The holding is performed by fixing the particle nearest to the hand to the hand position. This manipulation can be performed if the distance between the hand and the particle shorter than a threshold. The releasing is demonstrated by releasing the fixed particle. The attaching can be performed after the cloth model is held. The holding particle is moved to the particle of the object model nearest to the hand, and then dynamic calculation and collision reaction are performed. Next, the particle in the cloth model is fixed to the position where it moved by these calculations and released from the hand position. In the mapping, the particles in the cloth model are arranged based on the guideline of the dummy model. And then left side and top of the cloth model are fixed and dynamic calculation and collision reaction are performed. These manipulations except the holding are performed by pressing keys on the keyboard. In combination of the manipulations, the manipulations are performed by pressing their supporting keys

As the results, this algorithm can perform the manipulations and the combination of the manipulations can be also performed. Therefore, manipulations which user has intended are performed according to the hand motion in the real world. The results suggest the possibility of performing virtual draping by using this algorithm.

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 and Grants for Excellent Graduate Schools, MEXT, Japan.

REFERENCES

Yasseen Z., Nasri A., Boukaram W., Volino P., Magnenat-Thalmann N. (2013) Sketch-based garment design with quad meshes, COMPUTER-AIDED DESIGN, 45(2), 562-567

Wibowo, A., Sakamoto, D., Mitani, J., Igarashi, T. (2012), DressUp: A 3D Interface for Clothing Design with a Physical Mannequin, Proceedings of The 6th International Conference on tangible, embedded and embodied interaction (pp.99-102), Ontario, Canada,.

Igarashi T. & Hughes F. J. (2003) Clothing Manipulation, UIST and I3D Reprise session, ACM SIGGRAPH 2003, 697

Inui S., Suwa S., Kobayashi T., Horiba Y. (2012) Virtual cloth handling, Fiber Preprint, 67(1), 423

Mesuda Y., Inui S., Horiba Y. (2013) Cutting Method for Cloth Handling, Proceedings of 1st International Symposium on Affective Engineering, 145-151

Harada T. & Koshizuka S. (2007) Real-time collision computation between cloth and highly-tessellated models, Transaction of Information Processing Society of Japan 48(4), 1829-1837

Fuhmann, A., Gros, C., and Luckas, V. (2003) Interactive animation of cloth including self collision detection, Proc. WSCG, 141-148

Fuhmann, A., Sobottka, G. and Gros, C. (2003) Distance fields for rapid collision detection in physically based modeling, Proc. Graphi Con, 58-65

Zhao D., Wei C., Hujun B., Hongxin Z., Qunsheng P. (2004) Real-time Voxelization for Complex Models, Proc. 12th Pacific Conference on Computer Graphics and Applications, 43-50

BIOGRAPHY

Yuko Mesuda

Yuko mesuda enrolled in department of Kansei Engineering, Faculty of Textile Science and Technology, Shinshu University in 2006. She enrolled in department of Kansei Engineering, Faculty of Textile Science and Technology, Shinshu University in 2010. She is now the third year of the doctoral program at department of Bioscience and Textile Technology, Interdisciplinary Graduate School of Science and Technology, Shinshu University. In doctoral course, she studies simulation of deformation of a textile and handling of the textile model for virtual draping.

Shigeru Inui

Shigeru Inui is a Professor of Kansei Engineering Course at Faculty of Textile Science and Technology, Shinshu University since 2013. His research interest includes Kansei engineering, and computer simulation for garment design. He is a member of JSKE, Society of Fiber Science and Technology Japan, Textile Machinery Society of Japan, Information Processing Society of Japan and so on.

Yosuke Horiba

Yosuke Horiba received the M. E. from Shinshu University in 1999. He received the Ph.D. in Engineering from Shinshu University in 2001. Since 2002, he is an Assistant Professor of Kansei Engineering Course at Faculty of Textile Science and Technology, Shinshu University. His research interest includes Kansei engineering, and computer simulation for garment design. He is a member of JSKE, Society of Fiber Science and Technology Japan, Textile Machinery Society of Japan, Japan Research Association for Textile End-Uses and so on.