EVALUATION OF COMFORT OR PAIN BY VIRTUAL HUMAN IN USING OF SOME PRODUCT

Yoshinori Maekawa [1] **Bunzo Hasegawa** [2]

Department of Information Systems Engineering, Osaka Sangyo University[1]
3-1-1, Nakagaito, Daito-City, Osaka, Japan 574-8530
e-mail: maekawa@ise.osaka-sandai.ac.jp
Daito Medical Service Corporation[2]
1-1-30, Terakawa, Daito-City, Osaka, Japan 574-0014

Abstract

A virtual human which can evaluate Kansei such as comfort, pain, etc. when the virtual human uses some product is developed. In this paper, method of the evaluation of Kansei by the virtual human is presented. The body of our virtual human is modeled as an uniform non-linear elastic one with a skeleton. The deformation of the body on the contact with some product is simulated using a FEM analysis, and by using of the simulated results (load distribution, strain, etc.) on the contact surface the Kansei is predicted. As examples of the application, comfort of buttocks on seating and pain of arm on hanging of bag are shown. This virtual human can apply for the design of virtual products and also the simulation of medical care.

Keyword: comfort, pain, virtual human, body deformation

1. Introduction

Current practice in the design and development of a new product has utilized virtual human in evaluating motion and mechanism for the user-friendliness and ergonomics [1]. In this research we are developing a virtual human which can estimate the feelings (mainly pain and comfort) when a human's body has a contact with some object [2].

A feeling when a person uses some product comes from a contact surface between the person's body and the product. Then the condition of the contact surface is simulated, and the relationship between some factor in the simulated results (for instance, strain/stress values and load distribution) on the contact surface and the person's feeling is searched.

In this research, a model of human body for the simulation of the body's deformation was proposed and was verified. And also a relationship between a factor in the simulated results on the deformed body and the person's feeling was clarified.

By the simulation of a human body's deformation and the relationship between a simulated result and a person's feeling, we can predict a pain or a comfort in using of some product.

This virtual human developed in the research can

apply for the design of virtual products and also the simulation of medical care.

2. Mechanism of Virtual Human

The virtual human we are developing is modeled with a skeleton (a rigid body) and a uniform flesh (a non-linear elastic body) and is going to have the following functions (mechanisms) and databases:

1) Shape data of standard human bodies of men, women and also fat, medium, slender ones in their standing positions are available and the virtual human can transform itself into each of their human bodies.

2) When a human body changes the posture, the shape of each part of the body also changes. The virtual human can express the shape conversions of body accompanied with the motion.

3) Characteristic data of human body's (flesh) material for each part of a human body are available for the simulation of the contact deformation of body.

4) The virtual human can express the conditions of the contact deformation of the body by the simulation using a FEM.

5) Data of relationship between feelings (pain and comfort) and the condition of contact deformation are available and the virtual human can estimate the feeling using the simulated condition of contact deformation.

3. Model of Human Body

The characteristics of various parts of human body, such as skin, muscle and fat are different. In this work, we are interesting in the simulation of human's feeling in these body parts when subject to the contact with an object. Such feeling comes from the surface of human body, so the inside of human body is permitted as a simple model. Then we assume human body as a homogeneous rubber surrounding a skeleton as shown in Fig.1 and the homogeneous rubber behaves as a hyper elastic body according to Mooney model.

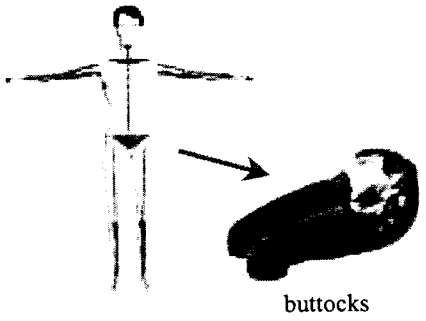


Fig.1 Model of human body

Characteristics of soft rubber and similar soft material like sponge are measured by Asker C_2-type hardness tester. We then adopted Asker C_2-type hardness tester to obtain material characteristics of human body, and tried to convert the hardness value by the hardness tester to Mooney constants.

Experimentally obtained Mooney constant for each part of human body is shown in Fig.2. The measured results have a dispersion naturally shown in Fig.2, because the measurements were done for the several persons. The large dispersions comes from the location which has the harder material

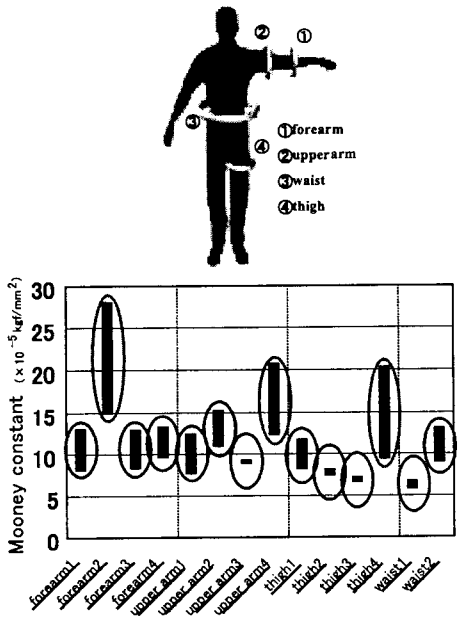


Fig.2 Experimentally obtained Mooney constant for each part of human body

characteristics. For the simulation of the human body's deformation, we employ the average value of the dispersion from the data of Fig.2.

4. Relation Between Pain and Contact Deformation of Body

After the result of the contact deformation of body is obtained by FEM simulation, the evaluation of a feeling is followed. For the evaluation, database of the relation between the feeling and contact deformation is requested.

As an example, for the feeling of pain we had the experiment to get the relation for each part of human body shown in Fig.2. As one method of the experiment, each part of the body was squeezed by a bandage with several intensity levels. We set three pain levels as follows:

Level 1 is that a person gets some discomfort.

Level 2 is that a person feels a distinct pain, but the person can endure it.

Level 3 is that a person can not endure the pain.

By the declaration of the pain level from each person who was squeezed by a bandage, strain (the amount of the squeeze) at each pain level was checked, and the relation between pain level and strain in the contact deformation of body was investigated.

Fig.3 shows the result for forearm and Fig.4 shows the result for waist. These results have some dispersions depend on the each person (examinee). In the result of forearm shown in Fig.3 we can distinguish each pain level, even though it includes the dispersion. On the other hand, in the result of waist shown in Fig.4 we can not distinguish level 1 and level 2. The case of the waist has a most difficulty to distinguish each pain level, so it is confirmed that to evaluate the pain at waist with a good reliability is hard, but at forearm, upper arm and thigh are possible to evaluate a pain level. The experiment was carried out actually for more pain levels into details, but the distinction between each pain level was impossible.

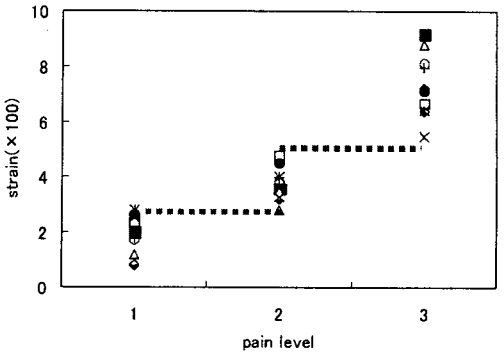


Fig.3 Relation between pain level and strain in deformation at forearm

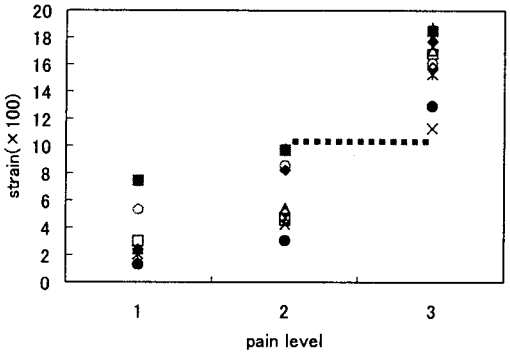
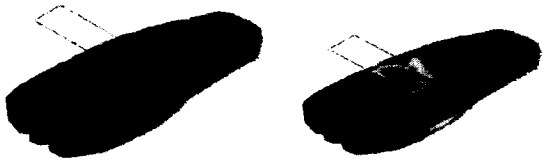


Fig.4 Relation between pain level and strain in deformation at waist

5. Evaluation of Pain Level in Using Bag

In this case we tried to evaluate the pain level of forearm on hanging of bag with two different weights. The same band-handle of bag with two different weights are hanged on the same forearm of our virtual human and their corresponding equivalent strain distributions are obtained as shown in Fig.5. The equivalent strain distribution between the forearm of the virtual human and the band-handle of bag is obtained in the simulation of the contact deformation and the maximum value of the obtained equivalent strain distribution is adopted to evaluate the pain level.



Pain level 1 Pain level 3

Fig.5 Simulation of deformation of forearm by the contact with band-handle of bag and evaluation of the pain level

In the case of the left in Fig.5 the evaluation by the virtual human comes pain level 1, and in the case of the right in Fig.5 the evaluation comes pain level 3. Then the virtual human expresses each feeling as shown in Fig.6.

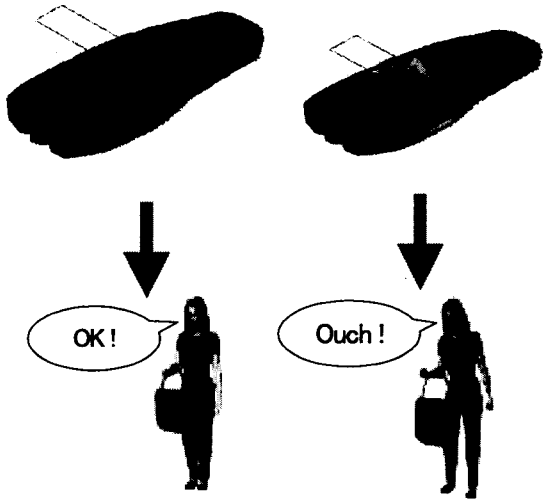


Fig.6 Evaluation of feeling by virtual human

Such a pain level depends on the weight of the bag, also the width of the band-handle of the bag. The virtual human is available to design such a band-handle of bag.

6. Evaluation of Comfort in Using Chair

In this case we tried to evaluate the comfort of buttocks on seating for two different sitting postures to a same chair. We utilized the same virtual human with two different sitting positions and their corresponding load distributions are obtained as shown in Fig.7. The load distribution between the buttocks and the chair is obtained in the simulation of the contact deformation by the virtual human.

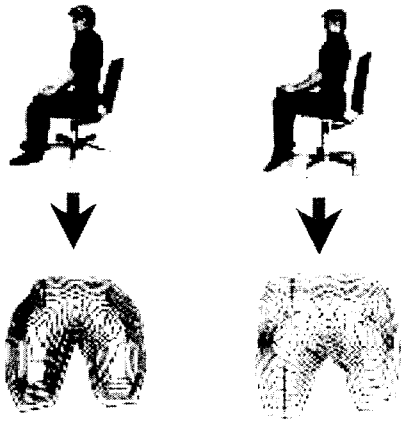


Fig.7 Simulation of deformation of buttocks by the contact with chair

The chair maker has the data of the relation between the load distribution of the buttocks at the contact with chair and the comfort of the chair experimentally. Based on the data, if overall load distribution is flat it is considered as comfortable, and if the distribution has a sharp peak it is considered as uncomfortable. The border value of the slope in the load distribution between comfort and discomfort is determined using experimental data.

In case of the Fig.7 the virtual human express each feeling as shown in Fig.8.

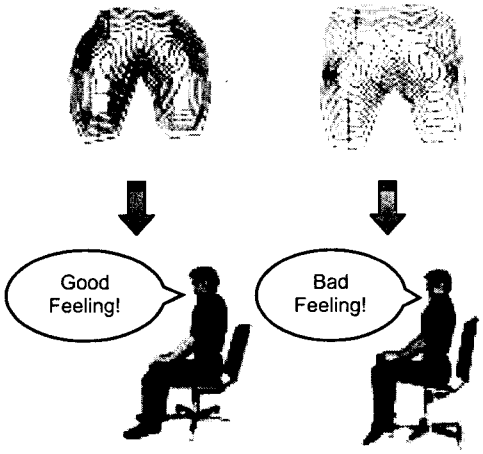


Fig.8 Evaluation of feeling by virtual human

7. Conclusion

The virtual human which can evaluate comfort and pain has been presented in this paper. In this research we are going to propose the concept of our virtual human and it's possibility. Reliability of the simulated result is confirmed by the comparison of simulated load distribution in buttocks to the experimentally obtained result. Fig.9 shows the comparison and they have a good coincidence.

We confirmed our virtual human can evaluate the feeling like comfort and pain, but yet many challenges must be tried.

We also confirmed our virtual human can be used in designing a new product through some examples of the application. The present methods can be applied to the design of nursing care robot with special consideration of what level and distribution of forces that can be applied to a nursing care patient. The concept is shown in Figure 10. Other applications include the design of bed in preventing soiled back, and the design of comfortable clothes.

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References

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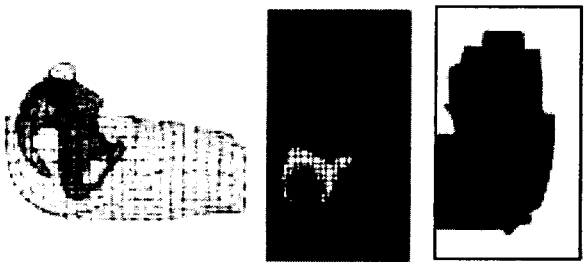

Model of buttocks | Experimental result | Simulated result

Fig.9 Comparison of simulated result with experimental result

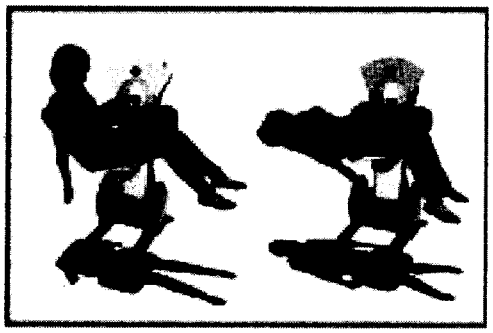

Fig.10 Example of application to nursing care robot