A STUDY FOR MODELING AND ANIMATION OF A HUMAN WITH BONE STRUCTURE AND CLOTHES

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ABSTRACT

A method to visualize human body is proposed for various human pose. The method affords three 3D-styles of the same body: firstly, one which wares clothes specified from pattern of dresses, second, body shape, lastly bone structure of body. For this objective, standard body data are prepared which is constructed from CT images. Individual body is measured by 3D body scanner. The present status of our research is limited to offer still images, though we are engaged to accommodate various poses.

Keywords: computer graphics, character animation, body line scanner, computed tomography, optimization problem, elderly care services, cloth simulation

1. Introduction

Topics in health care and medical applications are often shifted to discussion on instrument and equipment. This paper deals with clothes because of three reasons. Firstly, care for aged people at home gains relative importance. The aged and those who are responsible for care of elder people ware daily clothes, including street clothes instead of indoor ware used at hospitals and so on. Second, easiness in activity and safety become significant metrics at evaluation of clothes. Third, clothes will potentially gain multiple functions, including body measurement, treatment and communication.

Research in clothes was so far supported by specialists of domestic science. In the course of research, IT technologies were positively accepted as one of the major methodologies. Consequently, each course of pattern design, dressing simulation and ordering is realized by cooperation of computer and human design.

Clothes for care and medical uses come on market with special feature of easy fitting. However, variety of goods is poor because of market scale. The previous requirements fortunately give us an opportunity to change our approach to the design of clothes. Precisely, a new research of clothes had better focus on bidirectional visualization between clothes and human body, as well as that between human body and internal organ. Outcome of these technologies will offer us various knowledge about human body and clothes which corresponds to many cases of posture.

2. Related works

Measurement of human shape by 3D scanner is enforced inside and outside of Japan, where totally several thousands of peoples are joined in those experiments. Database [1,2], and statistical analysis [3,4,5] afford feature classification and composition of intermediate shape.

Though being in research stage, CG technologies are applied to CT/MRI images to extract anatomical structure of body[6]. For specified body, extracted 3D data of internal organs are commercially sold[7,8,9].

Animation of human body is usually seen in films and games. Commercial software, such as Maya and Poser, offer a platform to design 3D character. In research level, form of muscle is accurately reproduced[10,11]. Those methods are succeeded in specified human body. When, the same methods are applied to an arbitrary person, a precise measurement of human body is required in advance.

Special purpose programs are provided which reform accurate shape of muscle, though they are expensive, and hard to manipulate[13,14].

3. Modeling of human body

3.1 General flow

Figure 1 illustrates our experiment which generates individual body shape from standard body data. 3D scanned body shape is mixed with skeleton taken from CT image of the same body to generate a standard body data. Then, landmark points of target body are used to reform standard body data.

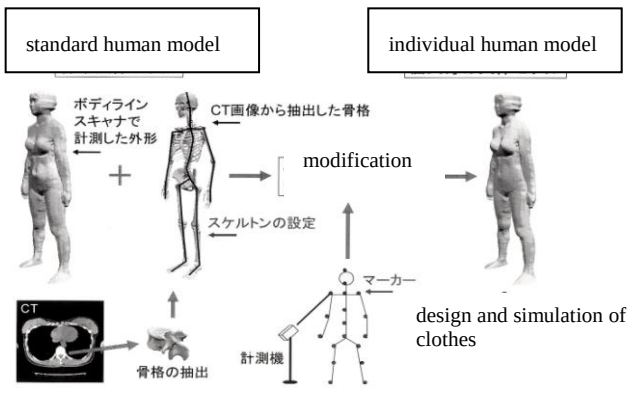


Fig. 1 General Flow

3.2 CT scan

With the cooperation of the Kanazawa medical university, a monitor (female, 20's) is CT scanned. Totally 2000 slices, with each slice being 512 x 512 pixels, are taken at the interval of 0.5mm. The time needed is about 10 minutes, including CT manipulation. Figure 2 shows CT slices.

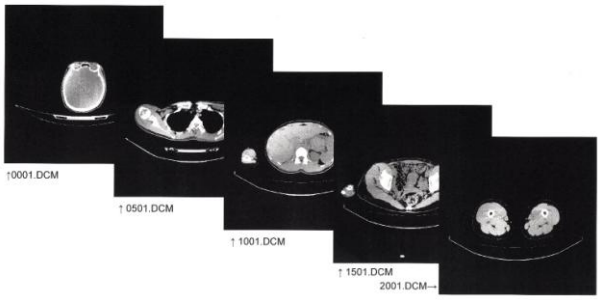
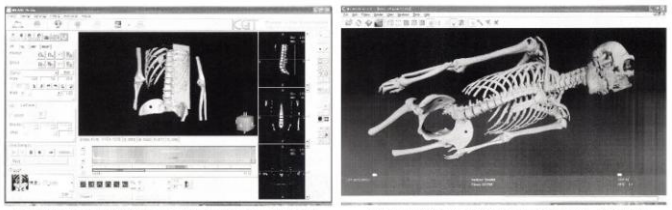


Fig.2 DICOM image scanned by CT

3.3 Extraction of bone structure

For DICOM data, threshold '170' is used to get bone structure. Extracted skeleton is stored as general polygon format, OBJ file. Left image in Figure 3 shows bone structure of CT browser. For image processing, original DICOM's dcm-format is transformed to obj-format, as in shown on the right side.



Output of Intage Realia Output of MeshLab

Fig.3 Extraction of bone structure.

Similarly, threshold '300' is used to get body shape, or skin surface.

3.4 Measurement of body shape

Bodyline Scanner (BLS), made by the Hamamatsu Photonics K.K., is also used to get body shape. In our experiment, the same monitor, who joins CT scanning, is chosen for simplicity of subsequent process. To be precise, body shape of CT and that of BLS are almost same, except for their pose. In future, we plan to remove the supposition . Since original body shape, taken by BLS, has disordered surface, simple smoothing is applied to it.

3.5 Position matching

Skeleton/body shape data taken from CT and BLS are both imported to CG software, MAYA. Landmarks are assigned to distinctive points of CT and those of BLS. Then, 3D position data are collected. Using these position data, Affine transform is applied to adjust the corresponding landmarks with each other. Figure 4 illustrates an example of landmark, and body image where CT and BLS are overlaid. Here, different position of arm is seen at overlaid body. This comes from different pose of monitor person.

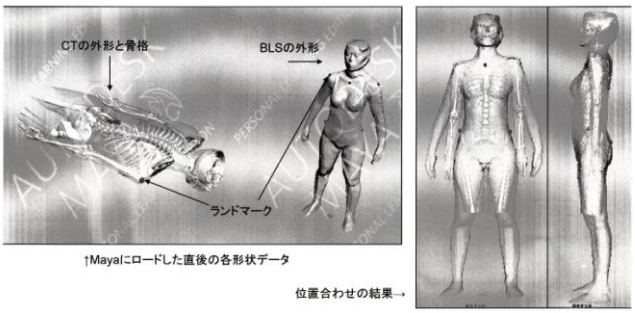


Fig.4 Position matching between CT image and BLS image.

3.6 Binding skeleton to CT and BLS

In order to accord poses of CT and BLS, skeleton is applied, at first, to CT image. After binding bone structure and skin to skeleton, we can get CT image with arbitrary pose. In our experiment, we select pose so that distance between landmarks of CT and BLS may be minimized. Figure 5 shows skeleton and bound image.

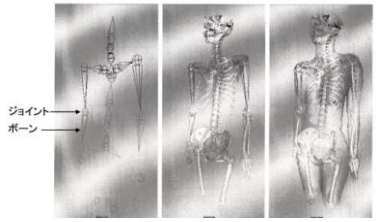


Fig.5 Skeleton and bound image.

After the preceding process, skeleton is bound to both CT bone structure and BLS. Hence, we can get BLS + bone image with arbitrary pose.

3.7 Discussion

In above process, both skin surface of CT and BLS are obtained from the same person. Therefore, in this case, introduction of BLS is not essential. However, in general case, CT scanning is not always available for those who are not sick. For general cases, an advanced approach will be necessary to yield CT like image only by scanning body shape. Though we have not clear ideas for this objective, a modified sample CT image may be used as candidate of CT image referred in the preceding sections.

4. Simulation of clothes

4.1 General flow

Motion of human body is simulated with his/her clothes. Poser and Maya are suited software for this objective. Compared with the existing approach, we aim at the following research target.

(1) Human body is specified by scanning skin surface, and is not given as prefixed data.

(2) There are occasions when user requires bone structure.

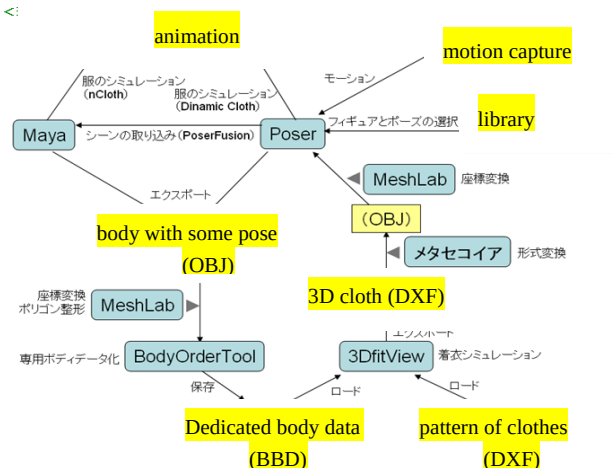


Fig.6 Flowchart of cloth simulation and pattern design.

(3) Clothes must be accompanied with their pattern diagram.

Typical applications that need those requirements are medical usage. An example is a cloth that is used at medical inspection, where a patient wares many sensors and lead cables during a day. In such a case, clothes must be safe and comfortable for patients. Figure 6 shows flowchart for cloth simulation and pattern design.

4.2 Cloth simulation

In the previous section, we discuss about modeling of human body. Its process outputs a 3D human body with bone structure. This section generates motion with given body data and captured motion. Poser is responsible for the role. Since output of Poser is in OBJ data format, its format is transformed to dedicated format BBD.

An example of pattern and ware is shown in Figure 7.

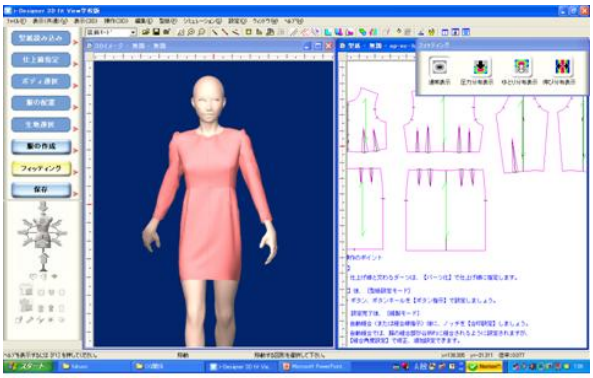
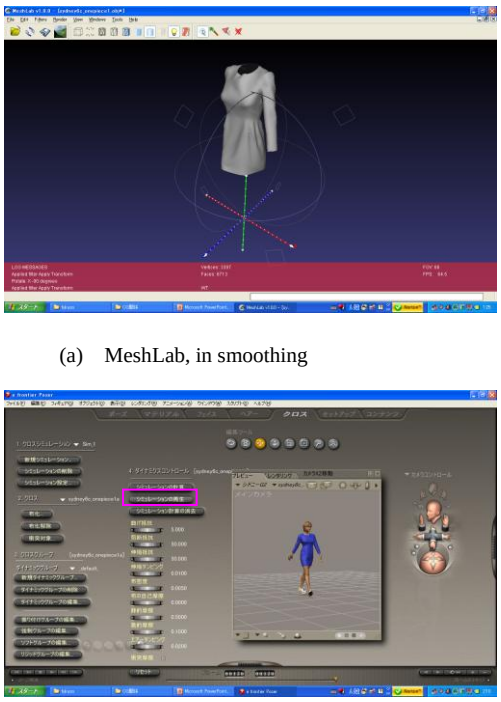


Fig.7 Example pattern of lady's ware.

Our present status is under development of total flow shown in Figure 6. An example of wore image is shown in Figure 7, which is also taken from 3DfitView. Since dedicated data format is used in the tool, we now cope with format transformation. Figure 8 shows samples of simulation process.



(a) MeshLab, in smoothing

(b) Poser, in simulation

Fig. 8 Simulated image of woman in clothes.

5. Conclusion

This paper discusses how to simulate human body with his/her bone structure and clothes. Since the whole processing flow includes many steps, we use various tools, and in consequence, many data format are introduced. Main objective of the paper is to present an overall problem. Detailed discussion must be necessary for system development.

One of the difficult problems is to estimate CT image from BLS data. Though CT image include internal organs as well as skeleton, named as bone structure in this paper, at least CT with skeleton had better be estimated. Clinically, it is well known that skeleton of human body varies individually. As a result, it is necessary that CT scan images must be accumulated so as to tackle statistical estimation in reasonable way.

Another important problem is to develop effective application of the proposed method. In the present paper, we propose special clothes for medical inspection. We think that another promising scene is assumed to be education. An example is usage at training school for nurses. Care actions for elder people require attentive manner in order to avoid medical accident. Though existing textbooks and videos can offer typical motion, one cannot learn status of internal body, with respect to both nurse and elder person.

The subsequent research plan is to develop remaining software at first. Measurement tool of electrical potential for muscle is supposed to be applied for inspection ware. For this objective, discussion with a doctor is in progress. Since the tool also requires communication media, it takes sufficient time for development. Design of education tools

is also planned, and CT scan was executed for about 20 young men/women. E- learning tools are under development in parallel.

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