3D Character Animation In Augmented Reality Using 3D Laser Scanned Body Data

Gyu-Hong Lee[1], Geun-Ho Yoon[1], Chang-Suk Cho[1],

[1] Div. Of Information & Telecom., Hanshin University,
Yangsan-dong, Osan-si, Korea
cscho@hs.ac.kr

Abstract. An implementation of a motion editor using laser-scanned 3D body data and the animated result in augmented reality are reported in this paper. The body data were framed to skeleton model and organized as hierarchical structure. In order to implement the 3D animation of the body data, the vertexes of the objects were connected as skeleton structure and animated to follow dynamic patterns inputted by user. The proposed method can represent various 3D motion of the body in augmented reality.

Keywords: 3D animation, laser scanned body data, skeleton, augmented reality

1 Introduction

3D body animation contents are rapidly propagated with the development of realistic motion description technique. As researches for implementing 3D character animation, hierarchical and skeletal modeling are widely used for 3D character animation. In recent researches, anatomy based hierarchical model were suggested in which the structure of bone and muscle were defined [1-2]. As for effective rotation Hermit curve were proposed, where the motion generated became smooth and natural without quirks [3]. We introduce a motion editor for 3D body animation using laser scanned body data and report the result of the 3D body animation represented in augmented reality. The body data were framed to skeleton model and organized as hierarchical structure in order to edit the 3D body object.

2 3D Animation Using the Body Data

The body data were obtained using a laser scanner (Cyberware WB4). This body dataset is composed of about 120,000 points and the 220,000 polygons. The body object should be framed to skeleton model with hierarchical structure in order to implement 3D body animation. The 3D body is framed as skeleton model using the 14 points and partitioned into 10 objects in this research as shown in figure 1. The partitioned object should be connected with skeleton and built to hierarchical structure related as parent and child. When the skeleton is rotated, the vertexes of polygon connected with the skeleton also should be rotated to relative extent as rotation of the skeleton. Movement of child skeleton, that is, should be controlled so as to follow the movement of parent skeleton.

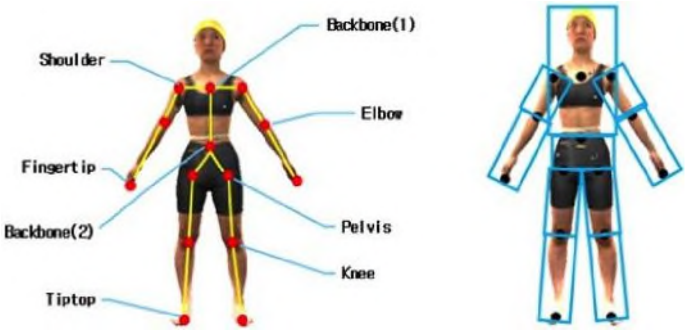


Fig. 1. The skeleton model of the body and the joint points with partitioned area

Equation 1 means the control for animation in hierarchical structure.

$$P_{end} = M_{child} M_{parent(n)} M_{parent(n-1)} — M_{parent(1)} P \qquad \textbf{(1)}$$

In equation 1, $P = (x, y, z, 1)^T$ and $P_{end} = (4)^{\prime},4\ 1)^T$ mean the 3D position vector of vertex (x, y, z) before and after moving. The transform matrix M can be interpreted into the following equation 2 as quaternion equation. The transform in equation 2 is very useful to represent bending motion in elbow, knee, pelvis, but is difficult to represent torsion of arm, leg and body in the equation [4]. In equation 2, T means translation matrix and u_x, u_y, u_z represent directions of unit vector u.

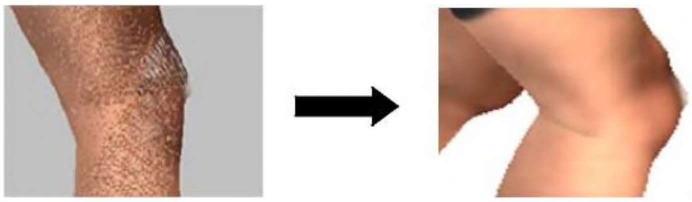
$$P_{end} = 7^{-1} M_R(6) TP \qquad \textbf{(2)}$$

$$M_R(\theta) = \begin{pmatrix} u_x^2(1-\cos\theta)+\cos\theta & u_x u_y(1-\cos\theta)-u_z\sin\theta & u_x u_z(1-\cos\theta)+u_y\sin\theta & 0 \\ u_y u_x(1-\cos\theta)+u_z\sin\theta & u_y^2(1-\cos\theta)+\cos\theta & u_y u_z(1-\cos\theta)-u_x\sin\theta & 0 \\ u_z u_x(1-\cos\theta)-u_y\sin\theta & u_z u_y(1-\cos\theta)+u_x\sin\theta & u_z^2(1-\cos\theta)+\cos\theta & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

Result after transformation around the joint shows unnatural interval or holes among vertexes. In order to interpolate these faults, an interpolation based on rotation angle is proposed here. In this interpolation the rotation angle given to the model are applied propositionally to the position of the vertex. The transformation in skin will be different to the position, so that interpolation areas on each joint are defined. The vertexes in the interpolated areas have a weight to rotation angle from 0.0 to 1.0. This weight can be defined to what extent of ratio that the rotation angle of the frame will be applied to the rotation angle of vertex. However the weight has a fixed difference in ratio, the result of the interpolation shows unnatural output. To avoid the problem we defined the ratio of weight as Hermit curve interpolation. Equation 3 shows Hermit curve interpolation.

$$\omega = -2S_v + 3S_v^2 \quad \left(S_v = \frac{|l_v|}{|L_v|}\right) \qquad \textbf{(3)}$$

In equation 3, l_v means the distance between the basis of the frame and the vertex which needs weight. L_v is the distance between the top and the bottom in the interpolation area. Figure 2 shows the border on knee joint between the pelvis and the leg. From (A) of the figure many cracks can be observed due to 3D rotation. (B) of the figure is the output applied to our proposed method. From the figure (B) we can't observe such cracks shown in (A). Figure 3 represent the result of walking movement operated in our proposed system.



(A) (B)

Fig. 2. The interpolation areas defined on the joints

Fig. 3. Walking animation applied to our proposed algorithm

3 Implementation of 3D Animation on augmented Reality

Our goal in this section is to show the 3D body animation mixing with active moving image under Android mobile OS. A marker, which is an image, works to show the animation graphics to monitor instead of itself if it is recognized by a camera. In figure 4 a marker is shown to be recognized. This marker was made in monochrome image. We used some tools like QCAR [5] and UNITY [6] to implement animation in augmented reality. QCAR is used to recognize the marker. The recognition using QCAR is very successful, so that it shows over 99% success rate in recognition. Recognition module of marker made in QCAR should be imported in UNITY which unifies recognition module of QCAR and graphic animation module. Figure 4 shows the combined result of the marker and the 3D body object in augmented reality. We implemented the body animation in augmented reality under Android OS. QCAR and UNITY support Android OS.

4 Conclusions

We introduced the editing system for 3D body data animation and also showed the implemented result the 3D animation in augmented reality. The motion editor for 3D body animation shows good results and proved our proposed algorithm's effectiveness. Our research has a merit in using the laser-scanned body data instead of a graphic avatar since it can be used for the service which should use only real body data. Especially, using this system digital actor can serve instead of stunt actor in dangerous action. Also the result presented in augmented reality can be used in fairy tale since child can have interest to see self-animation in fairy tale.

(A) **(B)** **(C)**

Fig. 4. Marker and the 3D body object in augmented reality

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