A Skinning Technique Considering the Shape of Human Skeletons

Hirofumi SUDA[i] **Kentaro YAMANAKA** **Shigeo MORISHIMA**

Waseda University

1. Abstract

We propose a skinning technique to improve expressive power of Skeleton Subspace Deformation (SSD) by adding the influence of the shape of skeletons to the deformation result by post-processing.

2. Introduction

It is general that the deformation of 3DCG character model is expressed by motion of the skeleton. The representative example of the transformation method is SSD[1]. SSD is a technique to deform character by linear blending of transform matrices with weight for each skeleton. The expression is as follows (1).

$$S' = \Sigma_{i=1}^{b} w_i T_i T_{0,i}^{-1} S_0 \tag{1}$$

S_0 is a vertex on the original surface in rest pose, $T_{0,i}^{-1}$ is the transform from the surface to the skeletal flame in the rest pose, T_i is the transform from the skeletal flame to the surface containing S_0 in the current pose, w_i is the weight for each skeleton and S' is the vertex on the surface in current pose. SSD is fast to compute and most common technique, on the other hand, the deformation with SSD can't get enough expressive power. For example, the defects called "Joint-Collapse", "Candy-Wrapper" happen. To solve this problem, several techniques as post-process interpolation have been proposed. For example, Damien et al proposed a shape interpolation technique with volume preservation [2]. This technique can interpolate the original surface in arbitrary direction. On the other hand, it isn't suite for part that need more detail like human joints. So, we focus on the part where joints shape appear remarkably, and propose the technique for improving expressive power by considering influence of bone shape.

3. Modeling the skeleton motion from Mocap data

Reproducing the internal skeleton movement is important in expressing real shape of human body. So, we focused on the forefinger as a part to which shape of joint remarkably appears and obtained coordinate data of characteristic points of each bone from motion capture system. From the obtained data, we estimate the center of rotation about the phalanx proximalis, phalanx media and phalanx distalis from optimization by Simulated Annealing. Finally, we generate the skeletal motion by applying these to the bone models.

Figure 1: *Scenery of capturing motion data.*

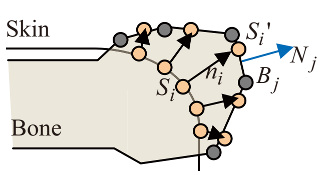

Figure 2: *Expression of projected bones.*

4. Representation of skin shape around joint

To represent the skin shape around the joint, we bury the bone models under the skin and reflect its shape in the original surface. When the bones project over the skin, we find the intersection of a straight line which extends from the vertex of the skin model to the direction of normal vector and the mesh of the skeleton model like the following expressions (2). After that, we transform the mesh according to that (Figure 2).

$$t_i = \frac{-N_j \cdot (S_j - B_j)}{N_j - n_i}$$

$$S'_i = S_i + n_i t_i \tag{2}$$

S_i is the vertex on the original surface, n_i is its normal vector, and B_j is one of the vertices that compose a polygon of the bone model. N_j is the normal vector of this polygon. Figure 3 shows the result that applied our method in the right hand forefinger. (a) is the result of applying the SSD only, (b) is the result of applying the our method, (c) is the real photography. In the (a), the outside of the joint is transformed smoothly. On the other hand, the result in (b) is more similar to real shape.

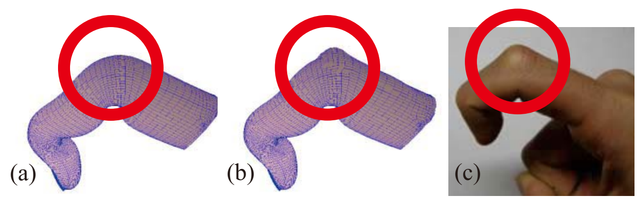

Figure 3: *Comparison of SSD (a), our method (b) and real photography (c).*

5. Conclusion

In this work, we proposed a skinning technique to improve representation around the joint which reflects the shape of skeletons remarkably by post-process deformation. As future work, we should construct the more accurate skeleton model and evaluate accuracy by measuring accurate positions of skin and skeletons with MRI. We also need to consider the interpolation of the inside of the joint which have not taken up in the present study to improve the expression.

References

[1] Magnenat-Thalmann, N., and Thalmann, D. "Humanbody deformations using joint-dependent local operatorsand finite element theory", *In making them move:mechanics, control, and animation of articulated figures*. Morgan Kaufmann, 1991. pp.243-262.

[2] Rohmer D., Hahmann S., Cani M.-P. "Exact volume preserving skinning with shape control", ACM SIGGRAPH Symposium on Computer Animation. 2009.

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[i] email: hirofumism_0319@ruri.waseda.jp

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