Real-time Human Hair Modeling and Animation

Chuan Koon Koh and Zhiyong Huang
{kohchuan | huangzy}@comp.nus.edu.sg
Department of Computer Science, School of Computing
National University of Singapore, Lower Kent Ridge Road, Singapore 119260

1 INTRODUCTION

In recent years, we have seen significant advances being made in 3D computer graphics technology, software APIs such as Microsoft's Direct3D and Sun's Java3D, as well as in the consumer 3D acceleration hardware. Thus there is a need to review the existing techniques of modeling and animation of hair.

Various methods have been employed to model human hair, including modeling hair strands individually [1, 4]; using trigonal prisms with 2D hair distribution maps [3, 9] and more recently, volumetric visualization techniques [6, 7]. These approaches concentrate mainly on modeling hair accurately, and often require specialized rendering algorithms. As such, hardware acceleration is unlikely to be available for the above approaches, making them more suitable for off-line graphics system.

We propose a different but simple framework of hair modeling and animation that is suitable for real-time applications. The main idea is to model and animate hair in strips, using polygon tessellation, texture-maps and transparency.

2 THE FRAMEWORK

Hair strands can be grouped into strips, which are modeled geometrically by parametric surfaces. Texture mapping using hair images can then be applied on these surfaces (Figure 1(a)). The alpha map (Figure 1(b)) in texture mapping removes the "rectangular look" of these surfaces and adds the final realism (Figure 1(c), 1(d)). A variety of shapes may be defined for each strip (Figure 1(e)).

We took all advantages of parametric surface such as its accurate and compact representation, shape editing techniques, and inherent continuity.

Another advantage of this framework is that the level-of-detail is scalable (Figure 1(f) and 1(g)) by applying multiresolution techniques. When the viewpoint is far, a courser tessellation is used. When getting closer, it can be tessellated more finely. Similarly, we can use different resolution of images for texture mapping. The established technique of MIP Mapping is also applied [10].

The use of texture mapping, as well as a large number of polygons tessellated from parametric surfaces, makes good use of current development of software and hardware acceleration technology [5, 8].

Animation is achieved by displacement of the control points of hair strips. Existing techniques such as the physically based modeling of clothes [2] can be applied to solve animation issues like collision detection. We are exploring further in this direction now. The current experiments are done using key framing (figure 1(i)).

3 IMPLEMENTATION

Our framework is object-oriented. The Java3D 1.1.3 API is used for the implementation. Each hair strip is implemented as one object, which contains information of its geometry and appearance. In addition, the hair strip object contains methods to re-tessellate and deform its geometry to generate new key-frames. It also has listeners that wake up on events to trigger animation and selection of different level-of-detail for tessellation. The object-oriented model improves interactivity.

4 REFERENCES

[1] K. Anjyo, Y. Usami, T. Kurihura. A Simple Method For Extracting The Natural Beauty Of Hair, SIGGRAPH(92), pp. 111-120.

[2] D. Baraff and A. Witkin. Large Steps in Cloth Simulation, SIGGRAPH(98), pp. 43-54.

[3] L. H. Chen, S. Saeyor, H. Dohi, and M. Ishizuka. A System of 3D Hair Style Synthesis Based on the Wisp Model, The Visual Computer, 15 (4), pp. 159-170 (1999).

[4] A. Daldegan, T. Kurihara, N. Magnenat Thalmann, and D. Thalmann. An Integrated System for Modeling, Animating and Rendering Hair, Proc. Eurographics '93, Computer Graphics Forum, Vol.12, No3, pp.211-221.

[5] H. Hoppe. View-dependent Refinement of Progressive Meshes, SIGGRAPH(97), pp. 189-198.

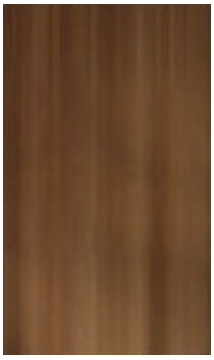
[6] W. Kong and M. Nakajima. Visible Volume Buffer for Efficient Hair Expression and Shadow Generation, Computer Animation '99, (May 1999, Geneva, Switzerland). IEEE Computer Society.

[7] F. Neyret. Modeling, Animating, and Rendering Complex Scenes Using Volumetric Textures, IEEE Transactions on Visualization and Computer Graphics, 4(1), pp. 55-70 (January-March 1998).

[8] C. C. Tanner, C. J. Migdal, and M. T. Jones. The Clipmap: A Virtual Mipmap, SIGGRAPH(98), pp. 151-158.

[9] Y. Watanabe and Y. Suenaga. A Trigonal Prism-Based Method For Hair Image Generation, CGA(12), No. 1, 1992, pp. 47-53.

[10] L. Williams. Pyramidal Parametrics, SIGGRAPH(83), pp. 1-11.



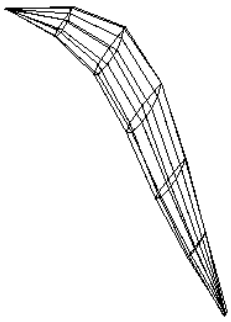
(a) Texture Map

(b) Alpha Map

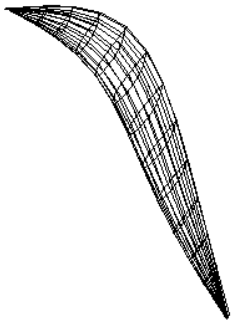
(c) A Collection of Hair Strips, Gouraud Shaded

(d) With Texture and Alpha Maps Applied

(e) A “Volumetric” Pony Tail Hair Strip



(f) Low Level of Detail



(g) Higher Tessellation

(h) Front View

Original, Frame 0

Interpolated, Frame 1

Interpolated, Frame 2

Generated, Frame 3

(i) Snapshots of Four Frames from the Key Framing Animation

Figure 1: Experiment Results