Parameter Controlled Hair Rendering

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概要：最近、頭髪や毛皮にみられるような複雑かつ非常に細かなテクスチャをコンピュータ・グラフィックスにより生成する方法の研究がさかんになってきた。このような状況において、第３８回全国大会における筆者らの「三角柱と房のモデルによる頭髪の生成」は、頭髪特有の複雑で細かなテクスチャを生成できるのみならずその全体構造である髪型を制御することをも可能とする方法を述べた最初の報告であった。本報告は、前記報告での頭髪生成方法に基づき、頭髪像を生成するために必要な１０個のパラメータについて述べ、パラメータの変化が生成頭髪像に与える影響を実際の生成画像で示す。

Introduction

Hair and fur image generation is an important problem in CG [1]-[6]. The appearance of hair and fur is not characterized by their complex textures alone. Our trigonal prism based wisp model seems to be the first which clearly handles hair style (shape) generation [2, 3]. This paper introduces the ten parameters needed for efficient hair image generation using the trigonal prism based wisp model.

Parameters for hair image generation

Figures 1 and 2 illustrate the trigonal prism based wisp model. Various hair images are easily generated by controlling just the ten parameters listed in Table 1. A hair is modeled as a chain of trigonal prisms defined by the six parameters: l, t, v, d, N, and C. A wisp is composed of a bundle of hairs defined by two parameters: M (number of hairs per wisp) and R. The hair style is controlled by T and K. The roles of these parameters are described below using examples.

The hair style is controlled primarily by changing wisp shape. Though a wisp is defined as a set of hairs having various properties, e.g., thickness, stiffness, and straightness, the wisp shape is strongly affected by the external conditions, i.e. gravity, combing, hair oil, a permanent wave, etc. The loci of wisps are determined to obtain the desired hair style with the specified hair roots. Figures 3(a), (b) and (c) show the effect of changing the number of prisms per hair, N. Despite the fact that no other parameters are changed, this generates different hair styles. Next, hair stiffness control is illustrated based on the image shown in Figure 3(c). By changing only v, images of very hard hair, hard hair, medium hair and soft hair are obtained as shown in Figure 3(c), Figures 4(a), (b) and (c), respectively. Figures 5(a), (b) and (c) show the effect of changes in hair density M (number of hairs per wisp). By changing only M, various images with a lot of hairs, a medium number of hairs and a few hairs are obtained.

The rendering time is proportional to the product of M and N (the number of drawing primitives). Comparing Figures 4(b) and 5(a) for example, the picture quality is almost the same. Figure 5(a) seems to have more hairs than Figure 4(b), while the rendering time is shorter for Figure 5(a). This is mainly due to the difference of M. Generally speaking, the rendering time is reduced if d is increased, and M decreased, though the parameters should be properly chosen according to the required image quality.

Conclusion

This paper described the ten parameters needed for efficient hair rendering using the trigonal prism based wisp model. We showed that various hair styles are easily generated by controlling a small number of parameters. A notable feature of the proposed method is that it is suited to the conventional z-buffer algorithm and hardware, which is the fastest practical rendering tool available today.

パラメータ制御による頭髪像の生成
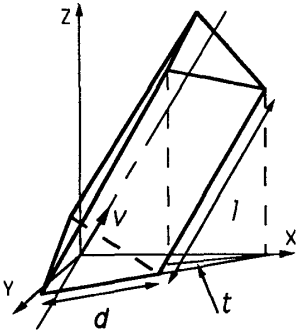渡部　保日児　　末永　康仁
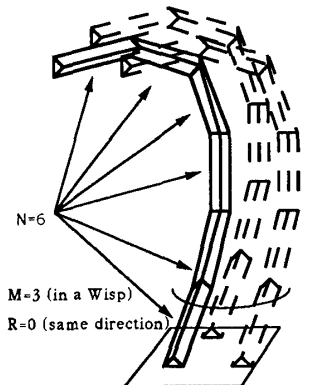ＮＴＴヒューマンインタフェース研究所

Figure 1. Trigonal prism

Figure 2. Trigonal Prism based Wisp model

Table 1   Parameters for hairy image generation

No.	Symbol	Description
1	t	Twist angle (of trigonal prisms)
2	v	Direction vector (of trigonal prisms)
3	l	Length (of trigonal prisms)
4	d	Thickness (of trigonal prisms)
5	N	Number of trigonal prism(s)
6	C	Hair color
7	M	Hair density (number of hairs in a wisp)
8	R	Direction vector randomness
9	T	Total number of wisp(s)
10	K	Kind of wisp(s)
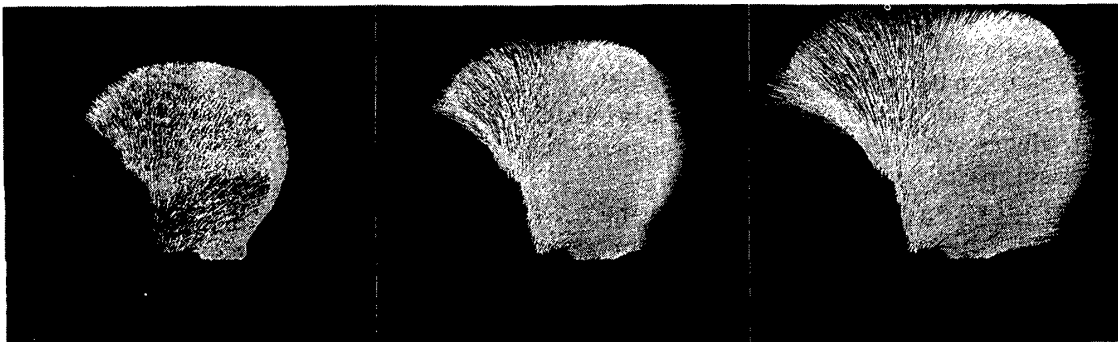
(a) N=1 (15sec)   (b) N=6 (53sec)   (c) N=9 (77sec)

Figure 3. Images rendered for various values of N
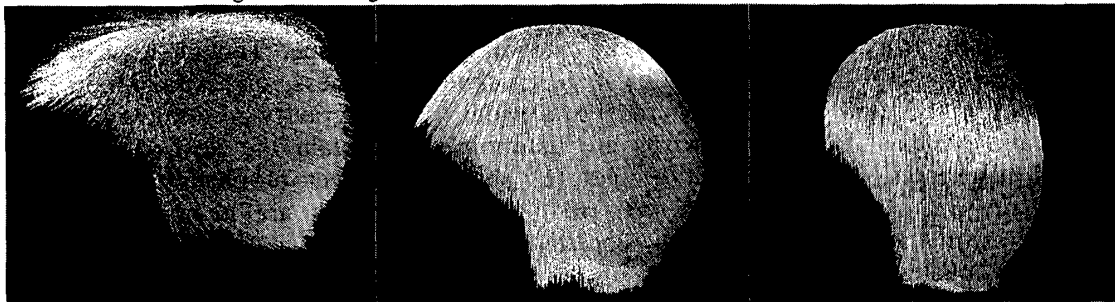
(a) (77sec)   (b) (77sec)   (c) (77sec)

Figure 4. Images rendered for various values of v
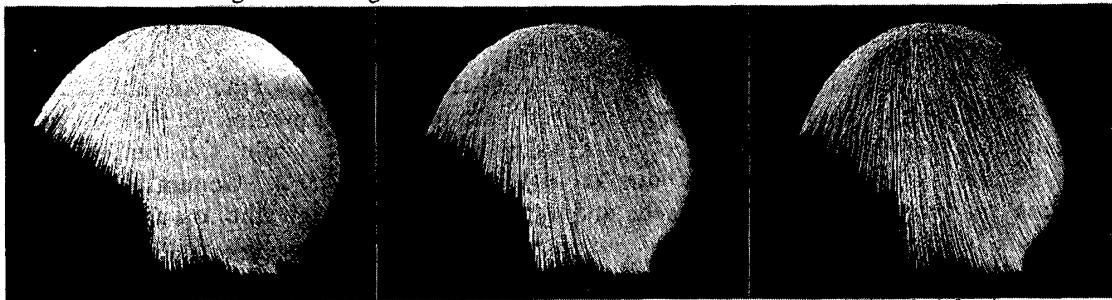
(a) M=1/2 (44sec)   (b) M=1/4 (25sec)   (c) M=1/8 (13sec)

Figure 5. Images rendered for various values of M

t, R: Constant, T=5652, K=1 (Rendered on IRIS-4D/70GT)

References

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