Generating Feather Coats Using Bezier Curves

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1 Introduction

Feathers, like hair and fur, dramatically alter the appearance of a surface. However, unlike hair and fur, feathers have a wide range of colours and patterns and a well-defined branching structure. The variety of individual feather structures and patterns contribute to the surface appearance. Thus, it is important to model the complete range of feather types found in a feather coat. Since a feather coat can consist of thousands of structurally unique feathers, it is desirable to automatically generate most of the feathers, while maintaining intuitive control over the coat design and the creation of a wide variety of feather types. Previous work on feathers [Dai et al. 1995] does not address the intuitive generation of such a coat.

2 Feather Structure

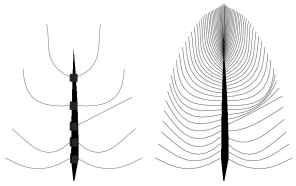

Figure 1: Left: keybarbs; Right: feather structure.

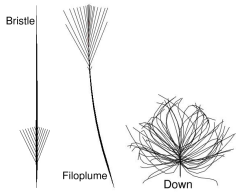

Figure 2: Variety of created feather types.

We need to automatically generate feathers that are individually unique, but that exist in a coat comprised of a certain range of feather types; therefore, the parameterization used to model the feather structure must allow for smooth interpolation between types and ages of feathers. The parameterization we propose is based on Bezier curves. Both the main shaft of the feather and the branching sub-structures (*barbs*) are defined by Bezier curves. A small set of parameters based on physical sub-structures of feathers are used. These include the barb spacing, the barb angle at the base and tip of the shaft, the length of the barbs and the length and width of the shaft. Additionally, a set of shape-defining **keybarbs** are specified. Barbs between these keybarbs are generated by interpolating the control points of the keybarbs (see Figure 1). In the absence of keybarbs, a default barb with random control vertices is used to simulate the downy portions of feathers. The generated feather types are shown in Figures 2, 4, and 6.

2.1 Interpolation

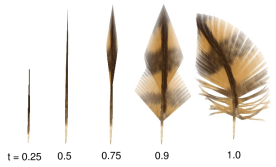

Figure 3: Interpolation simulating feather growth.

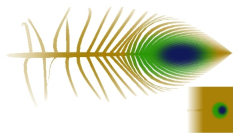

Figure 4: Simulated peacock feather.

In a similar manner, interpolating between keybarbs on different feathers generates a range of feather types. The number of keybarbs may be temporaily inflated to interpolate between feathers with varying numbers of keybarbs. Using the feathers defined with keybarbs and the interpolation constants, a feather with a new set of keybarbs is generated. Intermediate barbs are generated as above.

Finally, interpolation of all the parameters, in sequence, simulates feather growth. First the shaft length/width and barb length are interpolated to their final values. This simulates the growth of an encased *pin feather*. The opening of the feather is simulated by interpolating the keybarb control vertices, from a position along the shaft to their final positions, while interpolating the shaft control vertices to their final position. Figure 3 shows an example of simulated growth.

2.2 Texturing and Rendering

The shaft is modelled as a generalized cylinder and the barbs are modelled using two triangle strips on either side of the Bezier curve. The barbs are then alpha-blended with specific order length-wise (from base to tip) and width-wise (from the centre to the edges) to simulate the transparency of feathers.

3 Feather Coats

Finally, using a small set of defined feathers (*key feathers*) positioned at particular locations on the model, bi-linear interpolation is used to generate uniquely structured feathers at all intermediate locations (see Figure 5).

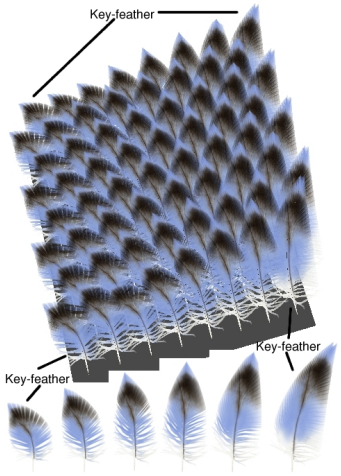

Figure 5: Feather coat example using two feather types positioned at the four corners.

Figure 6: Hawk feather; generated version on left, scanned on right.

References

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