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User Customizable Real-Time Fur

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Outline



- Shell and Fin Extrusion
- Per-Pixel Anisotropic Lighting
- Hair Color Sourcing
- Hair Density Control
- Hole Filling for Mip-maps
- Future Work



Bear Fur

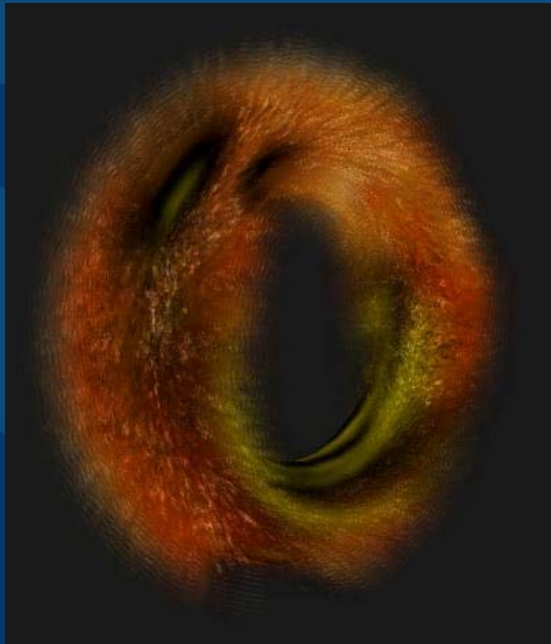
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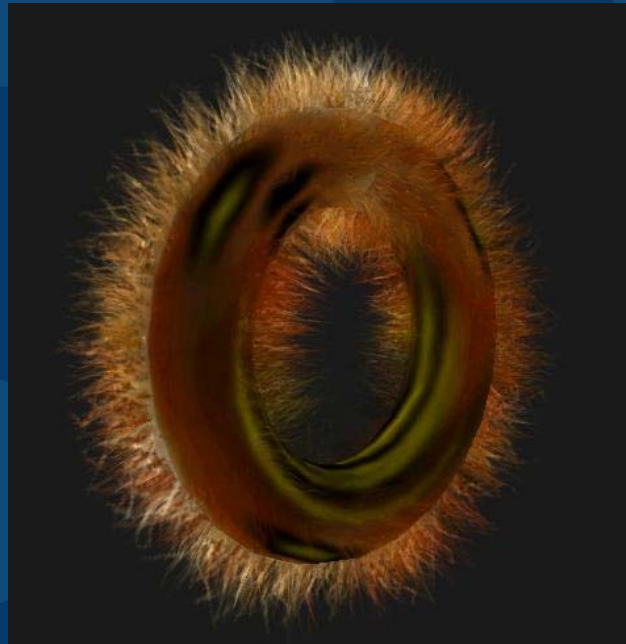


Shells and Fins



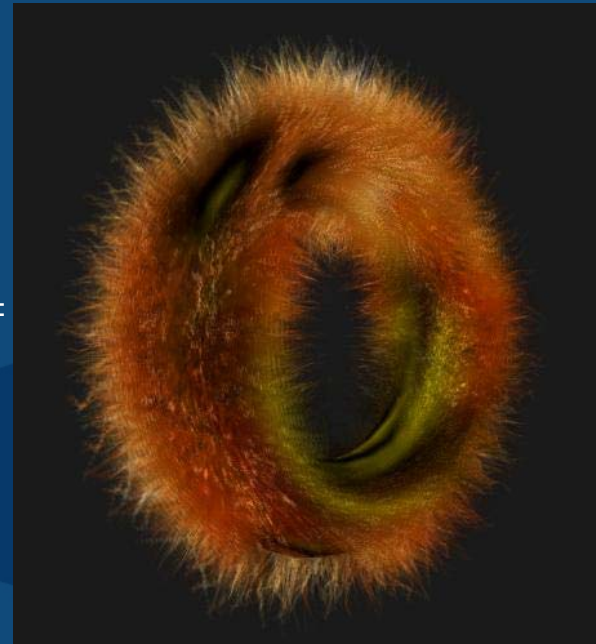
Shells

&



Fins

=



Fins & Shells

Original geometry
moved in direction of
normal for each edge.

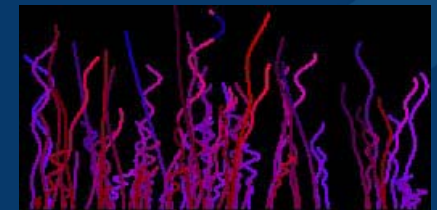
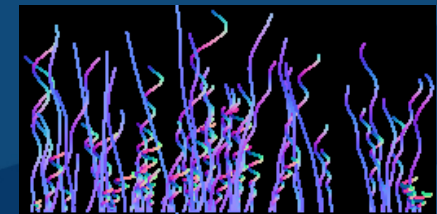
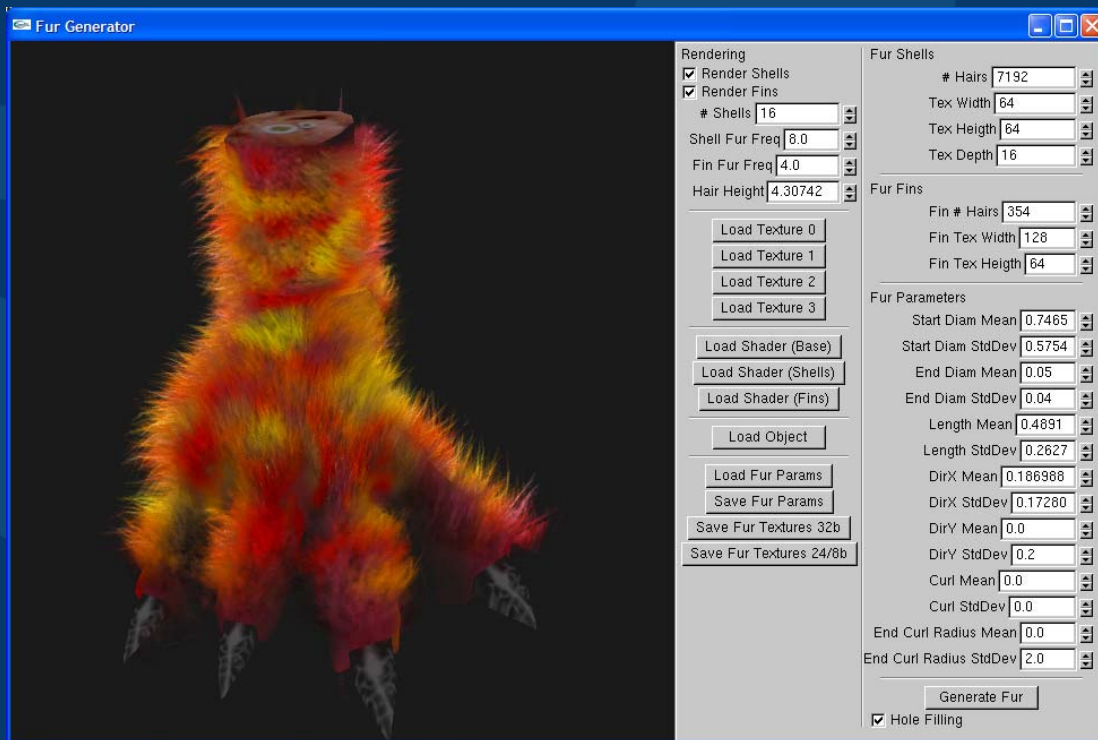
Additional Geometry
extruded along
direction of normal
for each edge.

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FurGen

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Generated Textures

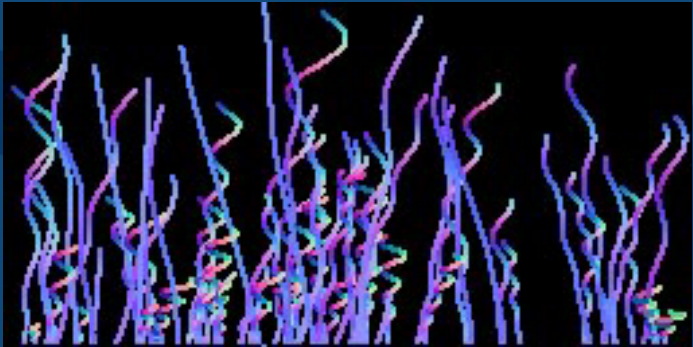
- Fur Texture Generation and Preview Tool.
- Textures contain per-pixel data used to determine fur opacity, hair direction, point of origin in base, and thinning information.

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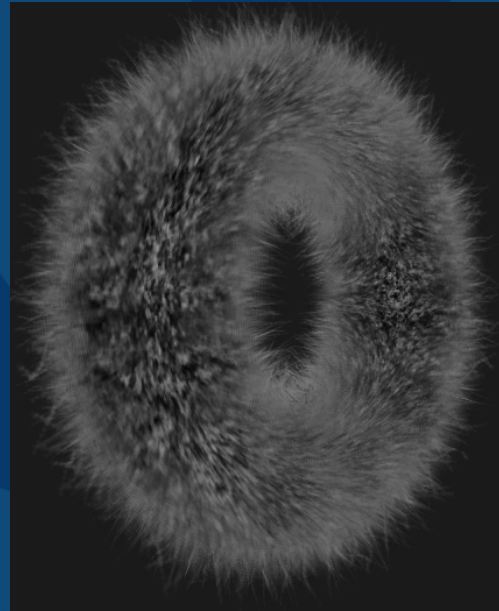


Anisotropic Lighting

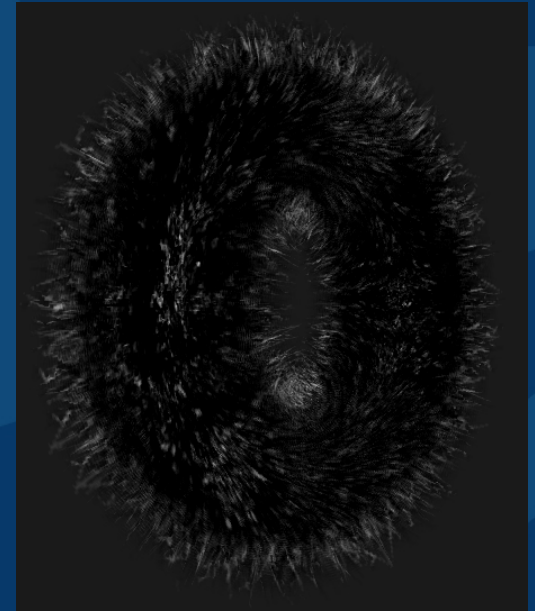
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Example: Direction Vectors for Fins



Diffuse



Specular

- Per-pixel hair direction vector encoded in RGB components of one of the fur textures for fins and shells.
- Used as tangent vector for per-pixel anisotropic lighting computations [Heidrich99]

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Hair Color Sourcing

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Without color sourcing



With color sourcing

- Per-pixel hair texture offset vector is used to determine source position of hair along its length.
- Allows each hair to keep the same base color along its length.



Hair Density Control

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Fur Density Map



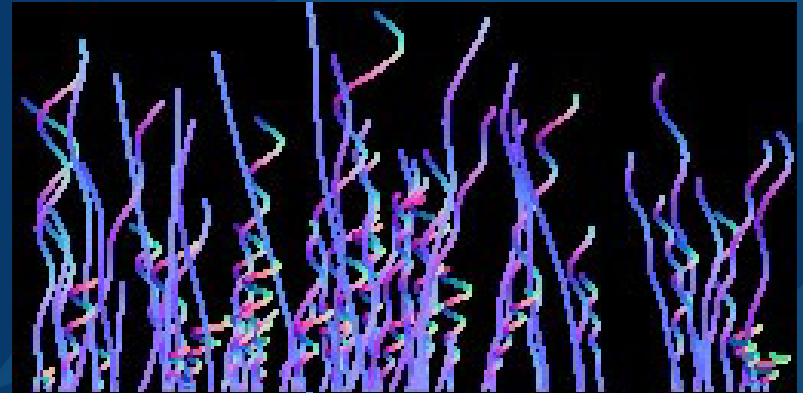
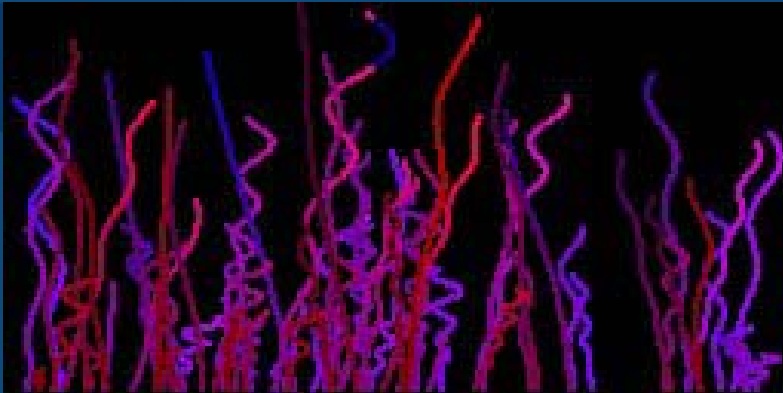
Fur density map used to thinout fur

- Per pixel thinning value [0-1] per hair
- Alpha of basemap can be used as a threshold for thinning to cull out a certain percentage of the hairs.
- Alpha channel acts as a fur density map



Hole Filling for Mip-maps

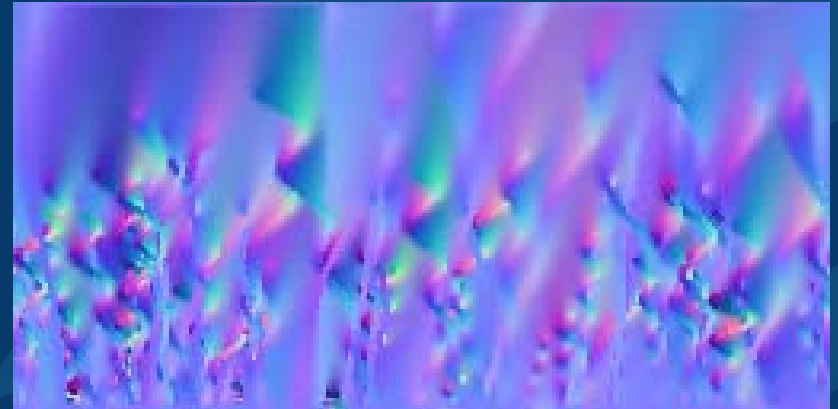
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Issue: Fur generation only generates pixels along path of each hair generated. Problem for mip-mapping.



Hole Filling for Mip-maps



Solution: Hole Filling technique used to propagate colors to unfilled regions of texture.

Makes mipmap generation straightforward.



Future Work



- Better animation of hair motion
- Physics
- Generalized lighting models, use of BRDFs etc.
- Non-Gaussian random variables used to determine each hairs properties.



Chimp Demo

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Summary

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- Per Pixel Anisotropic Lighting
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- Hole Filling for Mip-maps
- Future Work



References



1. W. Heidrich and H.-P. Seidel, "Realistic, Hardware-accelerated Shading and Lighting," SIGGRAPH 99
2. J. Lengyel, E. Praun, A. Finkelstein and H. Hoppe "Real-Time Fur over Arbitrary Surfaces," *ACM 2001 Symposium on Interactive 3D Graphics*, 2001.



End

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Questions?



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<Code page sample>



```
varying vec3   eNormal;           // input, eye-space Normal
varying vec3   ePosition;         // input, eye-space Position

uniform vec3   diffuseMtl;        // diffuse light Material
uniform vec3   specularMtl;       // specular light Material
uniform float   shininess;         // specular exponent
uniform vec3   lPosition;         // Light Position, eye-space
uniform vec3   lColor;            // Light color
```

