

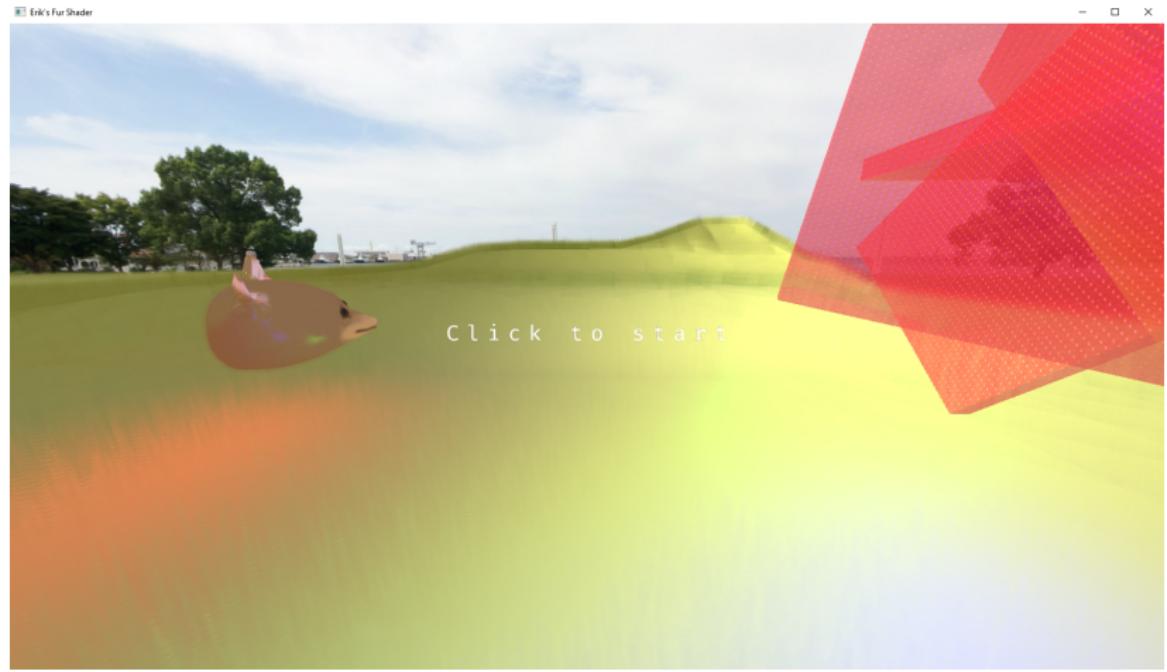
Fur rendering with shells, fins, and order-independent transparency

Odd-Erik Frantzen

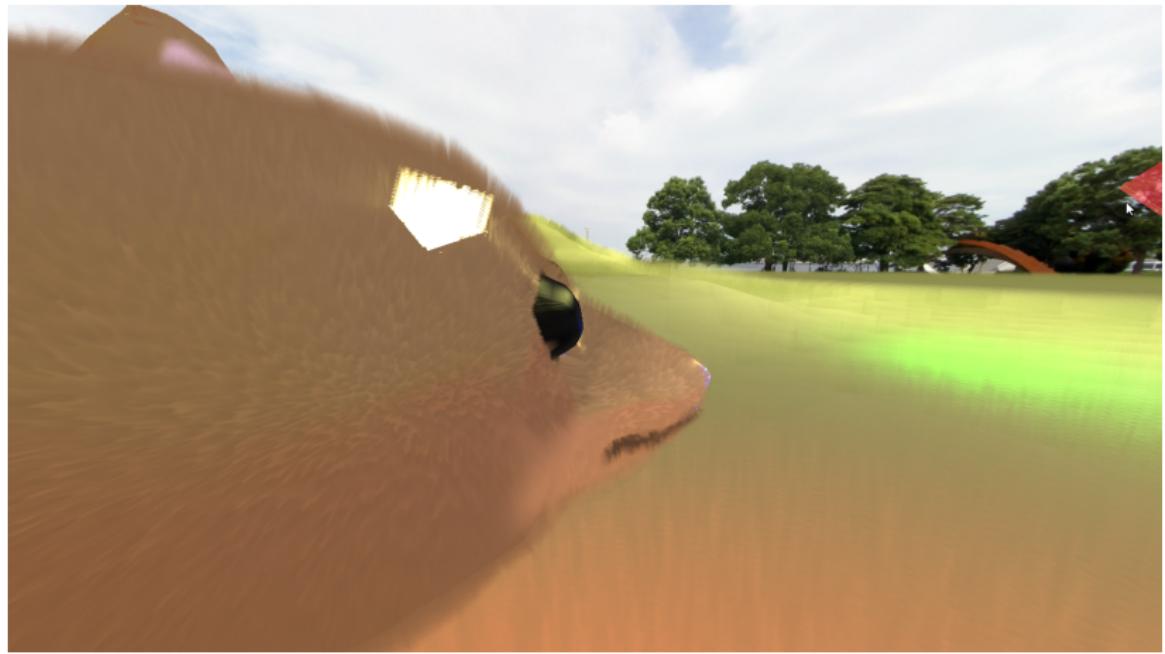
https://github.com/odderikf/fur_project

April 19, 2023

Results:



Results:



Elements of the scene:

- Things from previous exercises
 - Phong lighting with dynamic pointlight sources
 - Textured, normal mapped, roughness mapped objects.
- Skybox at infinity
- Blender-exported object files and painted textures
- Shell-method fur volume generation
- Fin-method fur-card generation for better silhouettes
- Blending shader for semitransparent elements

Skybox



Cubemap texture (6 images, samplerCube) mapped onto a box around origin with radius 1

Shell method fur generation

Render shells with geometry shader
Triangle → several displaced copies
Texture lookup determines direction and length of displacement
A uniform also scales displacement
Can add uniform vector for further dynamic displacement (wind, interaction)

Forming Strands

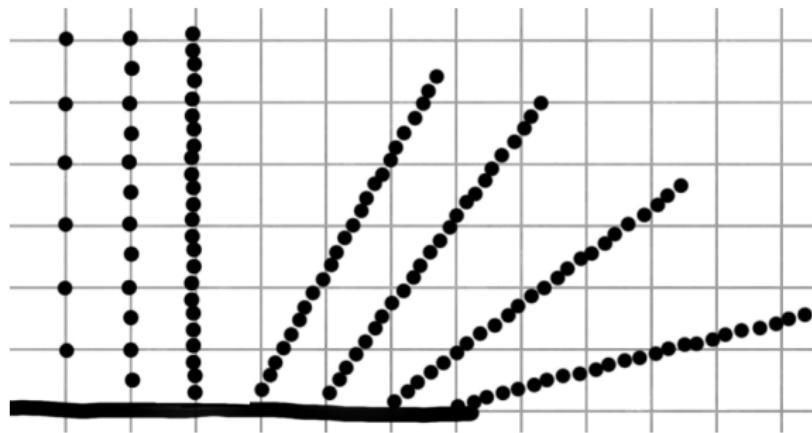
Render mostly transparent shells, with 'dots' of visibility.

These dots form lines, strands of fur.

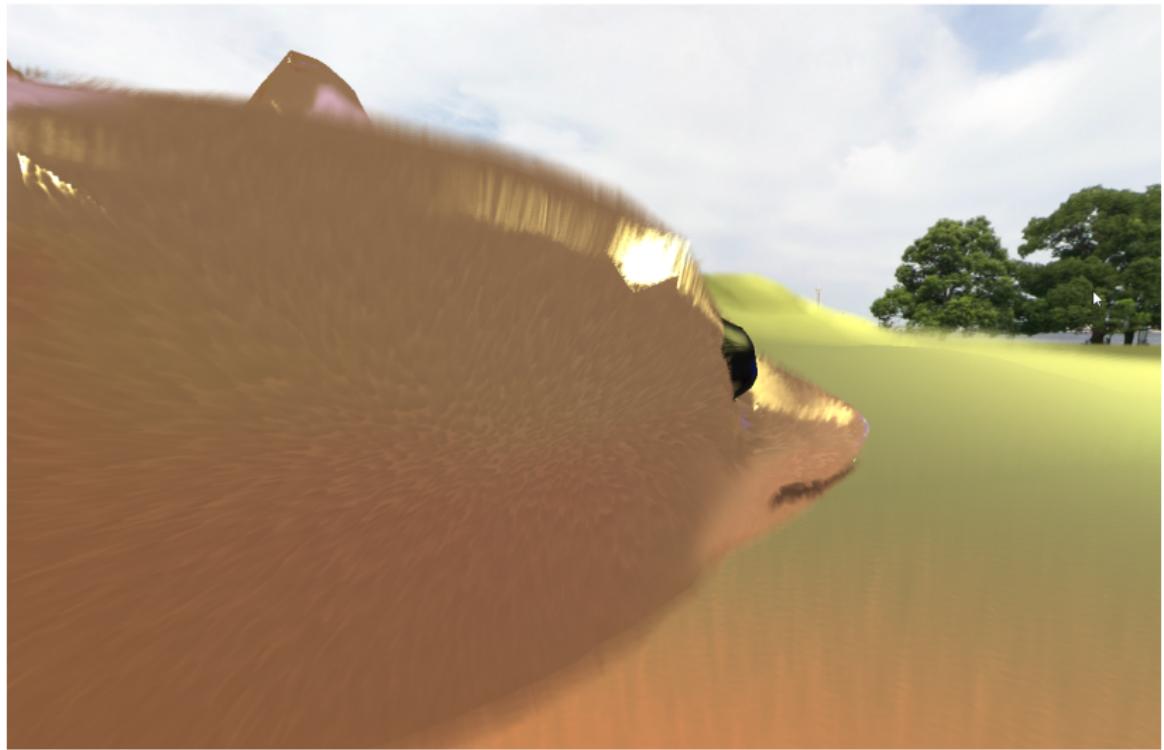
Darker roots, brighter tips, for cheap 'self-shadowing'

'Thinning' through lowering alpha along length.

Could use 3D textures



Shell result:



Dots texture:

Dots are stored as a texture,
generated with a simple python script.
Could replace this with 3d texture,
Could scale UVs (density uniform?)
to loop faster than other textures to save on space
Could make it implicit with some function in shaders
Could rig it to be more localized

Downside



Fin method fur generation

Dynamically generate fur cards
(Billboards that show fur strands)

Helps cover the silhouette,
where you see between the layers of the shells better
This is also done with a geometry shader

Fin method fur generation

Idea: edge → billboard

NVIDIA: adjacent triangles → billboard

My solution: triangle → 3 billboards (as triangle-strips)

Only edges at/near silhouette

Fade in and out

Draw if camera-to-point is near-normal on edge-normals.

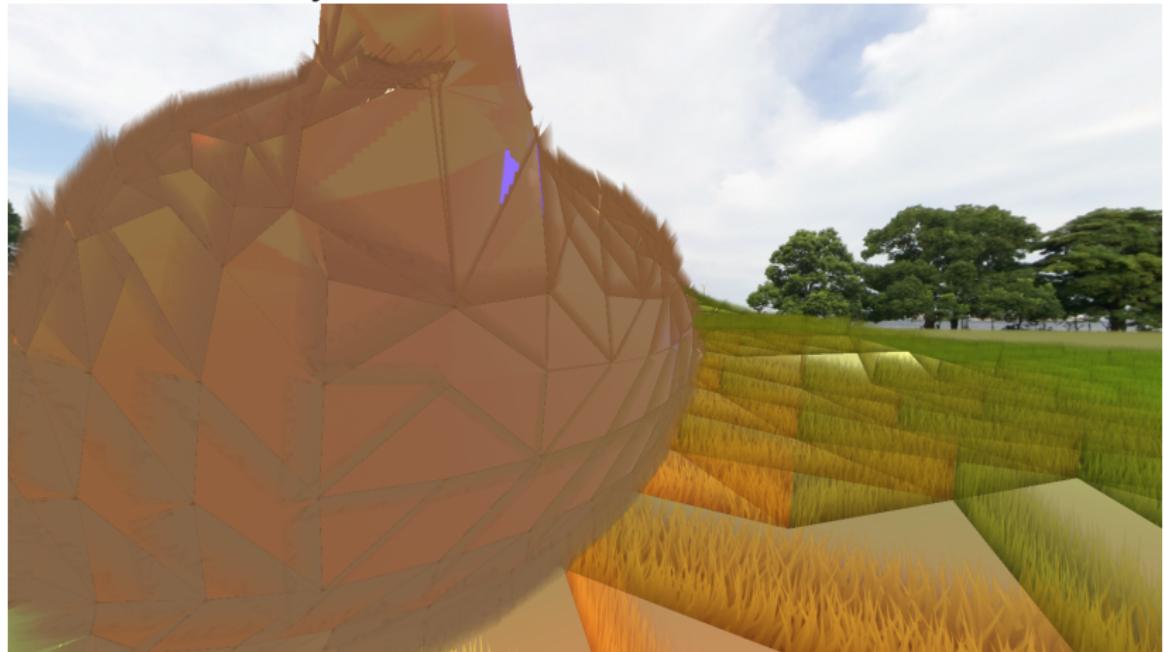
Billboards follow fur direction away from original edge

Density determined by edge density

Segmented vertically to enable 3d effects (like bending
nonlinearly in wind)

Fin Method results

Fins do not easily sell volume



Fin Method results

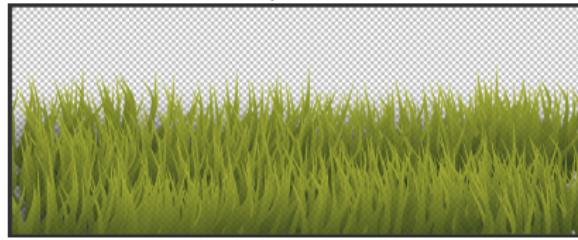
They do work great at the silhouette though



Fins textures

The grass texture was found free online

<https://pixabay.com/vectors/grass-background-border-green-grass-2029768/>



Blending

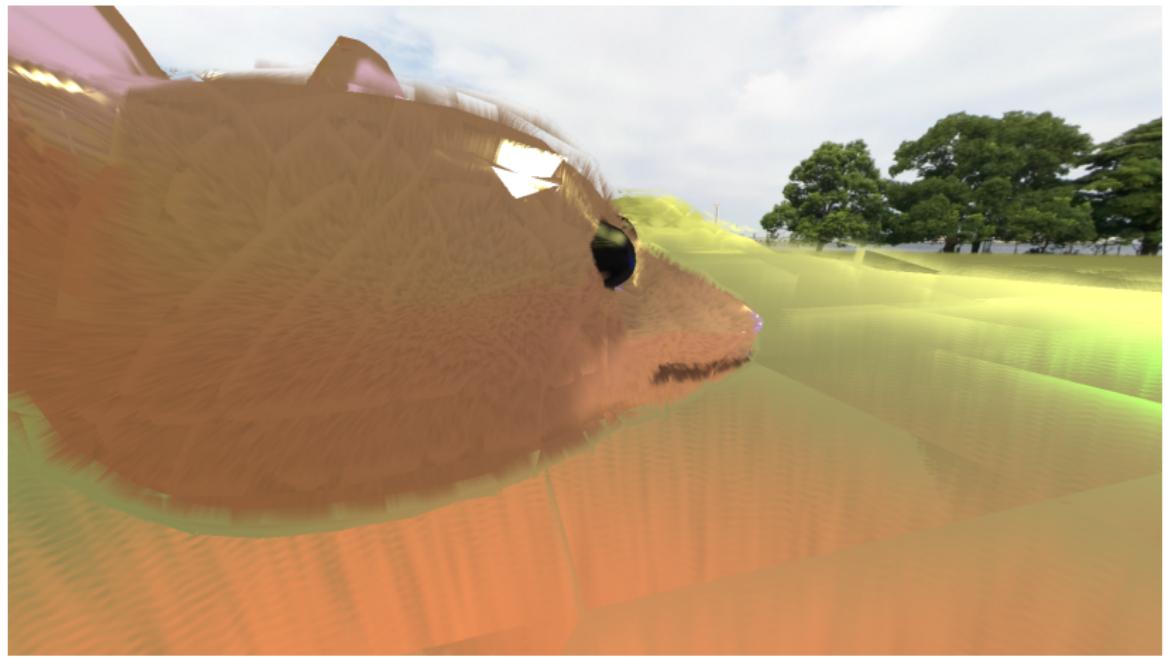
Hair and fur notably have very fine detail

My methods uses a lot of alpha.

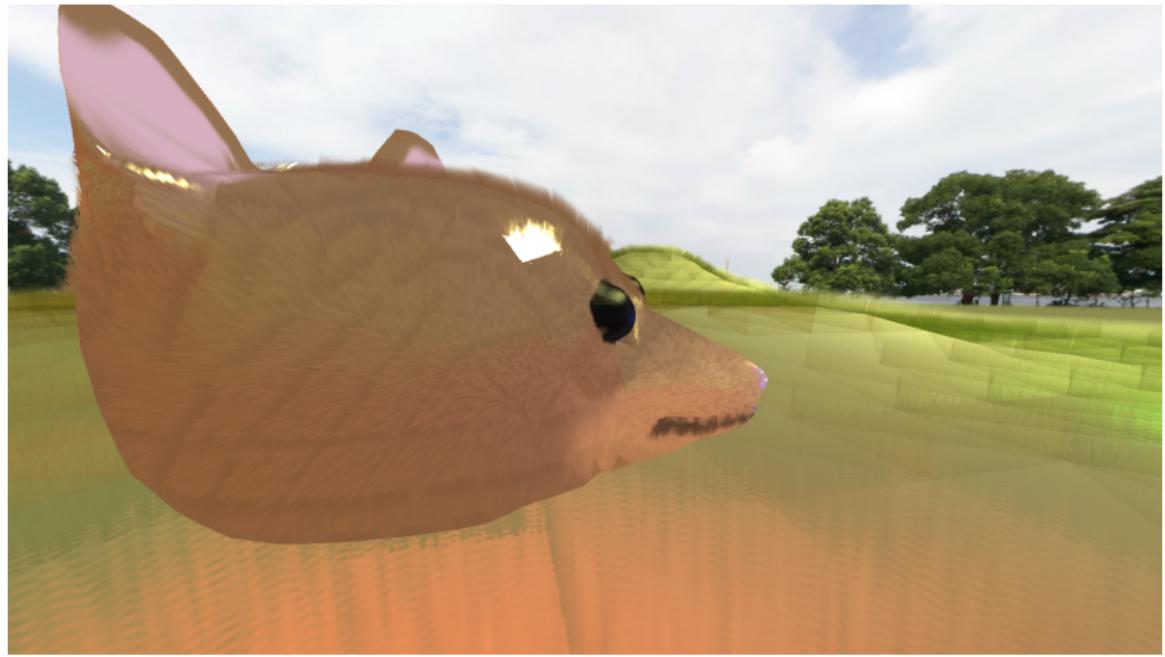
Hard to depth-sort volumes and billboards?

Lots of self-occlusion

Self-occlusion



No depth mask



Weighted Blended Order-Independent Transparency

Multipass multichannel method.

1. Render Opaque Elements (skybox, bases)
2. Semitransparent render
 - 2.1 Occlude base color out of background color
(colored glass filtering) (optional)
 - 2.2 Weighted sum to accumulation color buffer
(depth and alpha weighted contribution)
 - 2.3 Sum of weights to weights channel
 - 2.4 Subtract alpha from revealage channel
(remaining transparency)
3. Composite accumulation-buffer onto image
 - divide by sum of weights to scale the average
 - alpha of composite layer = $1 - \text{revealage}$

Blending results

