Point-Based Rendering

September 30, 2004

Announcement

• No class next Monday.
• Volunteers wanted for early paper presentations.
Review of 3D Warping

- Input: Depth Images.
- No 3D model is constructed.
- Each pixel is often considered as a point sample in object space.

Artifacts of 3D Warping

- Due to incorrect reconstruction.
- Due to occlusion (or visibility).
**Question:** how to fill the holes?

**Quick fix:** draw larger points.

**Next thought:** draw some larger points and some smaller points (based on distance).

**Another thought:** draw elliptical points (based on neighbors and surface orientation)

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**Reconstruction**

- **Solving it by meshing?**
  - Must know the connectivity between points.
- **Solving it by splatting?**
  - Size determined by viewing distance.
  - Shape determined by surface normal.
  - References: LDI [SG98], Surfel [SG2000], Surface Splatting [SG2001].
Simple Splats

• Fixed, oversized splats
• Calculation of splat size based on:
  – Distance
  – Normal
• QSplat’s approach
• LDI’s approach
LOD Control

Threshold: 15 pixels
Points: 130,712
Rendering Time: 132 ms

Threshold: 1 pixel
Points: 14,835,967
Rendering Time: 6308 ms

Preprocessing

- Building the Hierarchy tree…
  What do the nodes look like?

Interior nodes will have at most 4 children

Leaf nodes correspond to vertices
LDI’s Approach

• Consider both the distance and the normal.

\[
\sqrt{s_{00}} = \frac{1}{d_2} \cdot \frac{d_1 \sqrt{\cos(\theta_2) \tan(\psi_2) \tan(\psi_1) / 2}}{\sqrt{\cos(\theta_1) \tan(\psi_1) / 2}}
\]

\[
\approx \frac{1}{Z_2} \cdot \frac{d_1 \sqrt{\cos(\theta_2) \tan(\psi_2) / 2}}{\sqrt{\cos(\theta_1) \tan(\psi_1) / 2}}
\]

Surface Splatting

EWA Texture Filtering

Source Image

Output Image

Surface Splatting
Surface Splatting of Textured Surfaces

Source Image

Output Image

Screen-Space vs. Object-Space

• Screen space:

• Object-Space:
Hardware Features

• What happens if the many tiny splats are mapped to a pixel?
  – Solution 1: Prefiltering
  – Solution 2: Turn on antialiasing!

• Textured surfaces: why is it an issue?
  – Can’t we store the texture color with the point data?
  – No! If a splat covers more than 1 pixel, then it should trigger multiple texture lookups.
  – Solution: Turn on multi-texture and anisotropic texturing!
Data Representation

• The simplest form is a depth image.
• Layered Depth Image (LDI):
  – By combining multiple depth images.
• Layered Depth Cube (LDC):
  – By using 3 LDIs.
• The above may be extended to include multi-resolution.
  – Examples: LDI Tree, QSplats, Surfels.