Per-Pixel Displacement Mapping
with Distance Functions

William Donnelly
University of Waterloo
(Presented by Matthias Wloka)
Last Year’s Big Thing

- Parallax mapping

- Valid for smoothly varying height fields
  - No occlusion
  - No large displacements
  - No high frequency features
Advantages

- Handles high frequencies
  - For example, slats or text

- Correctly resolves self-occlusion
Potential Applications

- **Metal-grate walkways**
- **Chain-link fences**
- **Everywhere?**
  - In addition to bump mapping
- **Geometry can be painted on**
  - Need not be modeled
How Does It Work?

- Transform eye ray into tangent space
- Ray trace!?
Step Along Eye Ray

- **Volume texture encodes**
  - ‘Filled’ or
  - ‘Empty’ material

- **‘Thin’ texture**
  - Up to 16 voxels deep
  - E.g., 256x256x16
Step Size Problems

• Fixed size?
  – Too big: Misses high frequency detail
  – Too small: Wasted performance

• Vary with incident angle?
  – Still intractable at grazing angles
Volume Texture Stores Distance Map

• **Voxel stores:**
  – How far am I from closest surface?
Efficient Computation of Distance Maps

- See Section 8.4

- Tool with source on book’s CD

- Based on:
Equivalent to Sphere Tracing
Distance Maps Are General

- NOT limited to height fields
- Encode arbitrary geometry in volume
  - Chain mail
  - Overlapping slats
  - Chain-link fence
  - ...

Pixel Shader

float  distance;
float3 offset   = normalize(v2f.tanEyeVec);
float3 texCoord = v2f.texCoord;

// March the ray
for (int i = 0; i < NUM_ITERATIONS; i++)
{
    distance  = tex3D(distanceTex, texCoord).x;
    texCoord += distance * offset;
}
Performance

- Each iteration is \{tex; mad;\}
  - Single cycle on GeForce FX and GeForce 6

- Number of iterations depends on
  - Volume texture resolution
  - Smoothness of data
  - 16 iterations plenty for shown 256x256x16

- 90M pixels/s observed throughput
  - GeForce 6800 GT
  - Inclusive lighting
Questions?

• See GPU Gems 2, Chapter 8

  The Source for GPU Programming

• mwloka@nvidia.com

• Slides available online
GPU Gems 2
Programming Techniques for High-Performance Graphics and General-Purpose Computation

- 880 full-color pages, 330 figures, hard cover
- $59.99
- Experts from universities and industry

“The topics covered in GPU Gems 2 are critical to the next generation of game engines.”
— Gary McTaggart, Software Engineer at Valve, Creators of Half-Life and Counter-Strike

“GPU Gems 2 isn’t meant to simply adorn your bookshelf—it’s required reading for anyone trying to keep pace with the rapid evolution of programmable graphics. If you’re serious about graphics, this book will take you to the edge of what the GPU can do.”
— Rémi Arnaud, Graphics Architect at Sony Computer Entertainment
The Source for GPU Programming

developer.nvidia.com

- Latest News
- Developer Events Calendar
- Technical Documentation
- Conference Presentations
- GPU Programming Guide
- Powerful Tools, SDKs and more ...

Join our FREE registered developer program for early access to NVIDIA drivers, cutting edge tools, online support forums, and more.

developer.nvidia.com