Distance fields

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Overview

- Signed distance fields
- Distance fields in computer graphics
  - Textures
  - Geometry
Overview

http://chimera.labs.oreilly.com/books/1234000001814/ch07.html#ch07_id36000844
Overview
Textures

- Different way of storing bitmap data
- Used with source image
  - for every distance field value
    - value \( \leq 0 \)
      - yes? draw pixel
      - no ignore it
Textures

- Distance fields creation
  - High resolution source image
    - Downsampled to acceptable size
    - Lot of information preserved
    - 4k textures used to generate 64x64 distance field

(a) High resolution input  
(b) 64x64 Distance field
Textures

- Distance fields creation
  - Brute force
  - \(O(N^2)\) complexity
  - Mapped to 0f..1.0f range
  - 0.5f decision point (draw or not to draw)
Textures

Main application
- Font rendering
- Decals
- UI
Textures

Font rendering
● No need to pre-rasterize all font sizes
● Bonus features
  o Glow
  o Drop shadow
  o Outlining
  o Antialias (smoothstep between distance field values)

///// Antialiased text rendering /////
float4 ps( VS_OUTPUT IN) : COLOR
{
  // get the alpha value from the distance field texture
  float rawAlpha = tex2D( TextureSampler, IN.TilingCoords).a;
  clip (rawAlpha - (0.5f-delta));
  return float4(fillColour, smoothstep(0.5f-delta,0.5f+delta,rawAlpha) );
}
Textures

Decals

Original image

Signed distance field

30x  30x
Textures

Used internally in Source Engine
Can be used with any engine!

Geometry

- Unreal Engine 4
  - Distance Field Ambient Occlusion (DFAO) (4.3)
  - Distance Field Specular Occlusion (4.5)
  - Distance Field Soft Shadows (4.5)
DFAO

- Precomputed distance field for every static mesh
- Volume textures storing signed distance to nearest surface
- Pure GPU feature, requires DX11.
DFAO - OFF
DFAO - ON
DFAO - OFF
DFAO - ON
DFAO
DFAO

Cons

- Meshes can only use uniform scaling
- Memory overhead
- GPU overhead (3.5ms - 6ms Radeon 7870)
- Rigid meshes only
Specular Occlusion - OFF
Ray Traced Distance Field Soft Shadows (RTDFSS :-))

- Uses same DFAO data to compute efficient area shadows
- Point & Spot lights
  - ‘Source Radius’ determine how large shadow penumbras are
  - Sharp at shadow contacts softer over distance
  - Amazing quality (When using correct resolution)
Ray Traced Distance Field Soft Shadows (RTDFSS :-))
Ray Traced Distance Field Soft Shadows (RTDFSS :-))
Ray Traced Distance Field Soft Shadows (RTDFSS :-)

Directional lights
- ‘Light Source Angle’ determine how large is shadow penumbra
- No bias and self intersection problems as shadowmaps
- Efficient when used with larger distances
- Even faster than shadowmapping
Ray Traced Distance Field Soft Shadows (RTDFSS :-))
How does this work?

- Signed distance fields representing mesh surfaces
- Stores distance to the nearest surface at every point
How does this work?

- Efficient ray tracing
How does this work?

- Efficient cone tracing