

Rendering meso- structures

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Methods to present Mesostructures

■ Mesostructures

- The fine-scale geometric features and its associated visual effects lies between that of meshes (bulk) and BRDFs (fine)
- Shadows, Occlusion, Silhouette



Methods

- Displacement mapping
- Bump mapping
- Parallax mapping
- Ray casting based techniques

- Horizon mapping
- View Dependent displacement mapping



Displacement mapping

- Cook 1984:
 - “Since location is an appearance parameter, we can actually move the location as well as perturbing the surface normal”
- Reduce storage and bus traffic
 - Divide into the overall shape and a refinement of that shape
- Tessellate low-res mesh
- Displace along normals as defined by static or procedurally generated data



Displacement mapping

- Often used in offline renders
 - Saving processing power while animating, previewing etc.
- Hardware support
 - SM3.0 vertex texture lookup
 - Matrox Parhelia-512, Direct-x 9 support.
 - TrueForm II

Bump-mapping

- You know this one !

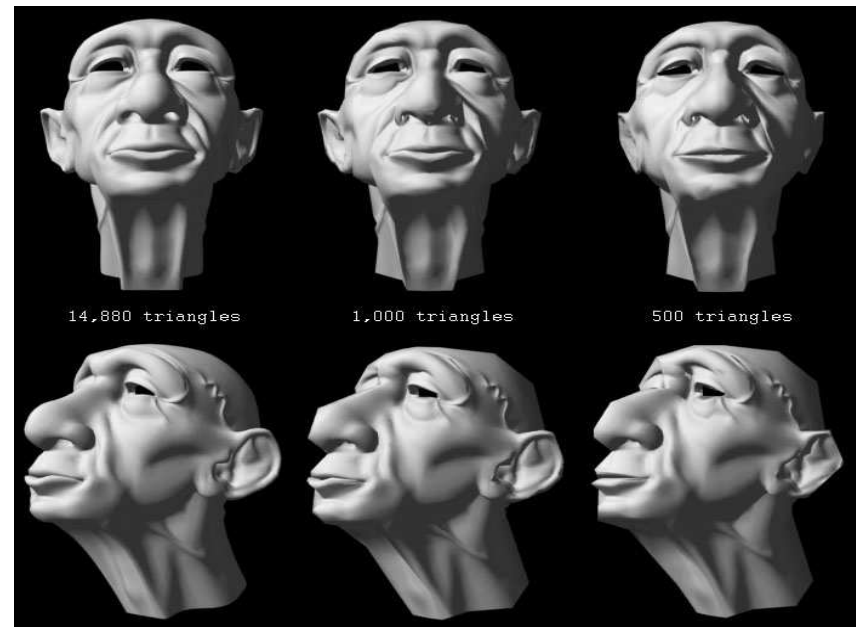


Image source: <http://amber.rc.arizona.edu/lw/normalmaps.html>

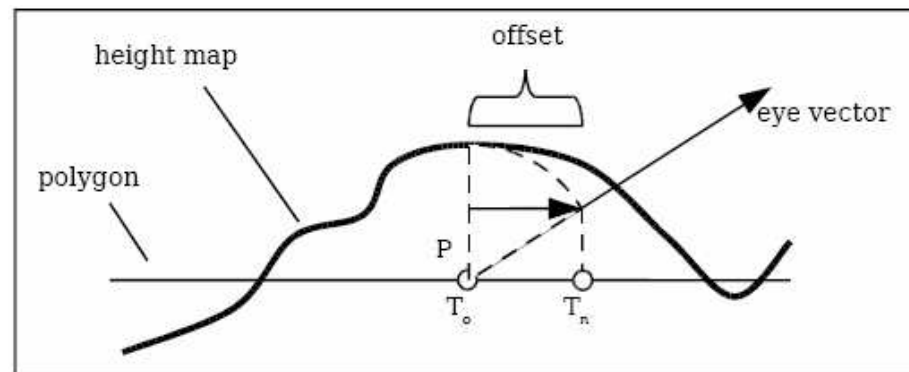


Parallax mapping

- Terry Welsh: “Parallax Mapping with Offset Limiting: A Per-Pixel Approximation of Uneven Surfaces”

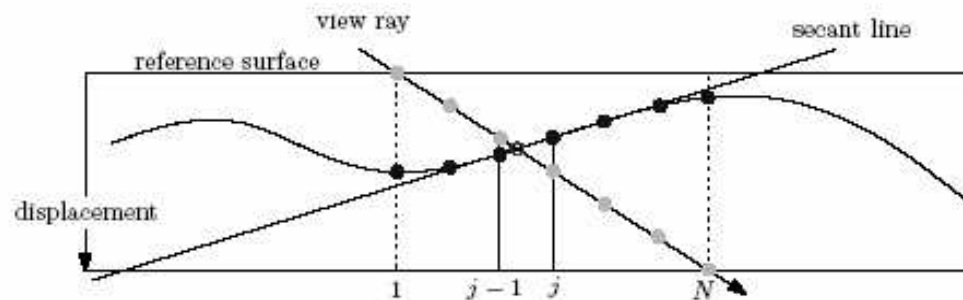
Parallax Mapping

- Height-map based
- Offsetting the (u,v) coordinate



Ray casting techniques

- Lot of work, one recent 1 page siggraph sketch:
 - Keith Yerex & Martin Jagersand “Displacement mapping with ray-casting in hardware”





Ray casting techniques

- “Relief Mapping in Pixel Shader using Binary Search”, Fabio Policarpo
- DEMO:
 - http://www.opengl.org/discussion_boards/cgi_directory/ultimatebb.cgi?ubb=get_topic;f=3;t=012454

Relief Mapping in Pixel Shader using Binary Search

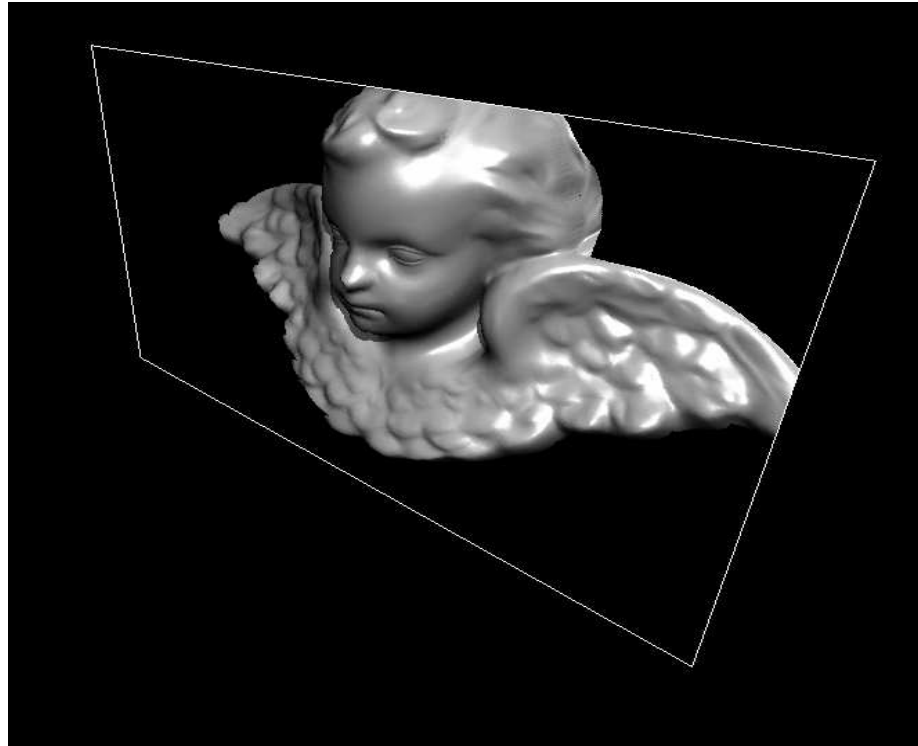
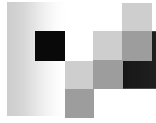


Image Source: Demo by Fabio Policarpo



Ray casting

- That is, it is really a search problem finding ray-heightmap intersections.

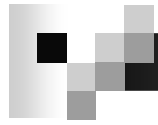


Pre-calculated



Horizon Mapping

- Peter-Pike J. Sloan & Michael F. Cohen
“Interactive Horizon Mapping”



Horizon Mapping

- Adding shadows to bumpmapping



Horizon Map storage

- $f(u, v, \theta) \rightarrow \Phi$
- (u, v) reference surface point
- θ orientation in tangent plane
- Φ (output) angle with normal when a light would become visible over the horizon.

Horizon Map storage

- θ orientation in tangent plane
 - 8 samples, N, NE, E, etc.
 - Interpolated
 - Saved in 2 texture maps (4 values RGBA)



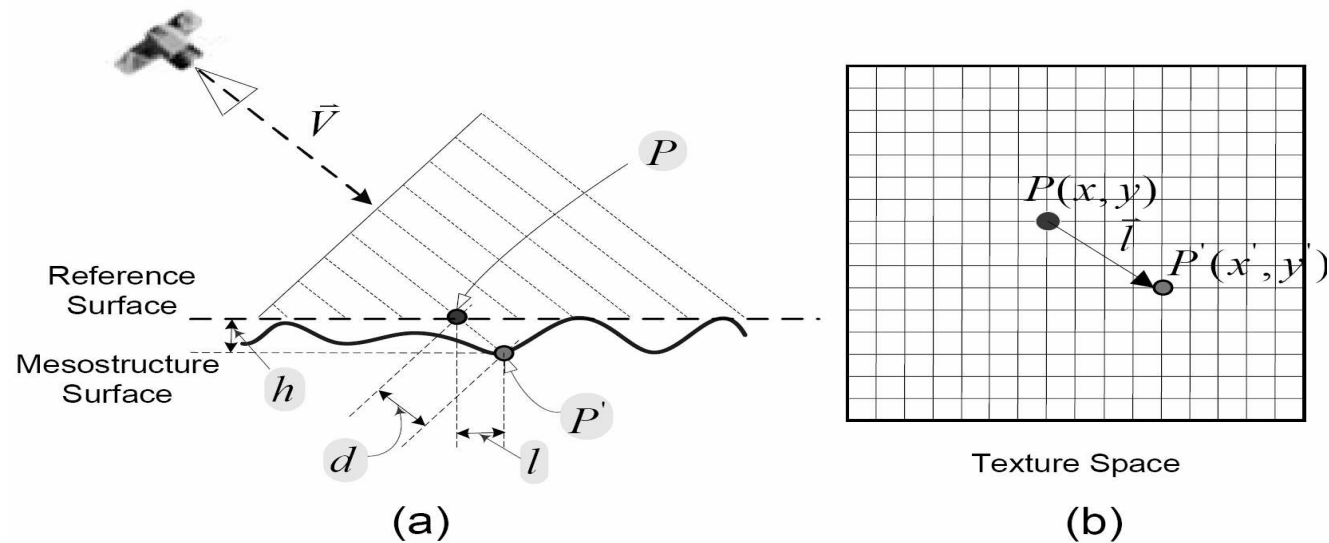


View Dependent Displacement Mapping

- Lifeng Wang et al. “View-Dependent Displacement Mapping”

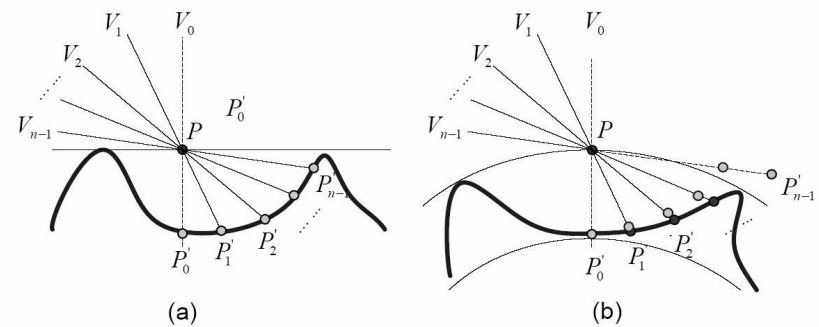
View Dependent Displacement Mapping

- Displacements along viewing direction, not normal.



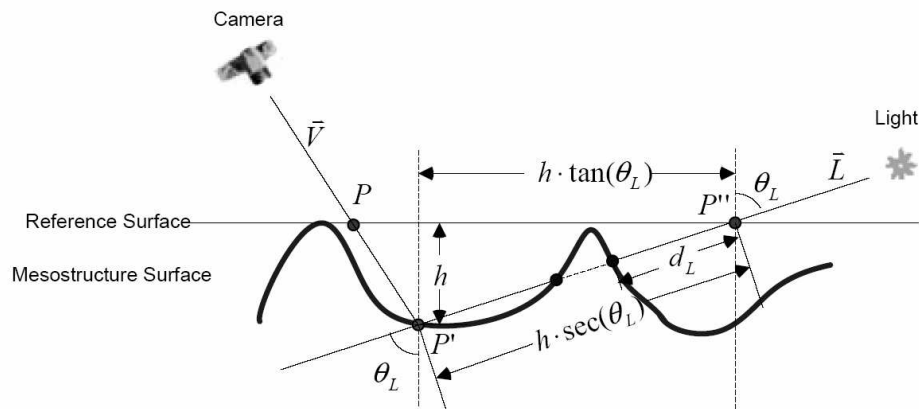
VDM storage

- $f(x, y, \theta, \Phi, c) \rightarrow d_{\text{vdm}}$
- (x, y) reference surface point
- (θ, Φ) viewing direction
- C surface curvature along viewing direction
- d_{vdm} (output): displacement from reference surface point to mesostructure surface



Rendering

- Silhouette
 - Explicit representation of visibility
- Texture coordinates
 - Project d_{vdm} onto tangent space and offset reference surface texture coordinate
- Shadow Determination (curvature ignored)
- Pixel Shading





Data

■ Data

- 128x128 texel area
- 12x8 viewing directions
- 16 curvatures
- → 64 mb of vdm data

- Compress with SVD → 4 mb.