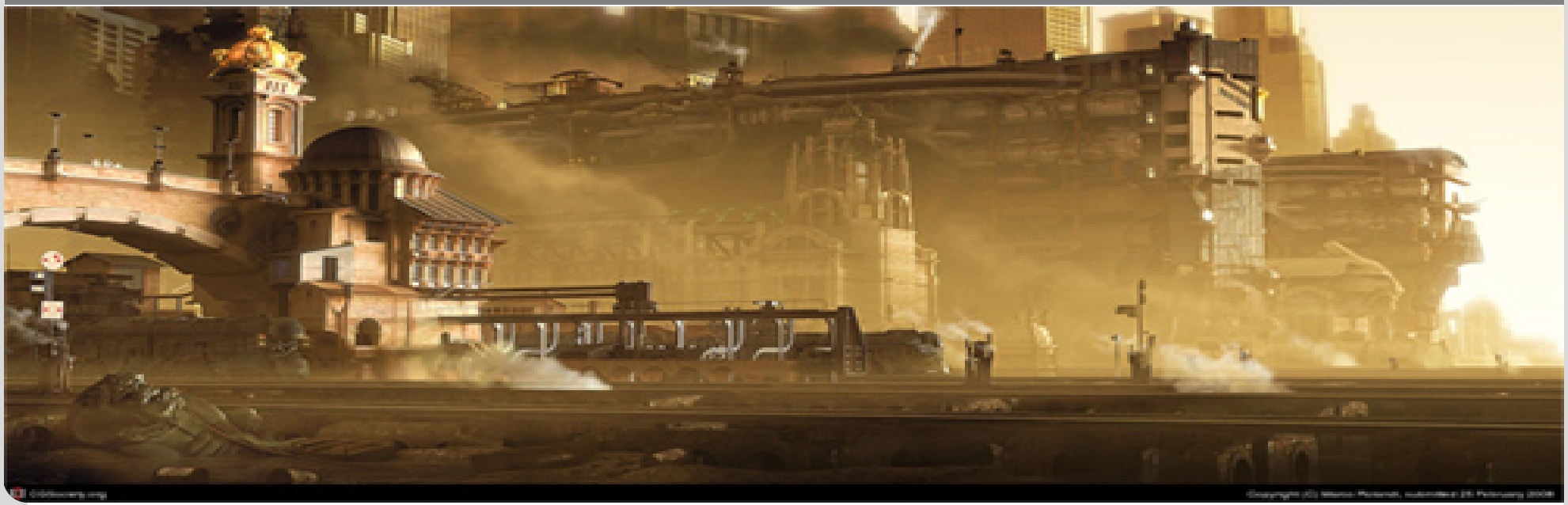
Bump Mapping

Computer Graphics - SET08116

EDINBURGH NAPIER UNIVERSITY



Outline

Review - Lighting

- Lighting is the technique we use to provide depth to our renders
- Three basic lighting types
  - Ambient - Background light
  - Diffuse - Directional light
  - Specular - Shininess

Review - Textures

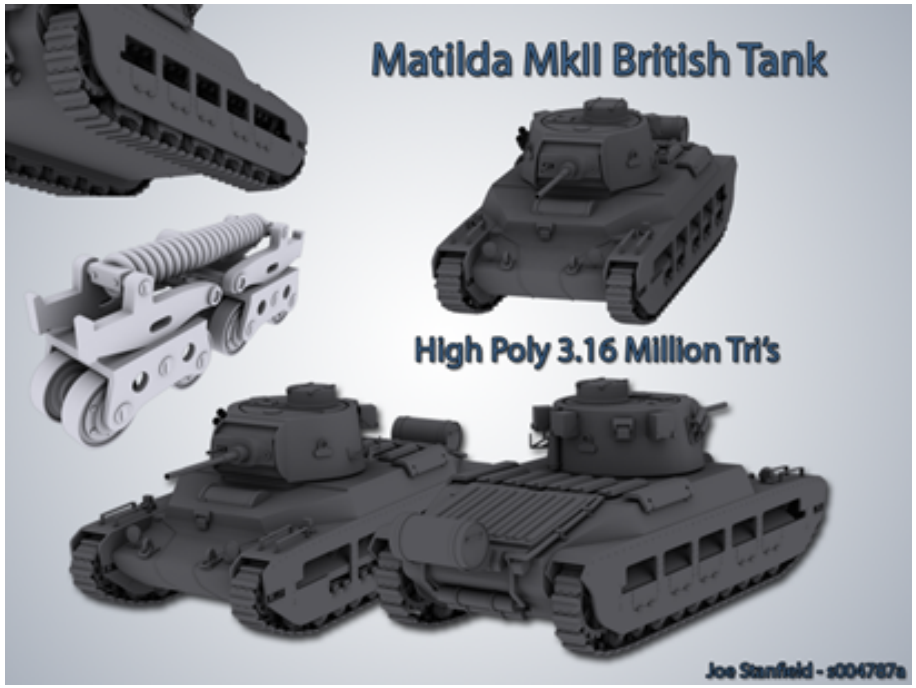
- Textures are just a 2D grid of pixels we can use for other purposes
  - For examples, alpha-mapping
- We can use texture data in our shaders to perform more elaborate effects
- Using texture data is one of the commonest techniques for adding more detail to a 3D model

Problem Adding Detail

- We want detail
  - The more detail the better
- How do we get high detail renders in our game so we can see creases in fingers, notches in swords, etc?

Solution Add Geometry

- Easy solution add more triangles
  - Artists solution
- More triangles means more geometry means higher quality
  - So job done, right?

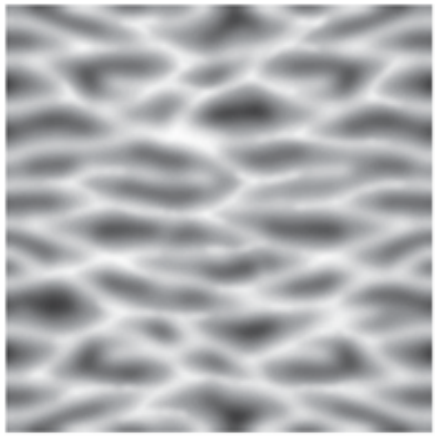


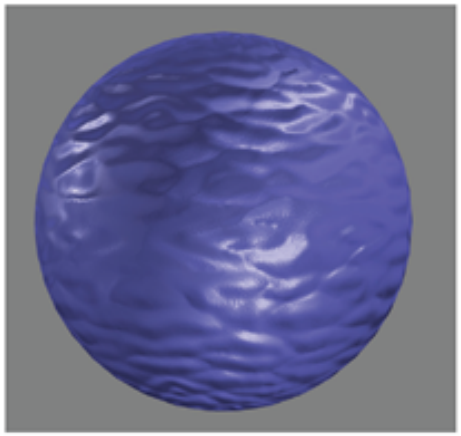
Problem Processing Geometry

- Problem is processing high poly count models
  - Typically try and keep characters down to 25,000
- High number of triangles means it takes longer to render
  - Fine for non-real-time applications
  - Games we need better techniques
- So how do we add detail, without adding geometry?

Cheating with Lighting

- Effectively, we have already been doing this
  - Lighting cheats
  - Phong shading is an example
- We need techniques which allow us to manipulate the light to make it look like there is detail





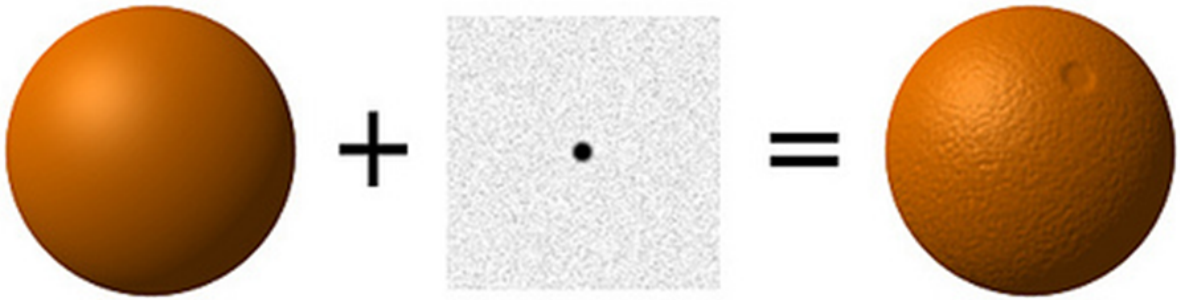
Options

Bump mapping is just one approach - variety of similar techniques - each with different advantages and disadvantages.

- Bump Mapping
- Normal Mapping
- Relief Mapping
- Parallax Mapping

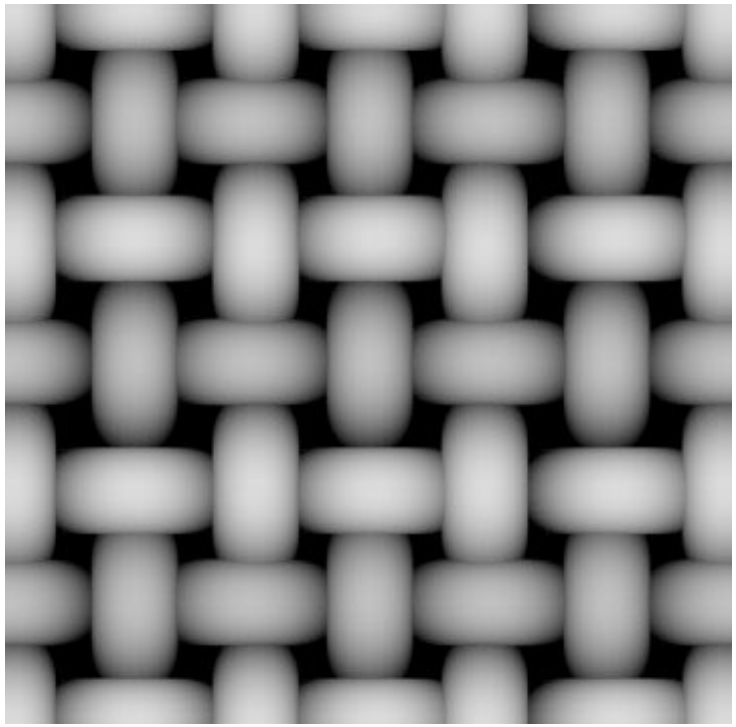
Bump Mapping

- Bump mapping is the technique used to add detail to a surface
  - Think roughness / texture
- Bump mapping is the simplest technique for adding detail using textures



Bump Map Texture

- A bump map is just a black and white image that is used to modify the surface a model to provide a rough look
  - Detail is very fine, surface level
  - Think cloth texture



Video Example

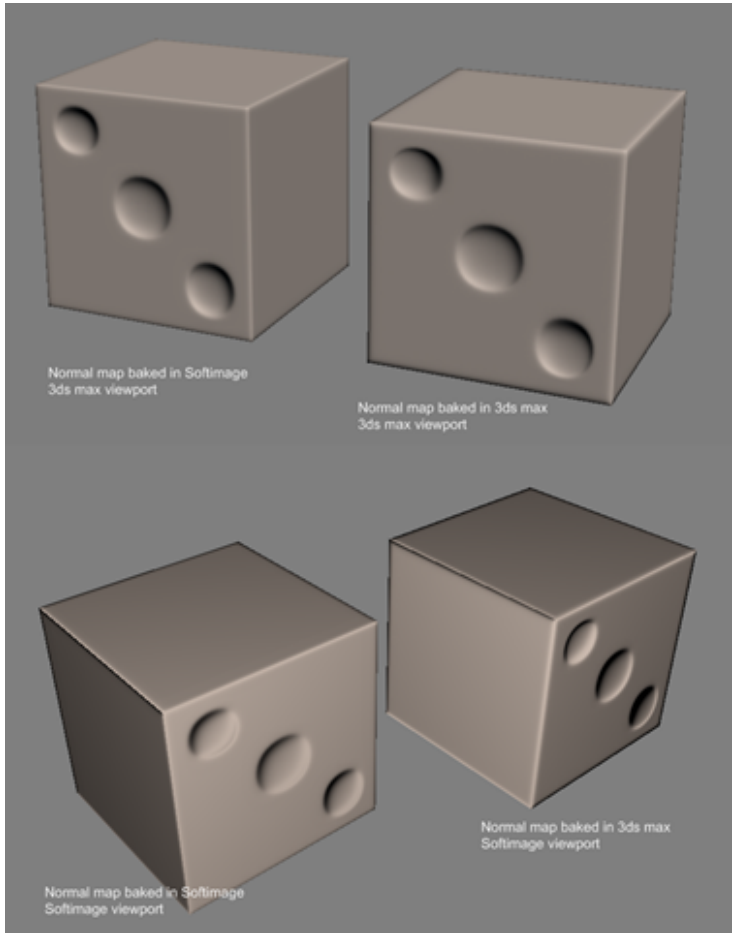
- http://www.youtube.com/watch?v=iviEv0uQZGY

Procedural Bump Mapping Frag Shader

```
vec3 litColour;
vec2 c = BumpDensity * TexCoord.st;
vec2 p = fract(c)     vec2(0.5);
float d, f;
d = dot(p, p);
f = inversesqrt(d + 1.0);
if (d >= BumpSize) { p = vec2(0, 0); f = 1.0; }
vec3 normDelta = vec3(p.x, p.y, 1.0) * f;
litColour = SurfaceColour.rgb * max(dot(normDelta, LightDir), 0.0);
vec3 reflectDir = reflect(LightDir, normDelta);
// Use reflectDir as relection normal
```

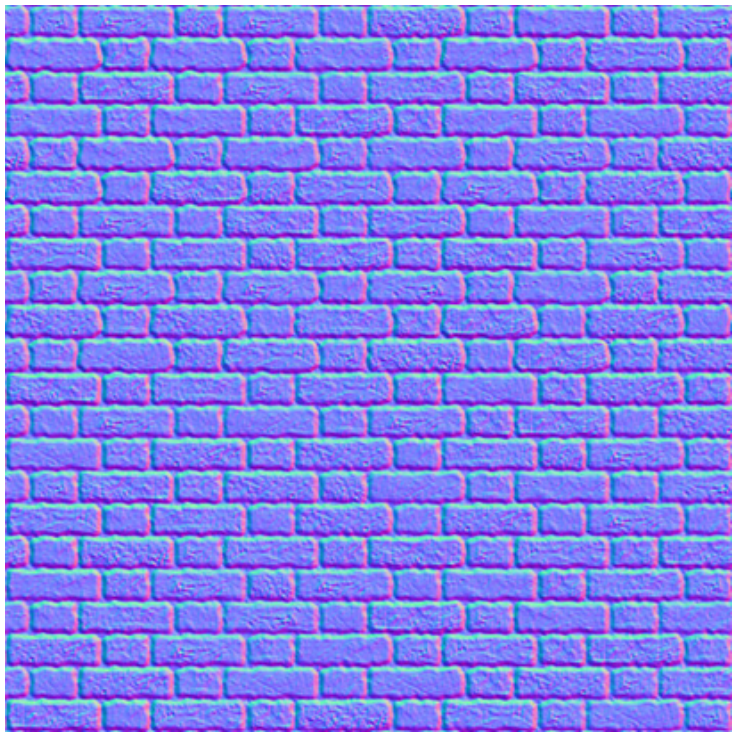
Normal Mapping

- Normal mapping extends on the bump mapping technique to more shaped detail
  - Think brick work rather than low level surface



Normal Map Texture

- Normal maps use RGB as their texture colours
- Depending on the colour, the lighting model determines the normal of the model at that particular point of the texture



Video Example

- http://www.youtube.com/watch?v=pQS2m18ebEI

Normal Mapping Shader

- Normal mapping shader works similarly to the bump mapping shader
- Typically, we add specularity as well
- Main difference is that our normals are more than two values, allowing a more realistic lighting effect

Relief Mapping

- Relief mapping is where we add detail using a texture, but actually manipulate the geometry to create the detail
- Actually, we talked a bit about relief mapping for terrain generation last week
  - We are manipulating a 3D plane into our 3D terrain
- Relief mapping is useful, but more expensive

Relief Mapping Example

- http://www.youtube.com/watch?v=5gorm90TXJM

Parallax Mapping

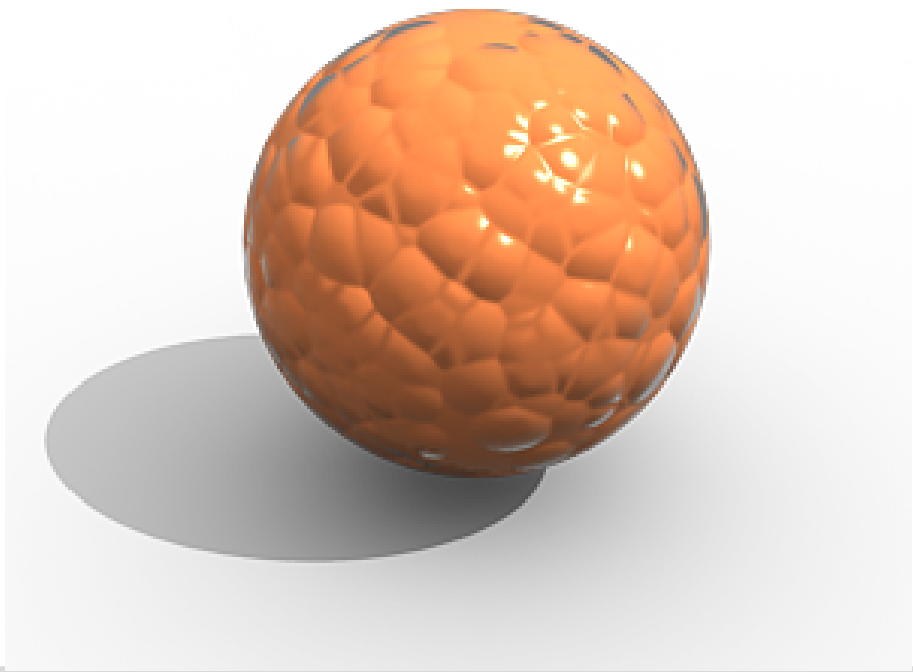
- AKA virtual displacement mapping
- Uses the viewer position to retrieve different pixels from the texture based on the height field

Video Example

- http://www.youtube.com/watch?v=R4vIQobnegk

Displacement Mapping

- Essentially relief mapping
- Proper relief mapping has the ability for self-occlusion and self-shadowing
- Technique requires geometry to be added to a model
  - Tessellation



Tessellation

- The big new addition to DirectX 11
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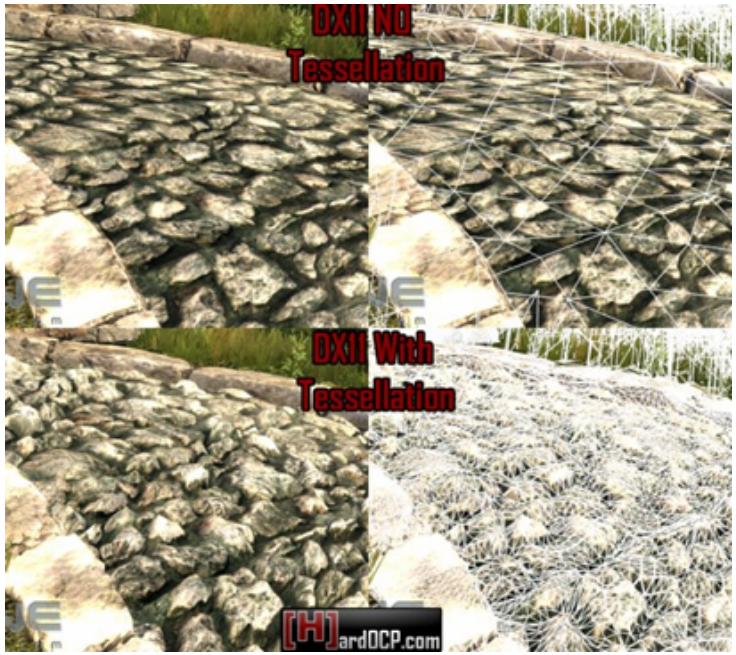
  - Think like mip-mapping, but for models
- Not like normal LOD where different models are used



Video Example

- http://www.youtube.com/watch?v=-uavLefzDuQ

Summary

- Adding details to a render is where current game technology is focused
- Various techniques allow us to modify a render to provide detail
- Bump mapping, normal mapping, etc.
- There is a cost, but usually less than adding geometry

- See recommended reading

Recommended Reading

Real-Time Rendering
Chapter 6 - Specifically, Section 6.7 onwards