Introduction to normal mapping

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The problem

What we want?

- better graphics
- better frame rate
Solution - More polygons!

What we get:
- better graphics
- better frame rate
Solution - More polygons!

What we get?
- better graphics
- better frame rate
Shading makes the difference

Example
Bump mapping

Example from wikipedia

How to:
Simulate displacement of surface.
Profit!

Topic of today.

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Bump mapping

Example from wikipedia

How to:
- Simulate displacement of surface.
- Profit!
Bump mapping

Example from wikipedia

How to:

- Simulate displacement of surface.
- Profit!
- Topic of today.
Texture mapping

Texture

Textured plane
Normal vector

- Three components
- Range $-1.0 \leq n_i \leq 1.0$

$$\vec{n} = (x, y, z)$$

RGB color

- Three components
- Range $0 \leq c_i \leq 255$

$$color = (r, g, b)$$
Normal compression

Normal vector

- Three components
- Range $-1.0 \leq n_i \leq 1.0$

$$\vec{n} = (x, y, z)$$

RGB color

- Three components
- Range $0 \leq c_i \leq 255$

$$\vec{color} = (r, g, b)$$

Compression

$$c_i = 127.5 \times (n_i + 1.0)$$

$$n_i = \frac{1}{127.5} \times c_i - 1.0$$
Normal map example

3D model

Corresponding normal map
Height map

Texture

Corresponding height map
From height map to normal map

Gradient

\[ x_{\text{grad}} = \text{pix}(x-1, y) - \text{pix}(x+1, y) \]
\[ y_{\text{grad}} = \text{pix}(x, y-1) - \text{pix}(x, y+1) \]
\[ \vec{n}' = \vec{n} + U \cdot x_{\text{grad}} + V \cdot y_{\text{grad}} \]
Revisiting Blinn-Phong lighting model

Different terms
- Diffuse
- Ambient
- Specular

Final equation

\[ I = L_A \cdot M_A + n^T \cdot I \cdot L_D \cdot M_D + (r^T \cdot v)^c \cdot L_S \cdot M_S \]
Applying normal map

How to

- Choose a consistent base.
- Convert normal to that base.
- Use that normal in the lighting model.

Example from The Cg Tutorial

Wall and Floor Lit Consistently and Correctly

Wall Lit Correctly Floor Lit Incorrectly (Too Dark)
Disadvantages of bump mapping

Example from wikipedia

Disadvantages
- Shadows
- Outline
Parallax mapping

Bump mapping

Parallax mapping