Mipmapping Normal Maps

• Technical brief by Michael Toksvig of Nvidia.
• Published in April 2004.
• Covers GeForce3 / Radeon 8500 generation hardware.
  − Requires DOT3 texture combine.
  − Requires dependent texturing.
Background

• Traditional mipmap calculations fail on normal maps.
  - Averaging multiple normals together gives a vector less than unit length, which results in lighting artifacts.
Theory

- By knowing how much shorter the averaged normal is, we can improve the lighting.
  - The paper suggests creating a table of scale factors and shininess exponent modifiers.
  - The new lighting equation becomes, where $N_a$ is the averaged normal and $s$ is the shininess exponent:

\[
\begin{align*}
  f_t &= \frac{|N_a|}{|N_a| + s(1 - |N_a|)} , \\
  K_s &= \frac{1 + f_t s}{1 + s} \left( \frac{N_a \cdot H}{|N_a|} \right)^{f_t s}
\end{align*}
\]
Implementation

- Since $N_a \cdot N_a$ and $N_a \cdot H$ must be between 0 and 1, all possible values of each can be plugged into the preceding equation and stored in a 2D texture.
  - The texture is accessed using $N_a \cdot N_a$ and $N_a \cdot H$ as texture coordinates.
  - Note that $N_a$ is **not** normalized.
Questions?
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