Shiny Surfaces

Mirror:

Light reflected in only one direction - reflected across $\hat{n}$

What direction is $\hat{r}$?

Dot product $\hat{l} \cdot \hat{n}$ gives length of projection of $\hat{l}$ onto $\hat{n}$ ($= \cos \theta$)

\[ \hat{l} \cdot \hat{n} = \cos \theta \text{ (scalar)} \]

This quantity times $\hat{n}$ gives the vector from the (flat) surface to $\hat{r}$'s endpoint. To get $\hat{r}$, take $-\hat{l}$ and add $2\times$ this vector:

\[ \hat{r} = \hat{l} + 2(\hat{l} \cdot \hat{n})\hat{n} \]

Shiny but not mirror:

Brighter (reflects more light) near "mirror" configuration.
Specular Reflection:

\[ \mathbf{L}_s = f(\mathbf{P} \cdot \mathbf{n}) = f(\cos \alpha) \]

Intuitive heuristic:

More light near mirror configuration \((\mathbf{P} = \mathbf{n})\)

Alternative: \(\mathbf{h} \in \text{bisector } (\mathbf{P}, \mathbf{n})\)

"half-vector": 

\[ \mathbf{h} = \frac{\mathbf{P} + \mathbf{n}}{\|\mathbf{P} + \mathbf{n}\|} \]

\[ \mathbf{L}_s = f(\mathbf{n} \cdot \mathbf{h}) \]

Not always equivalent in 3D; Blinn-Phong is closer to reality, and faster to compute.

In both cases, 

\[ f(x) = k_s \max(0, x)^p \]

"sharpness" of specularity

Strength of specularity

Blinn-Phong model, complete:

\[ \mathbf{L}_s = \mathbf{I} k_s \max(0, \mathbf{n} \cdot \mathbf{h})^p \]

Most surfaces are a mix of diffuse and specular, so the full shading model is

\[ \mathbf{L} = \mathbf{L}_d + \mathbf{L}_s \]