Lighting and Shading

Textbook Chapter 14

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Today

- Reminder: Pixar talk today 4pm DMP 310
- An example of what you can do with lighting
- Notes and pointers for Assignment 3
- A demo with fragment shading
- Transforming normals

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Note about Assignment 3

- This assignment has a slightly different flavor from the previous two
  - This is mostly classical OpenGL material. Simple and lots of sample code available on the Web (some pointers next slide). Please do look at this code, but implement it yourself so that you really understand what's going on
  - You are asked to write more of the shader (and OpenGL C++ glue), to understand how to put programs together
  - Grading will focus on whether you understand the parts you implemented

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Lighting and Shading Resources

- There are a huge number, esp. for per-vertex lighting and shading in OpenGL. The math is mostly the same.
- Per-fragment (Phong shading) examples
  - http://www.lighthouse3d.com/tutorials/glsl-core-tutorial/lighting/
  - http://www.arcsynthesis.org/gltut/Illumination/Illumination.html
  - Sample chapter of this book is on lighting and shading http://www.packtpub.com/opengl-development-cookbook/book

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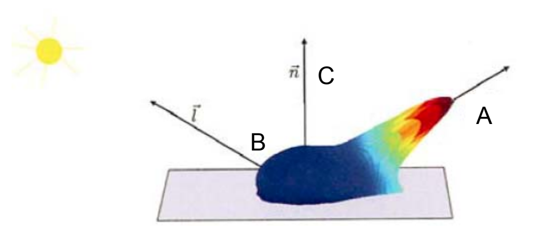
Demo

- http://www.packtpub.com/opengl-development-cookbook/book (sample chapter)

C^3 Review: Phong Reflection

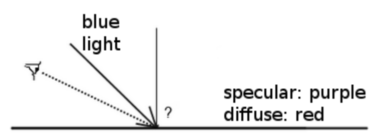
- Which feature in the figure is modelled by the specular component in the Phong reflection model?



a) A
b) B
c) C
d) All of the above
e) None of the above

C^3 Review: Lighting

- You're looking at a surface from the eye's position, as shown in the image, and a beam of blue light is hitting the point you're looking at. The surface's specular coefficient is purple (assume R,G,B = 128,0,128), and diffuse coefficient is red. What colour do you see from the eye's position?



a) Blue b) Purple c) Red d) Black e) White

Normal vectors

Note Title 2014-02-28

$$\bar{p}_{new} = \underline{\bar{A}}\,\bar{p}$$

Normals are not "regular" (normal :-) vectors

Intuitively this means things that look like displacement vectors.

e.g. velocity

tangent vectors

A tangent vector transforms with $\underline{\bar{A}}$ as well.

$$\bar{t}_{new} = \underline{\bar{A}}\,\bar{t}$$

A normal is a function on such vectors that defines the set of all tangents

That is $\boxed{\vec{n} \cdot \vec{t} = 0}$ for all tangent vectors

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So what we want is a $\vec{n}_{new}$ such that this relation still holds

$$\vec{n}_{new} \cdot \vec{t}_{new} = 0$$

In coordinates (in some frame)

$$\underline{n}_{new}^{T} \; \underbrace{\underline{t}_{new}} = 0$$

i.e. $$\underbrace{\underline{n}_{new}^{T} \; \underline{\underline{A}}}_{\underline{n}^{T}} \; \underline{t} = 0 \qquad \text{for all } \underline{t}$$

to make it consistent with Equation (1)

So $$\underline{n}^{T} = \underline{n}_{new}^{T} \; \underline{\underline{A}}$$

$$\boxed{\underline{n}_{new} = \left(\underline{\underline{A}}^{-1}\right)^{T} \underline{n}}$$

Important special case:

- If $\underline{\underline{A}}$ is a pure translation, no effect

  So people ignore the translation component and call the upper 3x3 matrix of $\left(\underline{\underline{A}}^{-1}\right)^{T}$ the <u>Normal matrix</u>

- If $\underline{\underline{A}}$ is a pure rotation?

  So $\left(\underline{\underline{A}}^{-1}\right)^{T} = \underline{\underline{A}}$