Normals, Shading wrap up

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Textbook Chapter 3.6, 14

1

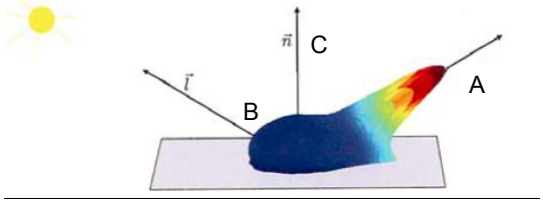
Today

- Announcements
  - Assignment 2: please show up only at the times you signed up for
  - Lost and Found: umbrella left at last office hour
- Transforming normals
- Lighting and Shading, odds and ends
- Assignment 3

2

Review: Phong Reflection

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



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

Switch to tablet

4

Normals are not "normal"

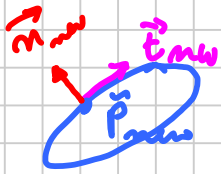
Note Title 2015-02-25

Suppose $p_{new} = A\,p$

$n_{new} = ? = A\,n$ Wrong

What exactly is a normal vector?

"Right angles to surface"?



$\vec{t}_{new}$ tangent vector

Better:

"Right angles to every tangent vector $\vec{t}$"

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

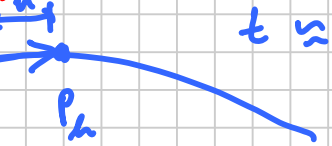
in coordinates

$$\boxed{n^T t = n_{new}^T t_{new} = 0} \quad (1)$$

But what is t_{new}?

$$\boxed{t_{new} = A\,t} \quad \checkmark \quad (2)$$

[Intuition tangent $\approx$ difference of points



$t \approx \frac{p_h - p}{h}$.

From ① & ②

$$n^T t = n_{new}^T A t$$

This must hold for **all** tangent vectors t

So: $$n^T = n_{new}^T A$$

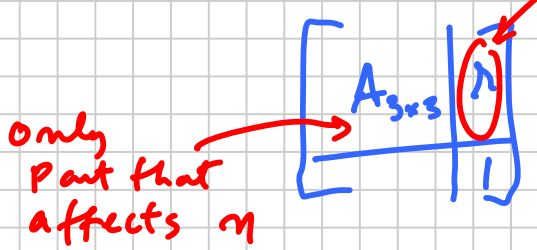
Taking transpose and moving A to the other side

$$\boxed{n_{new} = A^{-T} n}$$

Notation: $A^{-T} \equiv (A^{-1})^T$

Important special cases:

- If A is pure translation, has no effect.
  So you can safely ignore translation part of the matrix



$(A_{3\times3})^{-T}$ is called the "Normal Matrix"

THREE.js defines this for you automatically

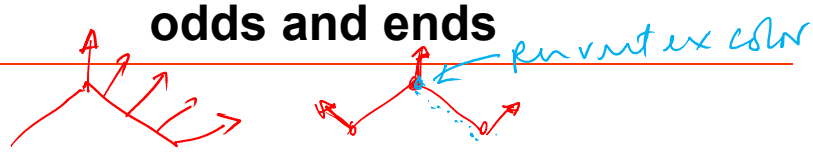
- If A is a pure rotation (ie Orthogonal)

$$A^{-1} = A^T$$

$$A^{-T} = (A^T)^T = A$$

★ So the wrong matrix A can still work!
Watch OUT: Hidden bugs.

Lighting and Shading, odds and ends



- Phong shading vs. Gouraud shading
- Phong reflection/illumination vs. Phong shading
- Global illumination and ambient
- Blinn-Phong reflection and the halfway vector
- Toon shading

5

Lighting and Shading odds and ends

- Phong shading vs. Gouraud shading
  - Gouraud == per-vertex normals and illumination. Interpolate vertex colors to fragments
  - Phong == Interpolate vertex normals, per-fragment illumination
- Phong reflection vs. Phong shading
  - P. reflection == an approximation of BRDF, into specular + diffuse + …
- Global illumination and ambient
  - Ambient term is a crude approximation of global illumination

6