Algorithm 5: Ray

Comp175: Introduction to Computer Graphics – Spring 2014

Algorithm due: **Monday April 7th** at 11:59pm

Your Names: Jayme Woogerd
Louis Rassaby

Your CS Logins: jwoogerd
lrassa01

1 Instructions

Complete this assignment only with your teammate. When a numerical answer is required, provide a reduced fraction (i.e. 1/3) or at least three decimal places (i.e. 0.333). Show all work; write your answers on this sheet. This algorithm handout is worth 3% of your final grade for the class.

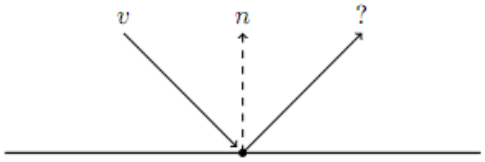
[2 points] The high-level view of our ray tracer is exactly the same as for intersect, except for a few additions. Below is the high-level pseudocode for `Intersect`. What needs to be changed/added to make this a full-fledged ray-tracer? Just specify what changes need to be made no pseudocode please.

for *point* $\in$ *Canvas* **do**
  Cast a ray to find the nearest object
  if ray intersects an object **then**
    for each light **do**
      Cast a ray to the light and evaluate the lighting equation
      $Canvas[pt] = Canvas[pt] + color$ with only diffuse/ambient components
    end for
  else
    $Canvas[pt]$ = background color
  end if
end for

Solution:
There are two modifications:

1. We need to check to see if the point is in shadow.
2. We need to modify the lighting equation to be the recursive lighting equation given on the assignment sheet.

[2 points] Given a vector $\vec{v}$ and a surface normal $\vec{n}$, find the equation for the vector $\vec{r}$ which is the reflection of $\vec{v}$ about $\vec{n}$ (i.e. in the equal and opposite direction). Write your equation in terms of vector operations. How do you compute the color contributed by the reflected ray? Give a brief description.



Solution:
We are solving for the reflected vector, $\vec{r}$.

$$\vec{v_{||}} = (\vec{n} \cdot -\vec{v}) * \vec{n}$$

$$\vec{v_{\perp}} = -\vec{v} - \vec{v_{||}}$$

$$\vec{r} = \vec{v_{||}} + \vec{v_{\perp}}$$

Or...

$$\vec{r} = 2\vec{n} * (\vec{n} \cdot (-\vec{v})) + \vec{v}$$

[1 point] Is ray tracing a local or global illumination algorithm? Why?

Solution:

Ray tracing is a global illumination algorithm. In addition to an object's inherent lighting, ray tracing depends on other objects, ambient and diffuse light sources, and specular, reflective, and other lighting effects.

[1 point] For what two cases will an object (or portions of an object) not be affected by a light source? There are actually more than two cases, but we expect you to be able to list at least two; you can list more for extra credit.

Solution:

1. If it is occluded by (i.e. in the shadow of) another object relative to a light source.
2. If the light source is directly behind the object, relative to the eyepoint.
3. If an object has so much light in a channel that it is already fully lit and cannot be lit any more. This was particularly apparent during a4.
4. If a light source emits a light that cannot be absorbed by the object.

[2 points] Recall that we can think of texture mapping in two steps. First, mapping from the object to the unit square, and second, mapping from the unit square to the texture map. Let a and b be the x and y values in the unit square that a particular point on an object gets mapped to in the first step. Note that a and b are calculated differently depending on the object. From here, how do you find the coordinates (s, t) to look up in a texture map in terms of a, b, u, v, w and h, where u and v are the number of repetitions in the x and y directions, respectively, w is the texture width, and h is the texture height?

Solution:

Solving for s and t:

$s = \lfloor (a * u * w)) \rfloor \bmod w$
$t = \lfloor (b * v * h)) \rfloor \bmod h$

[1 point] How do you use the color from the texture map and the `blend`value in the lighting equation?

Solution:

Given that the blend value is a fraction of how much the texture map should contribute to a single pixel's color,

pixel color =

$(blend * texture) + (1 - blend) * light)$

[1 point] What is the Phong lighting model used for? What is the purpose of its exponent?

Solution:

The Phong lighting model is used to cal-

culate the local illumination for a single pixel. The exponent controls the 'shininess' of the pixel, the larger the exponent the more shiny and mirror-like the surface. Its purpose is to control how fast the specular reflectance falls off. For larger exponents, the specular highlight will be small, i.e. fall off faster.

2 How to Submit

Hand in a PDF version of your solutions using the following command:

```
provide comp175 a5-alg
```