Programming Assignment #3
CS410 : Introduction to Computer Graphics
Fall 2015

Ray Casting
Due Tuesday, Nov 3rd.

Motivation

In the second assignment, you projected rays out from a perspective camera, and calculated whether they struck an object or not, by intersecting the rays with the polygons of the object. In this assignment, you do more than determine what pixels see what objects. In this assignment, your program will calculate the color of light bouncing off the object toward each pixel, assuming no inter-reflections.

Task

Your PA3 program will take in one more argument than in PA2. In other words, it will take in four or more command line arguments. The first argument is still a file containing the camera model. The last argument is still the name of the image your program will write. The second argument, however, is now a file containing material properties for polygons. Arguments three through N-1 are the names of ply model files (as written out by PA1). Note that there must be at least one object file, but there could be many.

Material Property Data

The material property file is an ASCII file with one light source or material per line. Lines that define light sources begin with a capital 'L', followed by six numbers (usually). The six numbers represent the RGB value of the light source and its 3D position. In the case of the ambient light source, it has no position, and as such the last three numbers are replaced by the letter 'A'. The RGB color values range from 0.0 (no light at all) to 1.0 (maximum possible brightness). For example, a material property file might contain the following three lines:

L 0.0 0.0 0.1 A A A
L 0.5 0.0 0.0 1000 0 0
L 1.0 1.0 1.0 0 1000 0 0

Such a scene has a weak blue ambient light (0, 0, 0.1), a red light (0.5, 0, 0) one thousand units down the x axis, and a bright white light (1.0, 1.0, 1.0) one thousand units up.

This same file also contains material properties of polygons. Material lines begin with the letter 'M', followed by 8 numbers. The first three numbers specify which polygons are made of this material. In particular, the 1st number is the object number (0–based). If this number is 0, the material is part of the first model on the command line. If this number is 1, it is part of the 2nd model on the command line, and so forth. The next two numbers are the numbers of the first and last polygons in the object that are made of this material. If these indices are the same, then the material applies to only one polygon. For example, a material property file might contain the following two beginnings of lines

M 1 57 57 …
M 0 0 5000 …

In this example, the first material would apply only to polygon 57 of the second object, while the second material applies to polygons 0 through 5000 (inclusive) of the first object.

The next five numbers in each line specify the reflectance properties of the material. In particular, the next three numbers are the diagonal terms of the 3x3 Lambertian (a.k.a. diffuse) reflectance matrix. (The off-diagonal terms are 0.) The remaining two numbers are the specular reflectance constant k_s and the shininess exponent α. Note that all five terms must be positive and only α can be greater than 1; the other four terms must be between 0 and 1.

An example file might look like:

```
L 0.0 0.0 0.1 A A A
L 0.5 0.0 0.0 1000 0 0
  L 1.0 1.0 1.0 0 1000 0 0
M 0 50 50 0 0 0 1.0 200
M 0 0 49 0.2 0.2 0.2 0.05 10
M 0 51 2235 0.2 0.2 0.2 0.05 10
```

In this example, there are three light sources (discussed above) and two materials. One polygon (#50) is a perfect mirror. All other polygons from 0 to 2235 are a dull, neutral color with very little specular reflection.

If a polygon is not assigned any material properties, assume its diffuse reflection values are 0.5, 0.5 and 0.5 (gray), and that its specular reflection value is 0 (perfectly matte). Given no specular reflection, its shininess value α is moot (feel free to use 1).

One hint for future reference: in PA4 additional material properties will be added (e.g. translucency, atmospheric effects).

Images

As before, images should be written as legal ASCII PPM files. This time, however, the pixel values should be scaled to the range 0 to 255. In particular, since light source colors range from 0 to 1, the calculated pixel colors will also be small (in the range 0 to 1 if only one light source is present). Color values should therefore be calculated as floating point numbers. When an image is written to a file, the minimum and maximum values occurring anywhere in the image should be linearly scaled to the range 0 to 255.

Submission/Grading

Make a tar file that includes your source files, a makefile if appropriate, and a README.txt file that explicitly tells us (1) how to compile your program and (2) how to execute it. Submit this tar file via the Checkin script on the class web site. The GTA will unpack your tar file, compile your program, and then test it.. Note that your tar file should not contain executable or compiled files, just source files.

Reminder

There is no "late period". The program is due when it is due. All work you submit must be your own. You may not copy code from colleagues or the web or anywhere else. Cheating will not be tolerated, and will be handled in accordance with university and department policy.