CS 500: Scene File Format

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This handout gives the format of the file used to specify the object, light, and camera information needed to render a scene.

Conventions. Objects, lights, and cameras are placed within a *right-handed* coordinate system. It is convenient to imagine that the units of length have been chosen so as to have most of the objects in a scene lie within the cube $[-1, 1] \times [-1, 1] \times [-1, 1]$. Note that this does not mean that objects outside this cube will not be rendered, or that one should not place objects outside this cube; rather, it is simply a matter of convenience to imagine that objects have dimensions on the order of unity.

In general, the scene file consists of five types of entries:

1. Comments
2. Objects
3. Lights
4. Camera
5. Global Quantities

Details about each of these types is given in the following sections.

1 Comments

A comment line starts with the `'#'` character, and ends with a newline. To make life as simple as possible, the comment marker `'#'` can only appear at the beginning of a line. Blank lines are ignored.

2 Objects

Objects are specified by a line, or lines, of the following form. Note that newline characters are considered whitespace (so that an object specification may span multiple lines).

```
<identifier> <spacial data> <surface properties>
```

where

<identifier> *is one of the following:* SPHERE, BOX, POLYGON, *or* ELLIPSOID.

<spacial data> *gives a list of data (vectors and/or values) specifying the spacial dimensions of the object (see below for the specifics).*

<surface properties> *s pecifies the surface characteristics for use with the lighting model, and always has the form*

$$(D_r, D_g, D_b)\ S_c\ S_e\ (A_r, A_g, A_b)\ \epsilon_r\ \mu_r$$

where (D_r, D_g, D_b) *are the diffuse reflection color coefficients (for the ray casting assignment, use this value and ignore all remaining values),* S_c *is the specular reflection coefficient,* S_e *is the specular reflection exponent (Phong model),* (A_r, A_g, A_b) *are the transmission attenuation factors,* ϵ_r *is the relative electric permittivity, and* μ_r *is the relative magnetic permeability (so that the index of refraction is given by* $n = \sqrt{\epsilon_r \mu_r}$*). All values are floating point values in the range* $[0, 1]$.

The <spacial data> list for an object depends on the specific object. The following specifies the format for each specific object.

SPHERE (c_x, c_y, c_z) r <surface properties>

A sphere with center (c_x, c_y, c_z) *and radius* r.

BOX (v_x, v_y, v_z) (l_x, l_y, l_z) (w_x, w_y, w_z) (h_x, h_y, h_z) <surface properties>

A rectangular box with corner (v_x, v_y, v_z)*, length vector* (l_x, l_y, l_z)*, width vector* (w_x, w_y, w_z)*, and height vector* (h_x, h_y, h_z).

POLYGON n $(v_{1,x}, v_{1,y}, v_{1,z})$ ... $(v_{n,x}, v_{n,y}, v_{n,z})$ <surface properties>

An n*-sided convex polygon with vertices* $(v_{1,x}, v_{1,y}, v_{1,z})$, ..., $(v_{n,x}, v_{n,y}, v_{n,z})$.

ELLIPSOID (c_x, c_y, c_z) (u_x, u_y, u_z) (v_x, v_y, v_z) (w_x, w_y, w_z) <surface properties>

An ellipsoid with center (c_x, c_y, c_z) *and semiaxes* (u_x, u_y, u_z), (v_x, v_y, v_z), *and* (w_x, w_y, w_z).

Individual quantities are separated by one or more whitespace characters; a vector quantity may, but is not required to, have whitespace between component values, parentheses, and commas.

3 Lights

A spherical light source centered at the point (p_x, p_y, p_x) with RGB color (I_r, I_g, I_b) and radius r is specified by the line:

$$\texttt{LIGHT}\ (p_x, p_y, p_z)\ (I_r, I_g, I_b)\ r$$

(the RGB values are floating point numbers, typically between 0 and 1). The value for the radius is for use in modeling soft shadows.

4 Camera

Our 'camera' model is as follows. The center of the view plane is located at $c = (c_x, c_y, c_z)$; the view window (whose center is also p) is defined by two vectors $u = (u_x, u_y, u_z)$ and $v = (v_x, v_y, v_z)$ in the view plane:

$$\textit{view window} = \{c + au + bv \mid -1 \leq a \leq 1, -1 \leq b \leq 1\}$$

(the vectors u and v are assumed to be orthogonal). The view reference point (eye) is located at $c + e$. With these conventions, the camera is specified by the line (or lines):

$$\texttt{CAMERA}\ (c_x, c_y, c_z)\ (u_x, u_y, u_z)\ (v_x, v_y, v_z)\ (e_x, e_y, e_z)$$

Some things to note about our camera model:

- The eye vector e is not necessarily orthogonal to the view plane!
- The width of the view window is $2|u|$, and the height is $2|v|$.
- The normal to the view window/plane is $u \times v$.

5 Global Quantities

We consider two basic quantities that will affect the overall appearance of the rendered scene: ambient light and air.

`AMBIENT` (I_r, I_g, I_b)

Ambient light of RGB color (I_r, I_g, I_b). If the `AMBIENT` identifier is not present in the scene file, the color should be assumed to be $(0, 0, 0)$.

`AIR` ϵ_r μ_r (A_r, A_g, A_b)

All objects in the scene are surrounded by 'air', which has relative electric permittivity ϵ_r, relative magnetic permeability μ_r, and RGB attenuation factors (A_r, A_g, A_b). If the `AIR` identifier is not present in the scene file, all values should be assumed to be unity .

6 Sample scene file

Here is an example scene file

```
# Sample scene file

SPHERE (0.5,0.25,-0.5) 0.25
  (0.5,0.7,0.5) 0.3 70 (0,0,0) 1e6 1

BOX (-0.2623,0.001,-0.7042)
    (0.6495,0,-0.375) (-0.125,0,-0.2165) (0,0.75,0)
  (0.3,0.3,0.5) 0.8 20 (0.5,0.5,0.5) 2.3716 1

POLYGON 4 (1,0,0) (1,0,-2) (-1,0,-2) (-1,0,0)
  (0.6,0.6,0.6) 0.4 20 (0,0,0) 1e6 1

ELLIPSOID (-0.5,0.5,-1.5) (0.25,0,0) (0,0.5,0) (0,0,0.25)
  (0.7,0.5,0.5) 0.3 70 (0,0,0) 1e6 1

LIGHT (-1,1,0) (1,1,1) 0.1
LIGHT (0.75,0.5,0) (0.8,0.8,0.8) 0.2

AMBIENT (0.1,0.1,0.1)

CAMERA (0,0.5,0) (0.5,0,0) (0,0.5,0) (0,0,1)
```