CSI 4341, Computer Graphics

Lecture 9: Viewing

Date: 2012-09-18
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This lecture is over some of the concepts in chapter 4 (viewing). Reference the book for diagrams to help in understanding the different views.

1 Classical Viewing

Classical viewing is what different perspectives are, and computer viewing is how we accomplish them.
Viewing requires:

1. One or more objects
2. Viewer with a projection surface
3. Projectors that go from the objects to the projection surface

Classical views are based on the relationship among these elements

- Viewer picks up object and orients it

Each object is assumed to be constructed from flat principal faces

2 Planar Geometric Projections

Standard projections project onto a plane. Projectors are lines that either 1) converge at a center or projection, or 2) are parallel.

Parallel projections will intersect at an infinity point (projective geometry).
Such projections preserve lines, but not necessarily angles.
Nonplanar projections are needed for applications such as map construction, because of the spherical nature of the projection surface.

3 Perspective vs Parallel

Computer graphics treats all projections the same and implements them with a single pipeline, but the API has helper functions to make it easier for people to understand.

Classical viewing developed different techniques for drawing each type of projection, but the computer treats it as all the same math.
Fundamental distinction for classical viewing is between parallel and perspective viewing, even though mathematical parallel viewing is the limit of perspective viewing.
Perspective is how our eyes work, so it looks real to us. The others do not look as real.

3.1 Orthogonal

Advantages

- Preserves distances, angles, shapes
- Can be used for measurements

Disadvantages

- Can't see what object looks like because many surfaces are hidden.
- (You can use isometric to see them)

3.2 Axonometric Projections

The type of axonometric projection depends on how many angles of a corner of a projected cube are the same. Also, in isometric (iso = "one"), 1 unit of distance is the same length in every direction. 1 "metric" for all three lines. Dimetric has two different metrics, trimetric has 3.

"How to be socially inept in ten easy lectures": start talking about how the graphics in a game are actually dimetric, not isometric. :)

- lines are scaled (foreshortened), but we can find the scaling factors.
- Lines are preserved, angles are not
- We can see 3 principal faces of a box-like object
- Some optical illusions are possible (parallel lines appear to diverge)
- Does not look real because far objects are scaled the same as near objects. However, this is useful in games, because you can generate an object once and do not have to change it based on the player's movement.
- Used in CAD applications

3.3 Oblique

Similar to orthogonal, but the projection plane is not parallel. There is an arbitrary relationship between the projectors and the projection plane.

- You can pick angles to emphasize a particular face
- Angles in faces parallel to the projection plane are preserved while we can still see "around" the side
- In the physical world, we cannot create this projection with a simple camera. It is possible with a bellows camera or a special lens. That is, it looks fake.

3.4 Perspective Projections

Projectors converte at the center of projection.
Vanishing points:

- Parallel lines (not parallel to the projection plane) on the object converge at a single point in the projection (the vanishing point)
- Drawing simple perspectives by hand uses these vanishing point(s)
- 1, 2, 3 point perspectives have 1, 2, and 3 vanishing points, respectively.
- Looks real (diminution; farther objects are smaller).
- Equal distances along a line are not projected into equal distances (nonuniform foreshortening).
- Angles preserved only in planes parallel to the projection plane.
- More difficult to draw by hand than parallel projection, but not more difficult to draw by computer.

4 Computer Viewing

Three steps, all implemented in the pipeline:

1. Position Camera (model view matrix)
2. Selecting a lens (projection matrix)
3. Clipping (Setting the view volume)

In OpenGL, object and camera frames are the same.
A default view is a cube of side length 2 (unit points), and the default is orthogonal projection with the z=0 plane. So it sort of defaults to a 2D view.
You can move the camera or you can move everything, but these are technically the same thing. We do both with rotations and translations.
Think of the XZ plane as the "ground".

4.1 LookAt function

LookAt(eye, at, up): "Eye" means camera location, "at" means where to look, and "up" means "Which direction is up"? "Eye" has three degrees of freedom, "at" has two (think point on a spherical surface), and "up" has one (think point on a circle), for a total of 6 degrees of freedom.

4.2 Other Viewing APIs

There are other ways of setting up the camera. You can try these on assignment 3, but talk to him about it first.

- View reference point, view plane normal, view plane up
- yaw, pitch, roll (think airplane)
- elevation, azimuth, twist
- Direction angles