Lecture Notes #4 - 3D Viewing

Reading:

Read Angel 1.5-1.8, and peruse chapters 2 and 3

- Optional: Foley et al., Sections 6.1, 6.2, 6.6

Viewing in 3D

Viewing in 2D:

What's different about 3D?

Useful Metaphor

Synthetic camera:
can be positioned, oriented

with snap of shutter => create 2D image of 3D object

camera = computer program that produces an image on display screen

object = 3D model = 3D dataset: collection of points, lines and surfaces.

Creating a "photo" with computer graphics

- Modeling => 3D dataset, including light sources
- Specification of projection type
  - projection: transformation from 3D objects to 2D projection plane
    - perspective
    - parallel
- Specification of viewing parameters
  -
  -
  -
- Geometric processing. Goal: to determine which objects appear on display and to assign shades (colors) to objects.
  - combine objects into single coordinate system together with camera.
  - clipping in 3D (transform so canonical view volume is created).
  - hidden surface removal
  - shading
  - projection to 2D
- Scan Conversion

Projections

"Projections" transform points in n-space to m-space, where $m < n$.

In 3D, we map points from 3-space to the "projection plane" (PP) along "projectors" emanating from the "center of projection" (COP):

There are two types of projections:

- "Perspective" -- distance from COP to PP finite
- "Parallel" -- distance from COP to PP infinite

Perspective vs. Parallel projection

Perspective projection pros and cons:

+ Size varies inversely with distance -- looks realistic
-- Distance and angles are not (in general) preserved
-- Parallel lines do not (in general) remain parallel

Parallel projection pros and cons:

-- Less realistic looking
+ Good for exact measurments
+ Parallel lines remain parallel
-- Angles not (in general) preserved

Vanishing points

Under perspective projections, any set of parallel lines that are not parallel to the PP will converge to a "vanishing point."

Vanishing points of lines parallel to a principal axis x, y, or z are called "principal vanishing points."

There are at most _____ of these

Types of perspective drawing

Perspective drawings are often classified by the number of principal vanishing points.

- One-point perspective -- simplest to draw
- Two-point perspective -- gives better impression of depth
- Three-point perspective -- most difficult to draw

All three types are equally simple with computer graphics.

Perspective Transformation

Parallel projections

For parallel projections, we specify a "direction of projection" (DOP) instead of a COP.

There are two types of parallel projections:

- "Orthographic projection" -- DOP perpendicular to PP
- "Oblique projection" -- DOP not perpendicular to PP

There are two kinds of oblique projections:

- "Cavalier projection"
  - DOP makes 45° angle with PP
  - Does not foreshorten lines perpendicular to PP
- "Cabinet projection"
  - DOP makes a 63.4° angle with PP
  - Foreshortens lines perpendicular to PP by one-half

Coordinate systems for computer graphics

The real computer graphics guru uses lots of different coordinate systems:

"Model space" -- for describing the objects

"World space" -- for assembling collections of objects

"Eye space" -- a canonical space for viewing

"Screen space" -- result of perspective transformation

"Image space" -- a 2-D space that uses device coordinates

Screen space

Many of the hidden surface algorithms we will study take place in "screen space":

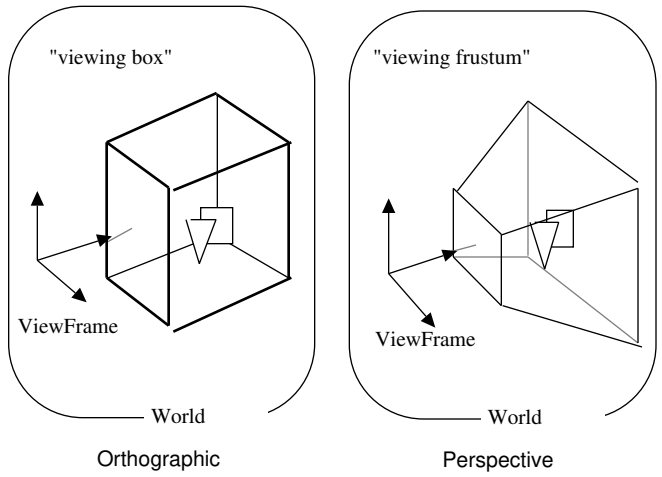
Screen space

Transforming from eye space to screen space involves two steps:

1. Multiplication with a 4 x 4 matrix:

2. Perspective divide:

Summary

What to take home from this lecture:

1. Basic steps in graphics pipeline
2. Types and properties of perspective and parallel projections
3. Names and functions of different computer graphics coordinate systems.