Visual Imaging in the Electronic Age

Lecture # 2

Drawing Perspective Images

Brunelleschi’s Experiment

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The Flagellation of Christ, c. 1458-60. Piero della Francesca. Tempera. 59 x 81.5 cm. Urbino, Galleria Nazionale delle Marche.
Planar Geometric Projections

- Parallel
  - Orthographic
    - Multiview Orthographic
    - Axonometric
      - Isometric
      - Dimetric
      - Trimetric
  - Oblique
    - Cavalier
    - Cabinet

- Perspective
  - One-point
  - Two-point
  - Three-point
Reference


(This reference contains a matrix method for combining all of the above types of projections)
Orthographic Projections

Projectors are perpendicular to the image plane

Object faces are parallel to the image plane

Axonometric Projections

Projectors are perpendicular to the image plane

Object faces are not parallel to the image plane

Oblique Projections

Projectors are parallel but not perpendicular to the image plane.

Object faces are parallel to the image plane.

Perspective Projection

Projectors are not parallel but converge on a single focal point (eye, camera)

Comparison of Axonometric & Perspective Drawings

What are the advantages of an axonometric drawing?
- Can measure distances on axonometric.
- Can’t measure distances on perspective.
The concept of the picture plane may be better understood by looking through a window or other transparent plane from a fixed viewpoint. Your lines of sight, the multitude of straight lines leading from your eye to the subject, will all intersect this plane. Therefore, if you were to reach out with a grease pencil and draw the image of the subject on this plane you would be "tracing out" the infinite number of points of intersection of sight rays and plane. The result would be that you would have "transferred" a real three-dimensional object to a two-dimensional plane.
Rays of light travel from the object, through the picture plane, and to the viewer's eye. This is the basis for graphical perspective.
1, 2, 3 Point Perspective Animation
(Perspective02_wmv)
Computer Graphics
Perspective Image Generation
Standard Computer Graphics Pipeline
The camera location, view direction, and frustum must be defined relative to the object.
Eye Coordinate System

The model is described in a right handed coordinate system.
Eye Coordinate System

Note the eye coordinate system is a left-handed coordinate system.
Left Handed and Right Handed Coordinate Systems

Left Handed

Right Handed
Simple Perspective Transformation

$P(x_e, y_e, z_e)$

$P'(x_s, y_s)$

$X_e$  $Y_e$  $Z_e$

$Z_e = 0$  $Z_e = D$

Picture Plane

Point On Object
Simple Perspective Transformation

Elevation drawn in the $Y_e, Z_e$ plane.
Simple Perspective Transformation

\[
\frac{x_s}{D} = \frac{x_e}{z_e}, \quad \frac{y_s}{D} = \frac{y_e}{z_e}
\]

\[
x_s = \frac{Dx_e}{z_e}, \quad y_s = \frac{Dy_e}{z_e}
\]

To convert to a dimensionless fraction, can divide by the window size \(S\).

\[
x_s = \frac{Dx_e}{Sz_e}, \quad y_s = \frac{Dy_e}{Sz_e}
\]
Pinhole Camera

Note that the entire image through the pinhole is totally in focus on a single image plane.
Camera Obscura
Brunelleschi’s first experiment: overhead view of Florence Cathedral and the Baptistry with indication of the position of the observer inside the central portal and his two possible angles of vision.
Plan of the environs of the cathedral and the Baptistry of San Giovanni. The broken lines correspond to the two possible angles of vision. A. Volta dei Pecori (corner of the sheep market); B. Canto alla Paglia (corner of the straw market); C. Misericordia; D. Saint Zenobius column.
Ghiberti’s Doors
Ghiberti’s Doors
Brunelleschi’s first experiment: how the tavolletta was used.
Illustration ix–2: Reconstruction of Brunelleschi’s visual angle from the portal of the Duomo toward the Baptistery. Site-plan from Bernardo Sansone Sgrilli, Descrizione e studi dell’ insigne fabbrica di Santa Maria del Fiore . . ., Florence, 1733.
Brunelleschi

Illustration x–1: Reconstruction of a ninety-degree visual angle from the portal of the Duomo toward the Baptistry. Site-plan from Sgrilli’s Descrizione...
Brunelleschi's second experiment: the panel in situ.
Brunelleschi’s Experiment
Brunelleschi’s Experiment
Brunelleschi Video  (render01_wmv)
Brunelleschi’s Experiment
Description of Homework Assignment #1
Assignment #1
End...