Chapter 1
Graphics System and Models

Image Formation
To capture the image of a scene we need
- Object(s)
- Viewer / Camera
- Light Source(s)

O, V, L are independent of each other!

Trace of Rays From Light Source
- Light source (LS) to Camera (C)
- LS to Object (O) to Camera (C)
  - by reflection (shiny vs dull surface)
  - by refraction (transparent surface)
  - by combination of both
- LS to O1, O2, O1, O2, ...., to Camera
- LS to O to infinity (away from camera)
- LS to infinity

Synthetic-Camera Model
- Projector lines
- Center of projection
- Projection plane
- Clipping

Graphics API
- Pen-Plotter Model (2D)
  - API to produce images by moving a “pen” on a drawing surface
- Three-Dimensional API
  - API to specify (not to draw): objects, light sources, viewer, material properties
  - The image is produced by the graphics rendering engine

Modeling-Rendering Paradigm
- First **model** the 3D scene then produce **render** the 2D image
Geometric Rendering Pipeline

Components of Rendering Pipeline

- Vertex Processor: “brings” objects into the camera via coordinate transformation
- Clipper & Primitive Assembly
  - Assemble vertices into lines, triangle, polygons
  - removes non-visible parts of objects
- Rasterizer: converts the visible primitives into fragments to be drawn on the image
- Fragment Processor: uses fragments attributes to actually render the image

Object Specification

- Graphics API for primitive objects:
  - Points (1D objects)
  - Lines and Curves (2D objects)
  - Polygon and Surfaces (3D objects)
- All objects are defined in terms of vertices
- Examples

Camera Specification

- Position and Orientation of Camera (6 DOF)
- Lens Type
- Film Size (Image Size)
- Pinhole Camera Model

Why Pinhole Camera Model?

- A real camera has a complex arrangement of lenses, prisms (and mirrors)
- The effect of capturing a 3D scene with a real camera is linear scaling (down or up) the actual view to the image
- A pinhole camera is a perfect model for linear scaling of image

Light Source Specification

- Type of light
  - Ideal single point source
  - Distributed source (infinitely many points)
  - Spot Light (cut off angle, attenuation, direction)
- Color Properties
Material Specification

- Color Properties
- Surface Properties
  - Diffuse / dull
  - Specular / shiny
  - Transparency
- Texture