Imaging Geometry

Imaging Geometry

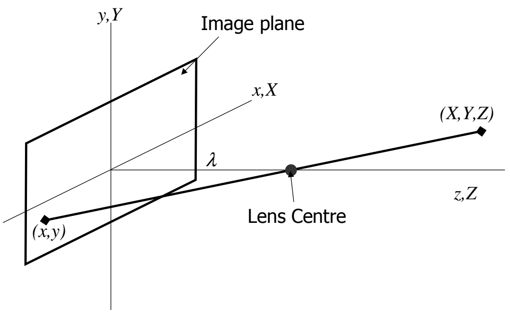
- Basic Transformations
  - Translation
  - Scaling
  - Rotation
  - Perspective Transformations
- Camera Model
- Camera Calibration
- Stereo Imaging

Basic Transformations

- Translation
- Scaling
- Rotation
- Concatenation and Inverse Transformations

Perspective Transformations

- How a 3 dimensional object looks
- Projects 3D points onto a plane
- Nonlinear, division by coordinate values
- Consider the image formation process



Camera coordinate system *(x,y,z)*

- image plane coincident with the xy plane
- lens optical axis along the z axis
- Centre of the image plane is at the origin
- Centre of the lens at $(0,0,\lambda)$
- If camera is in focus, λ is the focal length of the lens

World coordinate system *(X,Y,Z)*

- Assume aligned with the camera coordinate system
- Object is in front of lens, $Z > \lambda$
- Obtain a relationship that gives the coordinates (x,y) of the projection of point (X,Y,Z) onto the image plane

From similar triangles,

$$\frac{x}{\lambda} = -\frac{X}{Z-\lambda} = \frac{X}{\lambda - Z}$$

$$\frac{y}{\lambda} = -\frac{Y}{Z-\lambda} = \frac{Y}{\lambda - Z}$$

Image-plane coordinates

$$x = \frac{\lambda X}{\lambda - Z} \qquad y = \frac{\lambda Y}{\lambda - Z}$$

Camera Model

- Now, suppose coordinate systems of the camera and world are different
- Obtain the image coordinates of any point on the object

Camera calibration

- Determining the position of the camera from image points whose world coordinates are known

Stereo Imaging

- Obtaining depth information from two separate images

Pixel Relationships