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Steropsis

Why Stereo Vision?

- 2D images project 3D points into 2D
- 3D points on the same viewing line have the same 2D image
  - 2D imaging results in depth information loss

Stereo

- Assumes two cameras with known positions
- Can recover depth from this information

Recovering Depth

- Depth recovered with two images and triangulation
- Find correspondences between images and see where their projective lines meet
- Solution is not always unique
  - Looking at 3 points → 9 intersections in space → 3 possible solutions
- Find Correspondences and epipolar lines
  - Epipolar lines → lines formed by the intersection between the plane created by 2 correspondences and their intersection and the camera plane
  - Reduces correspondence problem to 1D search in conjugate epipolar lines

Simplest Case

- Image planes of cameras are parallel
- Focal points are at the same height
- Focal lengths are the same
- ⇒ Epipolar lines are horizontal scan lines

Calculations

$$\frac{T + x_r - x_l}{Z - f} = \frac{T}{Z}$$

$$Z = f\frac{T}{x_l - x_r}, d = x_l - x_r \implies \boxed{Z = f\frac{T}{d}}$$

- T is the stereo baseline
- d measures the difference in retinal position between correspondences
- Given Z we can compute X and Y

What Correspondences should we match?

- Objects? Edges? Pixels? Collections of pixels?
- Slide window along scanline and compare its contents with the reference window in the other image
- Matching Cost: SSD or normalized correlation
  - Minimize SSD or Maximized Correlation
- Correspondence at the minimum point of the matching cost
- **Effects of Window Size**
  - Window size too small → A lot of noise
  - Window size too big → Too much smoothing ⇒ loss of detail