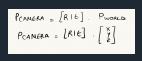
STEREO VISION

Camera Calibration

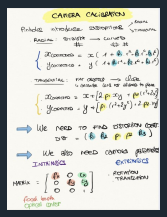
- **Extrinsic: world to camera**
  - Gives Rotation and Translation parameters



- **Intrinsic: camera to image**
  - Gives focal length f and optical center (u0, v0)

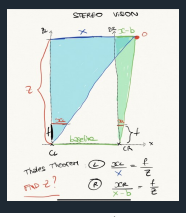
- **Full Calibration Formulas**

- **Chessboard Calibration**



Stereo Vision

- **Stereo Model**
  - Mathematical Model

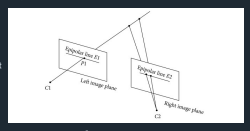


$X = Z*xL/f$

$Y = Z*yL/f$

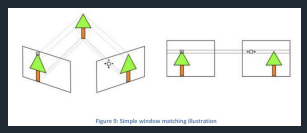
$Z = f.b/(xL-xR)$

  - Epipolar Constrainst



For a given point in an image, the corresponding point is along the epipolar line of the second

  - Image Rectification in Stereo Vision



- **Stereo Matching**
  - Traditional
    - Local
      - Fast
      - Low Quality
      - Idea: Select the lowest cost and uses a « winner takes all » approach
      - StereoBM
    - Global
      - Slow
      - High Quality
      - Idea: Skip Cost aggregation and define a global energy function
      - Graph Cut, Belief Propagation
    - Semi-Global
      - Good Tradeoff
      - Idea: Enforce smoothness constraints between neighboring pixels so that they take similar disparity values
      - StereoSGBM
  - Deep Learning
    - Non End-To-End
    - End-To-End
    - Unsupervised

3D Computer Vision

- **Fundamental & Essential Matrices**

Essential Matrix

Fundamental Matrix

- **Depth Map**
  - A depth map is the size of the image, every value is the corresponding depth for each pixel
  - We use the value Z = f.b/d
- **Obstacle Detection**
  - We use obstacle detection and combine it with the Depth Map
  - For each bounding box, we can take the closest point, the average, median, center, ...
- **3D Bounding Boxes**
  - It can be done from 2D images if we find the orientation, width, height, and length of the car
- **3D Reconstruction**
  - From a set of stereo images, we can get a point cloud that we can then process