Advanced Robotic Perception: Lecture 8

Lecture Notes

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1 Introduction to Depth Sensing

Goal of today: recovery of 3D coordinates.
There is dimension reduction which results in ambiguity of the distance of the coordinate in the pixel.

1.1 Non-contact distance measurement

- Reflective
  - Non-optical
  - Optical
    - Passive
    - Active

1.2 Image pairs

Theory on Two-view geometry. You can either have two cameras or a single moving camera. We will focus on static 2 camera setup.
There is two problems with this:

- Determine the point location (Search problem)
- Estimation problem, where is transform.

We focus on epipolar geometry. The epipolar line is the depth line of the first camera, where the distance from the first camera can be considered a constraint on the other dimension.
The Baseline is the line between the camera sensors.
The epipolar plane is spanned by the two sensors and the object position x.
The Epipoles are the location where the baseline intersects the image planes.

1.2.1 Calibrated case

We know the intrinsic and the extrinsic cameras parameters. and that the intrinsic parameters are the same for both cameras.
We can use the skew-symmetric matrix which is based on the camera parameters, which can then be used to compute the epipolar geometry.

1.2.2 Uncalibrated case

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1.3 Epipolar geometry

Instead of computing the epipolar line (which reduces the dimension from the entire image to just the epipolar line). Furthermore you can use **rectification** of the images to aling the epipolar lines so you do not need to compute epipolar lines for each pixel in the image.

2 Passive stereo vision

General stereo pipeline:
TODO: enumerate snippet

1. Calibration
2. Rectification based on the intrinsinc camera paramet calibration
3. Stero correspondence (Disparity map)
4. Depth map using triangulation

2.1 Depth map computation

$$z = \frac{fB}{x_r - x_l} \tag{1}$$

where z is the distance to the poiint in the physical world.
The longer the baseline, the more precision on longer distances

3 Active stereo

Can e.g. be a intel realsense with an IR projector.

3.1 Structured light

Project light patterns onto the object of focus. This can give a sense of depth. Can be done with a single camera.

3.2 ToF cameras

Resolution lower than stereo cameras but is improving. Requires high clock speeds.
Azure connect/kinect
Not robust towards glass, or high reflective surfaces.