Lab 8

Stereo Geometry

Learning Objectives:

- We will learn about the basics of Multiview geometry
- We will see what is epipole, epipolar lines, epipolar constraint etc.
- We will learn to create a depth map from stereo images.

Disparity map estimation using OpenCV

Disparity map estimation is a technique used to understand the depth or distance of objects in a scene captured by a stereo camera setup. In a stereo camera setup, there are two cameras placed apart, like human eyes. These cameras capture two images of the same scene from slightly different viewpoints. **Disparity map estimation compares the images from the two cameras to figure out how far objects are.**

How it works?

1- **Matching points**
   The first step is to find corresponding points in the two images. These are points that represent the same object or feature in both images.

```python
# Load stereo images
left_img = cv.imread()
right_img = cv.imread()
```

2- **Calculate Disparity**
   After matching points, we measure the disparity. If an object is closer to the camera, its disparity will be larger because the difference between its positions in the two images will be more significant. If it's farther away, the disparity will be smaller.

```python
# Initialize StereoSGBM object (Stereo Semi-Global Block Matching)
stereo = cv2.StereoSGBM_create(minDisparity=0, numDisparities=64, blockSize=5)
```

`minDisparity`: Specifies the minimum possible disparity value.
`numDisparities`: Defines the number of disparity levels to be computed. Disparity levels represent the range of possible disparities to be considered during the matching process.
`blockSize`: Specifies the size of the window used for matching.

3- **Creating disparity map**
   Each pixel value represents the disparity of the corresponding point in the scene. Brighter pixels indicate closer objects, and darker pixels indicate farther objects.

```python
disparity_map = stereo.compute(left_img, right_img)
```

Fundamental Matrix Estimation

The epipolar line: It represents the projection of a corresponding point in one image onto the other image in a stereo pair. The fundamental matrix helps us find epipolar lines. It's a matrix that contains all the information about the geometry and relative positions of the two cameras.

Fundamental Matrix Estimation method:

```
#pts1 & pts2 are the matched key points
cv.findFundamentalMat(pts1, pts2)
```

Exercise 1: Disparity map estimation using OpenCV:

Write a Python Program to create a disparity map given a pair of stereo images

Reference: https://docs.opencv.org/4.x/dd/d53/tutorial_py_depthmap.html

Exercise 2: Fundamental Matrix Estimation:

Extend the feature matching code which you built in SIFT feature Lab 6 to estimate the fundamental matrix of a pair of stereo images. Then, find the epipolar lines correspond to one feature in the first image and draw it on the second image.

Reference: https://docs.opencv.org/4.x/da/de9/tutorial_py_epipolar_geometry.html