Visual Odometry: Project 2

Explanation & Steps for Visual Odometry

The folowing steps were taken into consideration while completing Project-2:

1. **Extracting the Camera Parameters**

First of all, the Camera Parameters[3] are extracted using the ReadCameraModel.m file as provided in the Oxford Dataset.

The first input to this function are Bayer Images in .png format (path to the folder is to be provided to read the Bayer files). The second input to this function are the Models in .txt and .bin format (path to the folder is to be provided to access the Models and fetch the ourput of the camera parameters).

The output of this function are- fx, fy, cx, cy, G_camera_image and LUT

2. **Recovering Color Images using Demosaic Function**

Now, using the length of the for loop as the end, the for loop is executed to apply the Demosaic function[8] to the Black & White images in Bayer format. Then, using the inbuilt 'demosaic' function, the images are demosaiced with the format of pixels as green-blue-red-green (gbrg) as suggested in the question to convert it into RGB format.

Figure-1: Bayer Image in Black & White Format

Figure-2: Demosaiced Image into RGB Format

3. Undistorting the Image

After applying gaussian filter[2] to remove the noise from the color images, the images are undistorted using the UndistortImage.m file as provided in the Oxford Dataset.

Figure-3: Undistorted Image

4. Finding Correspondence Points

Using the inbuilt MATLAB function of 'detectHarrisFeatures'[1], the correspondence points are found between the pair of images. And at the end, the location of all the correspondence points are found out.

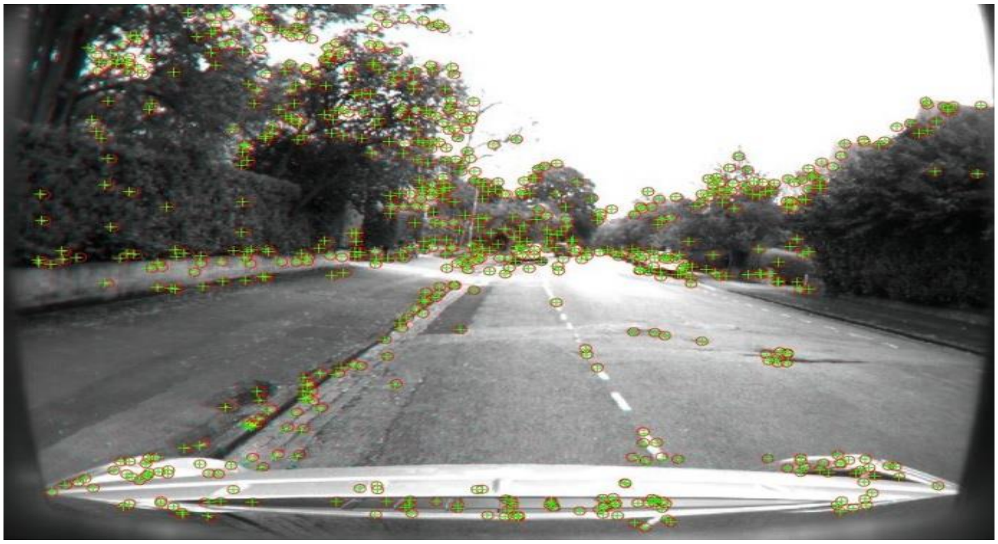

Figure-4: Correspondence Points plotted for Two Images

5. Normalization of Correspondence Points

As per the theory of Normalization of Correspondence Points, the centroid of all the points is found out and shifted to origin. Next, their mean is to be found out which should be sqrt(2). Hence, their values are scaled accordingly.

6. Application of RANSAC Function

Application of Ransac[4] to find out the Best Correspondence Points with the number of iterations of 500. Thus, the best 8 points are found out of all the 500 points.

7. Estimating Fundamental Matrix

The Fundamental Matrix ‘F’[4],[9] is found out using the normalized values. Hence, we get a normalized fundamental matrix. GoodInliers are found out from all the points using reference of the threshold value. The fundamental matrix is thereafter denormalized and we get the final fundamental matrix. This matrix is then denormalized to find the final Fundamental Matrix.

8. Estimating Essential Matrix

The Essential Matrix 'E'[5],[6] is now found out using the Fundamental Matrix and Camera Matrix. The E matrix is then disintegrated into three matrices- U, D and V. This is done using the Singular Value Decomposition (svd) to find out the Singular Value of E.

9. Extracting the Rotation & Translation Matrices

A new matrix W = [0, -1, 0; 1, 0, 0; 0, 0, 1] is defined for the calculation of Rotation and Translation Matrix[7]. Here, we'll get 4 answers for the Essential Matrix depending upon different values of R and T.

Rot1 = U*W*V’, Rot2 = U*W’*V’

Trans1 = U(:,3)’, Trans2 = -Trans1

10. Plotting the Camera Center

Once the value of R & T is known, the Camera Center can be plotted after that.

11. Plotting of Camera Center Inbuilt Functions

Using the inbuilt functions of MATLAB, viz., estimateFundamentalMatrix and relativeCameraPose, the values of F, E, R and T are found and then the Camera Centers are plotted.

Figure-5 Plot of Camera Center

The conclusion found after comparing both the results is that the trajectory plotted by both the methods is nearly the same with a slight over-shoot in the theoretical approach.

Dipam Patel
UID: 115809833

References

1. https://www.mathworks.com/help/vision/ref/detectharrisfeatures.html
2. https://www.mathworks.com/help/images/ref/imgaussfilt3.html?s_tid=doc_ta
3. https://www.youtube.com/watch?v=NWOL8yXL6xI
4. https://www.youtube.com/watch?v=K-j704F6F7Q
5. https://www.youtube.com/watch?v=Opy8xMGCDrE
6. https://www.youtube.com/watch?v=ViNChG-0yX4
7. https://en.wikipedia.org/wiki/Essential_matrix
8. https://www.mathworks.com/help/images/ref/demosaic.html
9. Book on 'Computer Vision- A Modern Approach' by Forsyth & Ponce