CSE 573 - Computer Vision and Image Processing (Report)

Homography & Fundamental Matrix Estimation

- **Name:** Sujit Singh
- **UBIT Name:** sujitjit
- **UBIT:** # 50247206

1. Homography Estimation:

1. **Implementation choices:**
   The implementation of image stitching into panaroma can be rationalized through appropriate homography estimation. For realizing the homography estimation algorithm following were the implementation choices that were made:
   a. **Feature Extraction:** The feature from both the images is extracted through blob detection. The threshold for detecting blobs is varied so that appropriate feature matches of the source and the target image can be formed.
   b. **Putative matches:** A constant number of matches are taken into consideration based on the lowest euclidean distance between the transformed co-ordinate and the target points. The constant number is varied in the experiment and best number giving the most optimum match is taken into consideration.
   c. **RANSAC:** The RANSAC algorithm is implemented by taking 4 random points through each iterations forming 4 pairs of homogenious equations. The solution to this equation gives the homography estimation matrix. Furthermore, a specific threshold is set in RANSAC to calculate the inliers present in the sample. The best of the inliers are taken for further computations.
   d. **Image Stitching:** The stiching of image is done using maketform and imtransform function. In this instead of passing the homography matrix to the maketform, we are passing the 4 best putative points of our maximum inliers' model. The implementation of this unit of code is build through the support of an external source.[1]
   e. **Panaromic Image:** The extra credit (forming panaroma) is implemented in such a way that it can take any number of images from the files and can form panaroma out of it.

2. **Observations:**
   The homography estimation of uttower gives the fine estimation of RANSAC implementation. The below figure states RANSAC implementation:

Fig 1.1 Putative matches of uttower-left

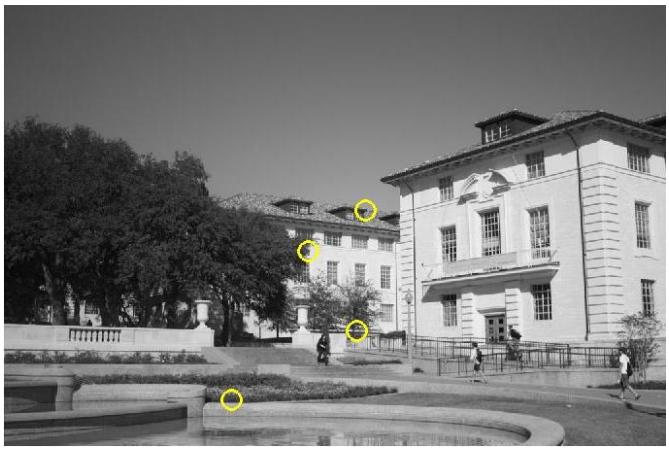

Fig 1.2 Putative matches of uttower-right

S.N.	Threshold (Blobs)	Threshold (Inlier Detection)	# Iterations	# Samples Points	Maximum Inliers	Residual Inlier
1	0.02	4	100000	500	104	2.1851

Table 1.1 Reporting residuals of homography on uttower.

3. Results:

The results of stiching and forming into panaroma for uttower is shown below:

Fig 1.3 Image stiching of uttower

Fig 1.4 Stiching image into panaroma (Extra Credit)

2. Fundamental Estimation:

2.1. Ground Truth fundamental matrix estimation:

Using the ground truth estimation the it can be reported that the inlier residual for unnormalized eight point algorithm is more in both the test image as compared to the normalized eight point algorithm. The results of the ground truth are displayed below:

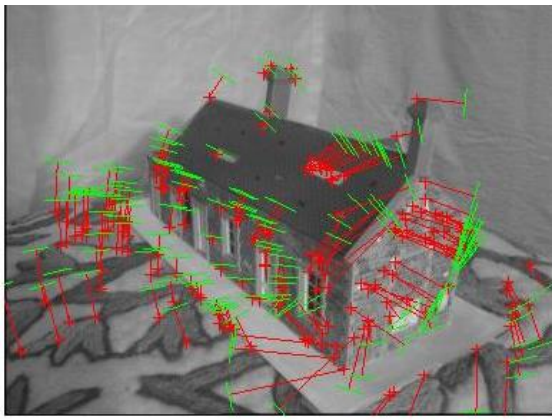

Fig 2.1 Un-normalized House

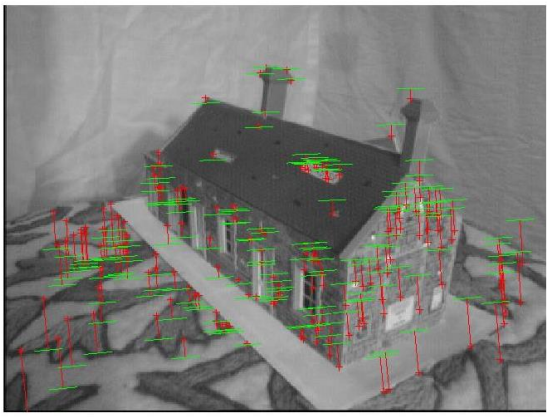

Fig 2.2 Normalized House

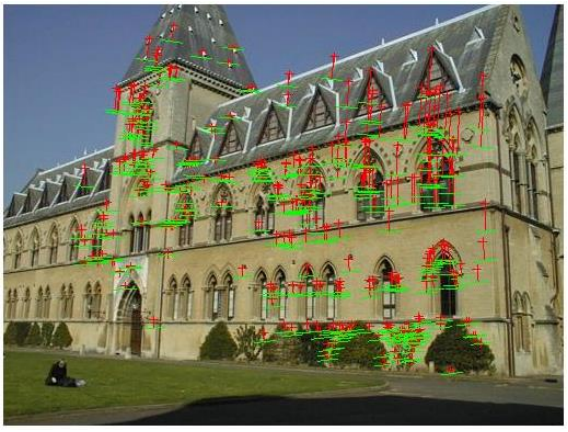

Fig 2.3 Un-normalized Library

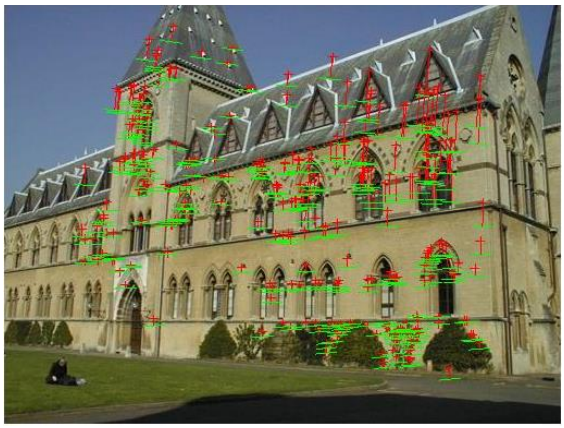

Fig 2.4 Normalized Library

Sr. No.	Image	Unnormalized Residuals	Normalized Residuals
1	House	26.7532	14.1947
2	Library	11.8459	10.1524

Table 2.1 Reporting residuals for ground truth

2.2. Fundamental Matrix RANSAC implementation:

The RANSAC implementation involves detecting the feature points of the images and finding out the best model having maximum inlier ratio for estimating fundamental matrix. The results of the fundamental estimation for house and library image is shown below:

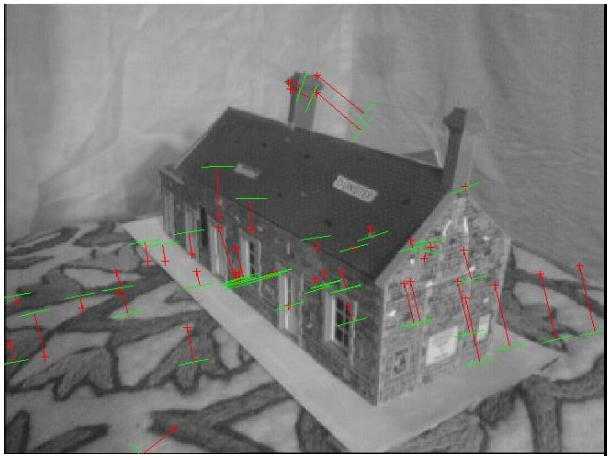

Fig 2.5 RANSAC – Fundamental Estimation (House)

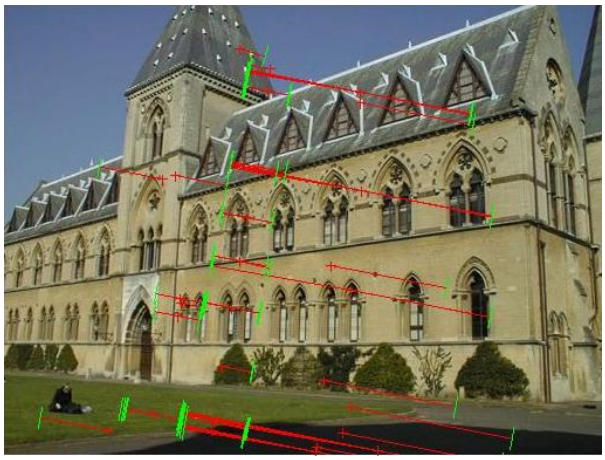

Fig 2.6 RANSAC – Fundamental Estimation (Library)

The number of inliers and the residual for inliers for both the image is shown below

Sr. No.	**Image**	**Maximum inlier ratio**	**Residual for inliers**
1	House	0.21	5.62
2	Library	0.61	14.15

Table 2.2 Reporting residuals for RANSAC

From the above comparision we can see that the number of inlier residuals is less in RANSAC and hence the image is different less efficient than ground truth matches. This can be improved by tuning various parameters like, threshold for blob detection, threshold for ransac inliers, increasing the iterations of RANSAC etc.

2.3.Triangulation into 3D space

The result of triangulation (mean residual) for both image pairs are shown in the below table.

Sr. No.	Image	Mean residual of image1	Residual for inliers
1	House	0.0025221	0.15655
2	Library	0.073128	0.26768

Table 2.3 Reporting residuals for Triangulation of image

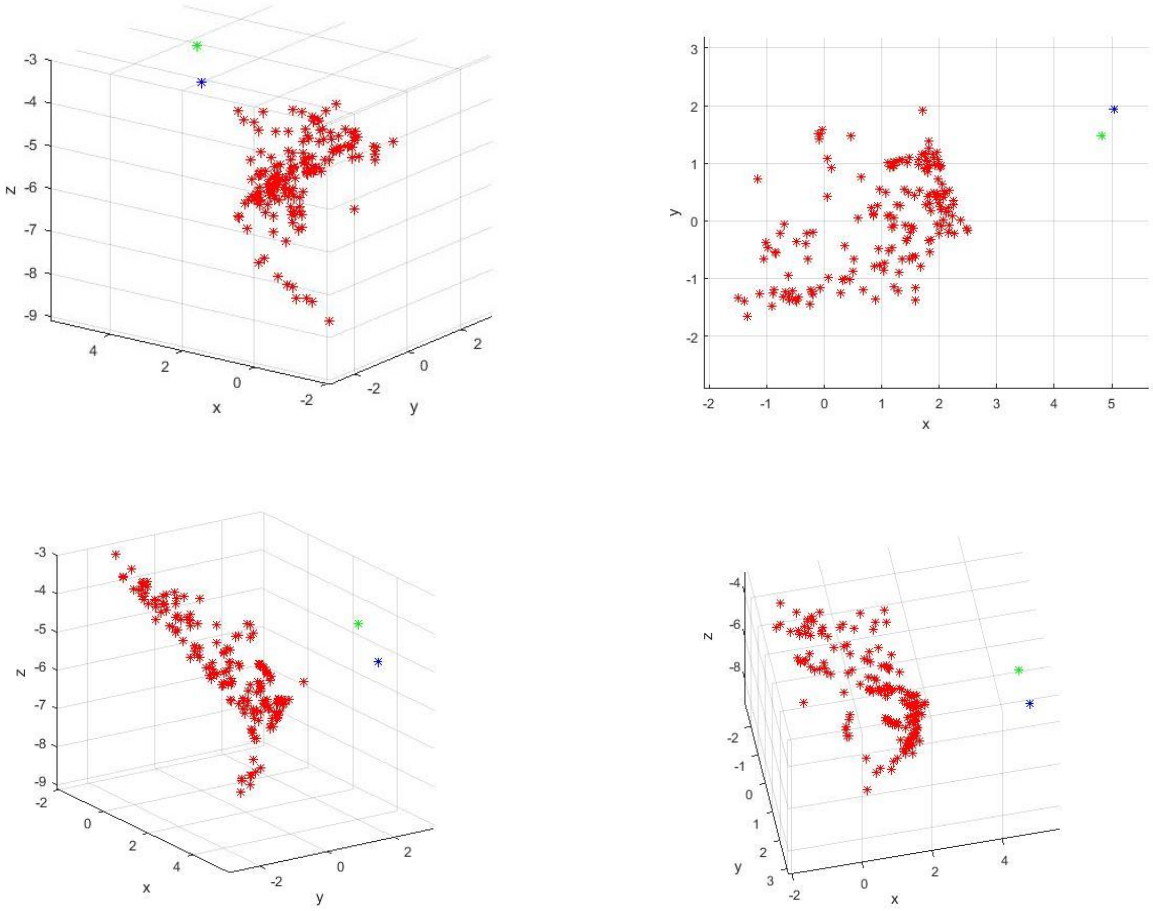

Fig 2.7 Triangulation of house with camera centers (3D plot)

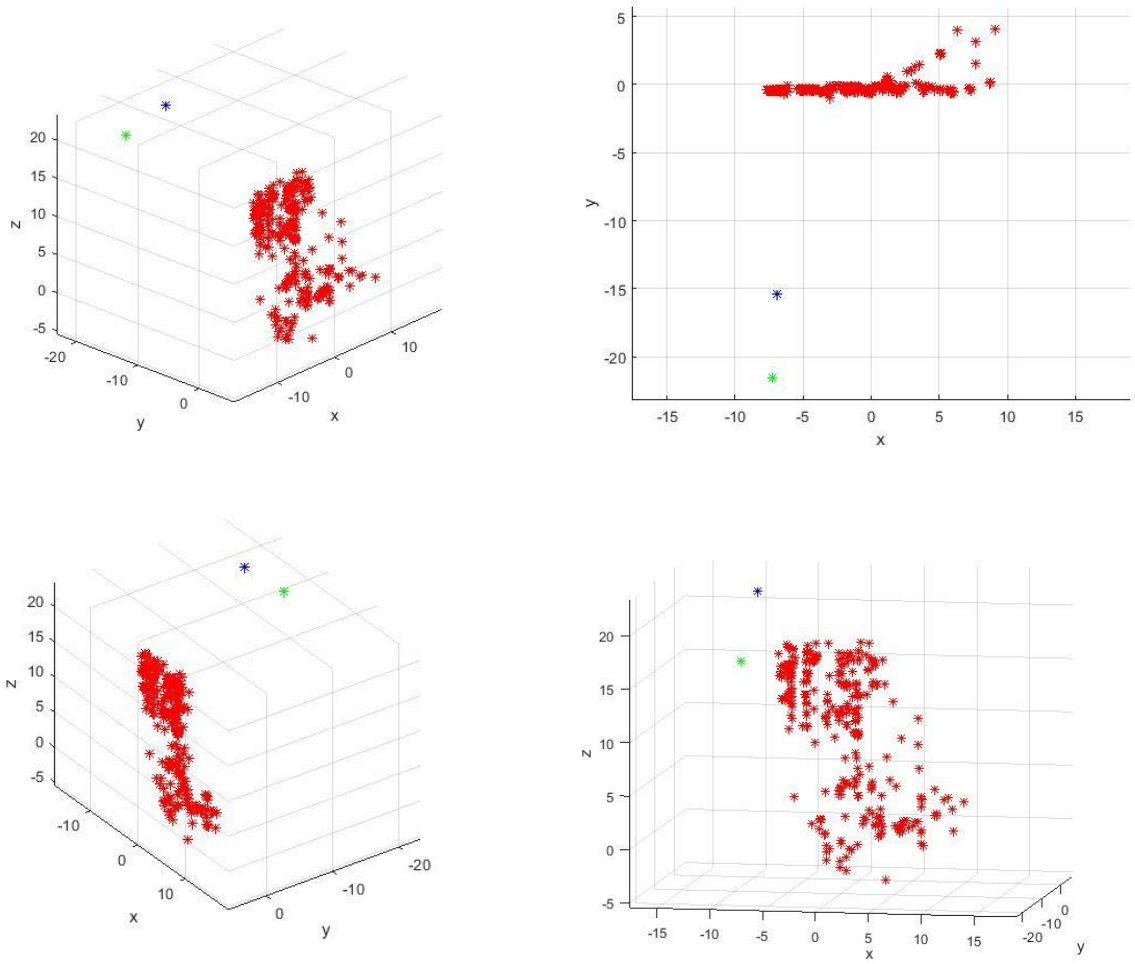

Fig 2.8 Triangulation of library with camera centers (3D plot)

References:

[1] http://home.deib.polimi.it/boracchi/teaching/IAS/Stitching/stitch.html

[2] https://math.stackexchange.com/questions/494238/how-to-compute-homography-matrix-h-from-corresponding-points-2d-2d-planar-homog - homography estimation

[3] http://dcyoung.weebly.com/fundamental-matrix--triangulation.html

***