

Project Report

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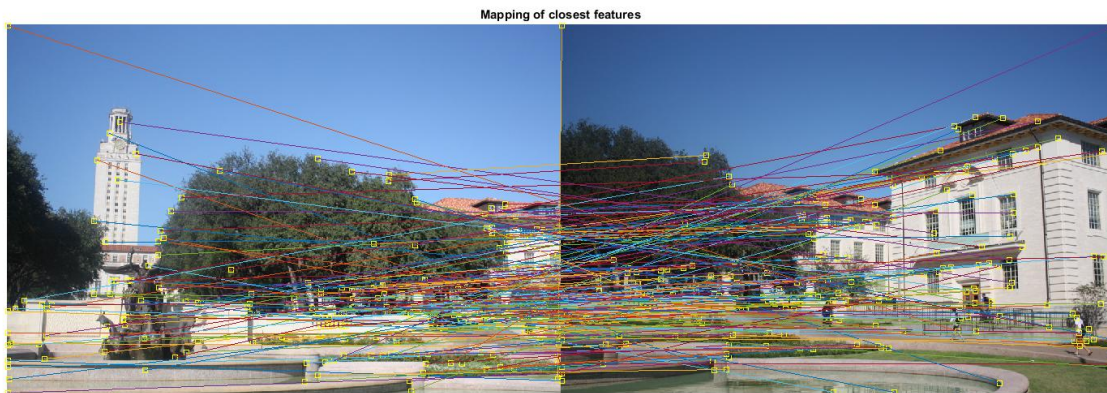
Stitching pairs of images

Usage: >> stitch_pair

For Harris detector, the radius was chosen to be 2 so that the size of mask is 5. This was done based on the knowledge from previous project.

Different neighbor sizes were selected and tested, they are displayed below

Neighbor size = 3



Neighbor size = 5



Neighbor size = 7

Mapping of closest features



Neighbor size = 9

Mapping of closest features



Neighbor size = 10

Mapping of closest features



To get descriptors, top 200 points with minimum distance were selected.

RANSAC was applied on these feature points to get the inliers and residual error

Number of Iterations = 10000

Number of Inliers: 42

Mean Residual Error: 0.7743

With these inliers found the optimal features, see below

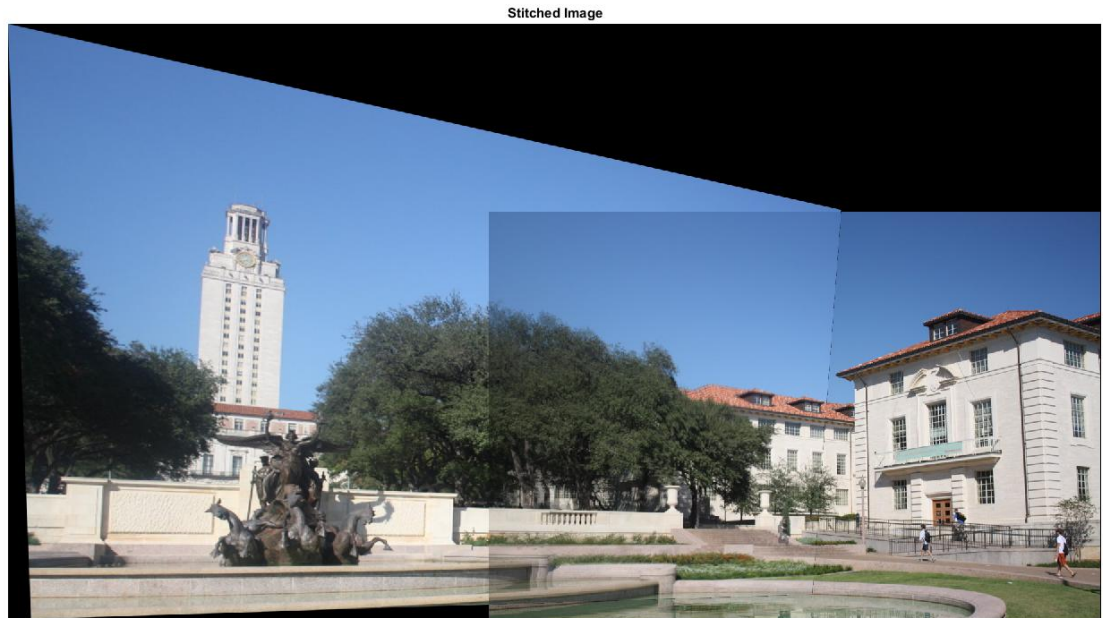


Homography transformed image was created. Instead of using maketform and imtransform, I used **projective2d** and **imwarp**.



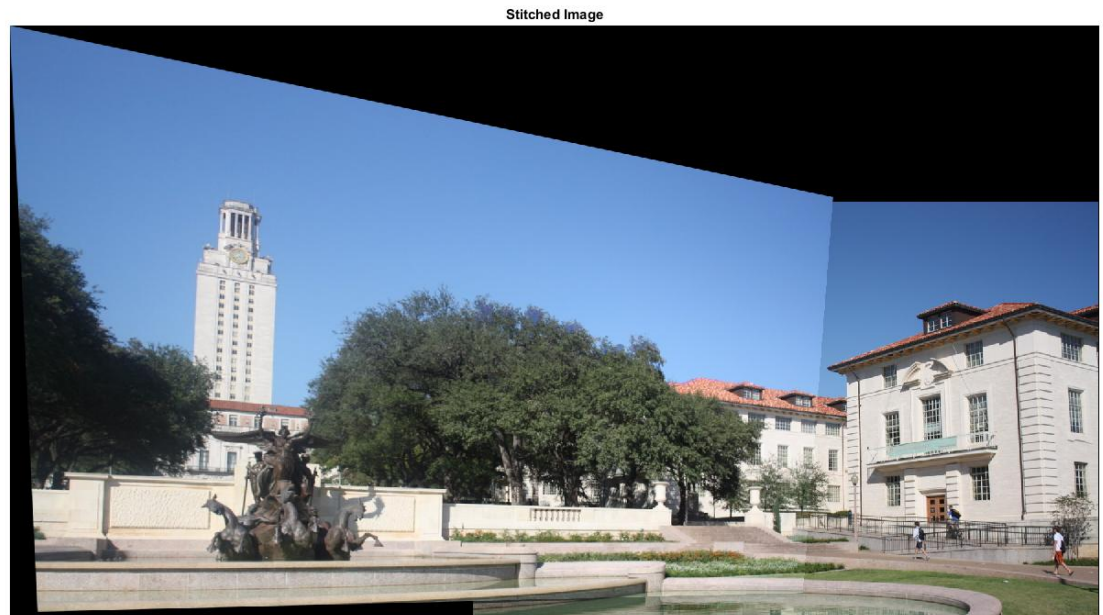
Finally the image was stitched. The following two approaches were taken to stitch the image

1. $\text{stitched_img} = \text{left_img}/2 + \text{right_img}/2$



2. $\text{stitched_img} = \max(\text{left_img}, \text{right_img})$

The idea for trying this method was adopted from a reference link.



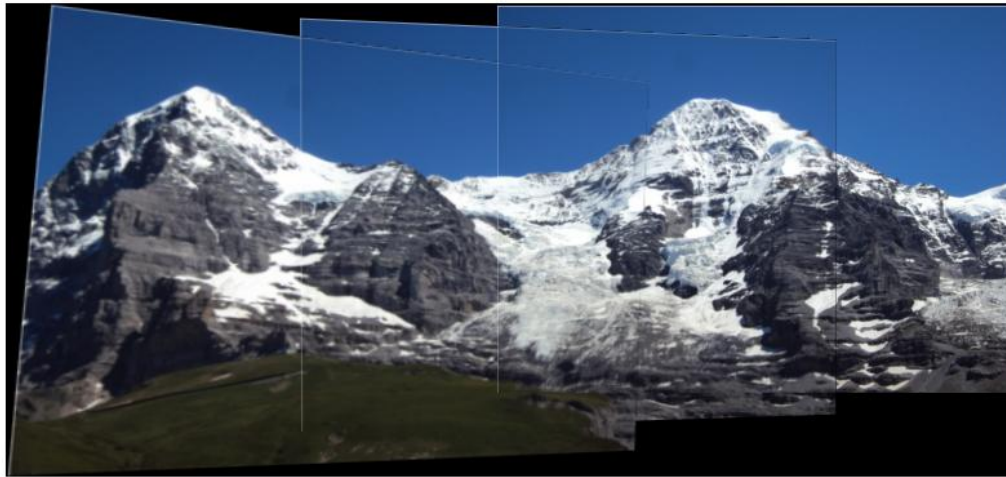
Stitching 3 Images

usage: >> stitch_multiple_images

Implementation logic:

- So to stitch more than 2 images, first we need to find the middle image, then the leftmost image and the remaining image will be the right most image. To do this, we can compute the number of inliers for each image.
- Then by logic the middle image will have the most number of inliers as it is being stitched from the left as well from the right.
- Once, we find the middle image we then find the left most image. After, the order of images has been identified we stitch them 2 images at a time and the stitch pair logic can be used for this.

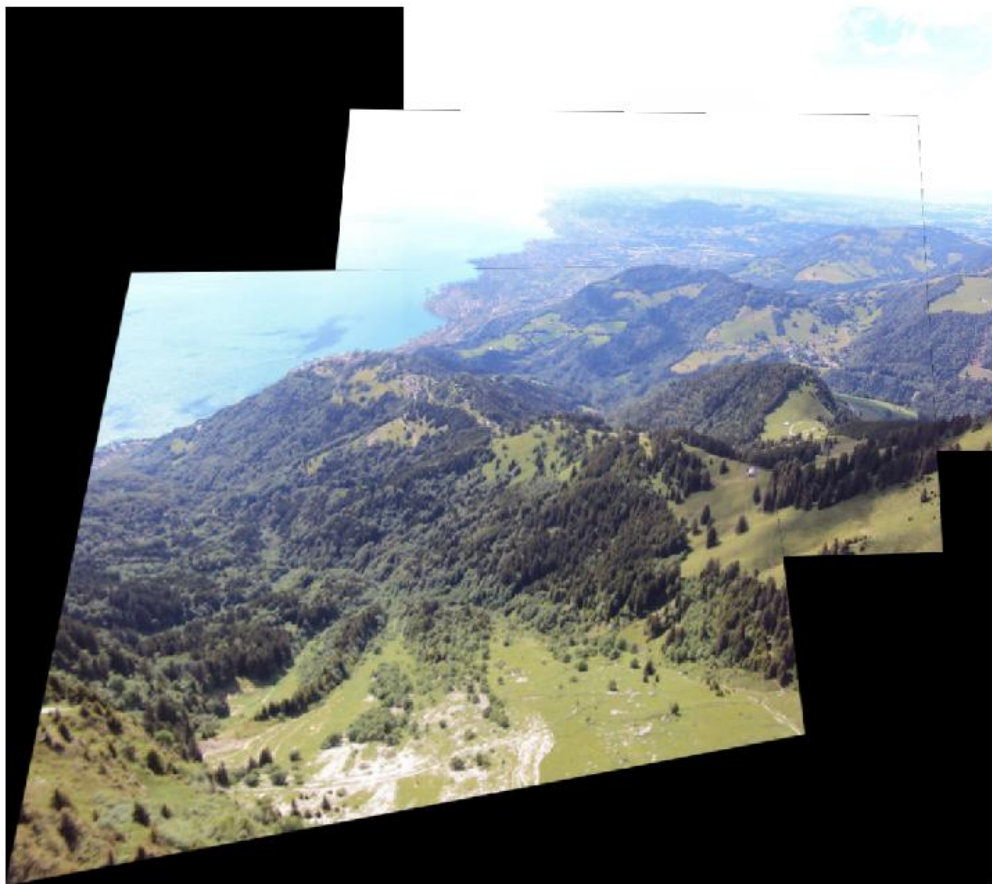
Hill Image:



Pier Images:



Ledge Images:



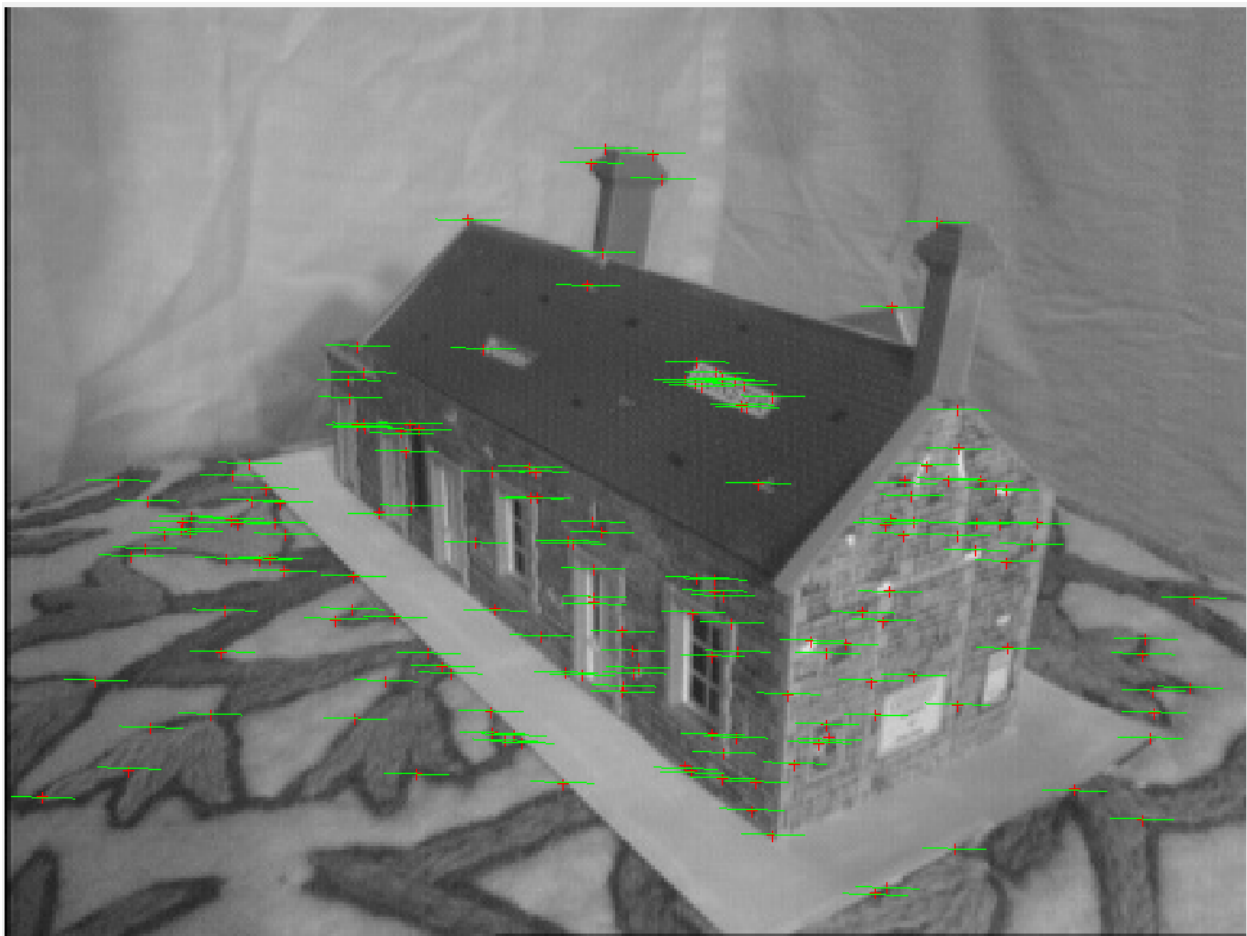
Fundamental Matrix Estimation and Triangulation

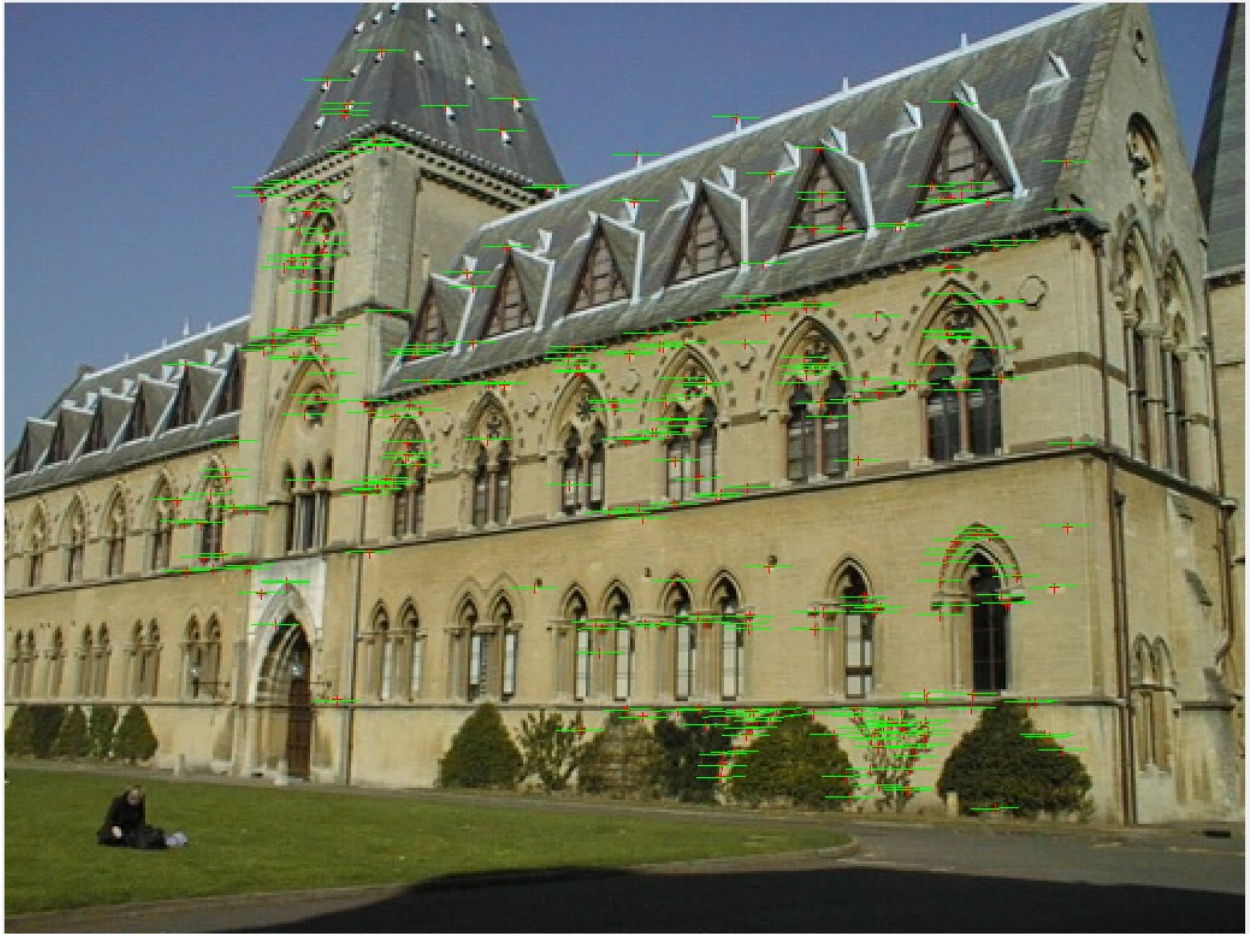
Usage: >> sample_code

The residual errors, mean squared distance between points in the 2 images and their corresponding epipolar lines, for normalized and un-normalized 8 point algorithm are given below

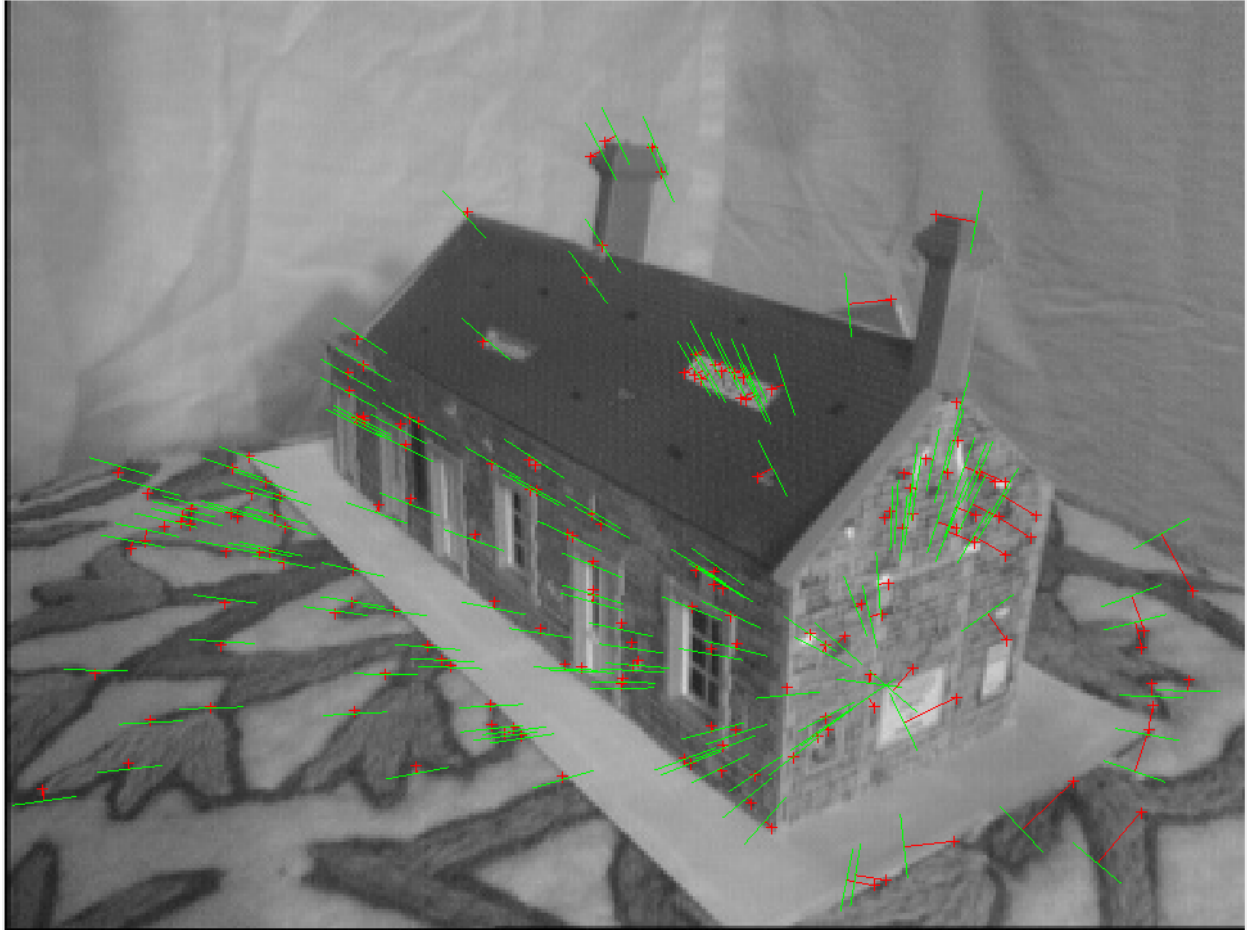
Image \ Algorithm	Normalized	Un-normalized
House	0.2103	3.0342
Library	0.1836	0.3385

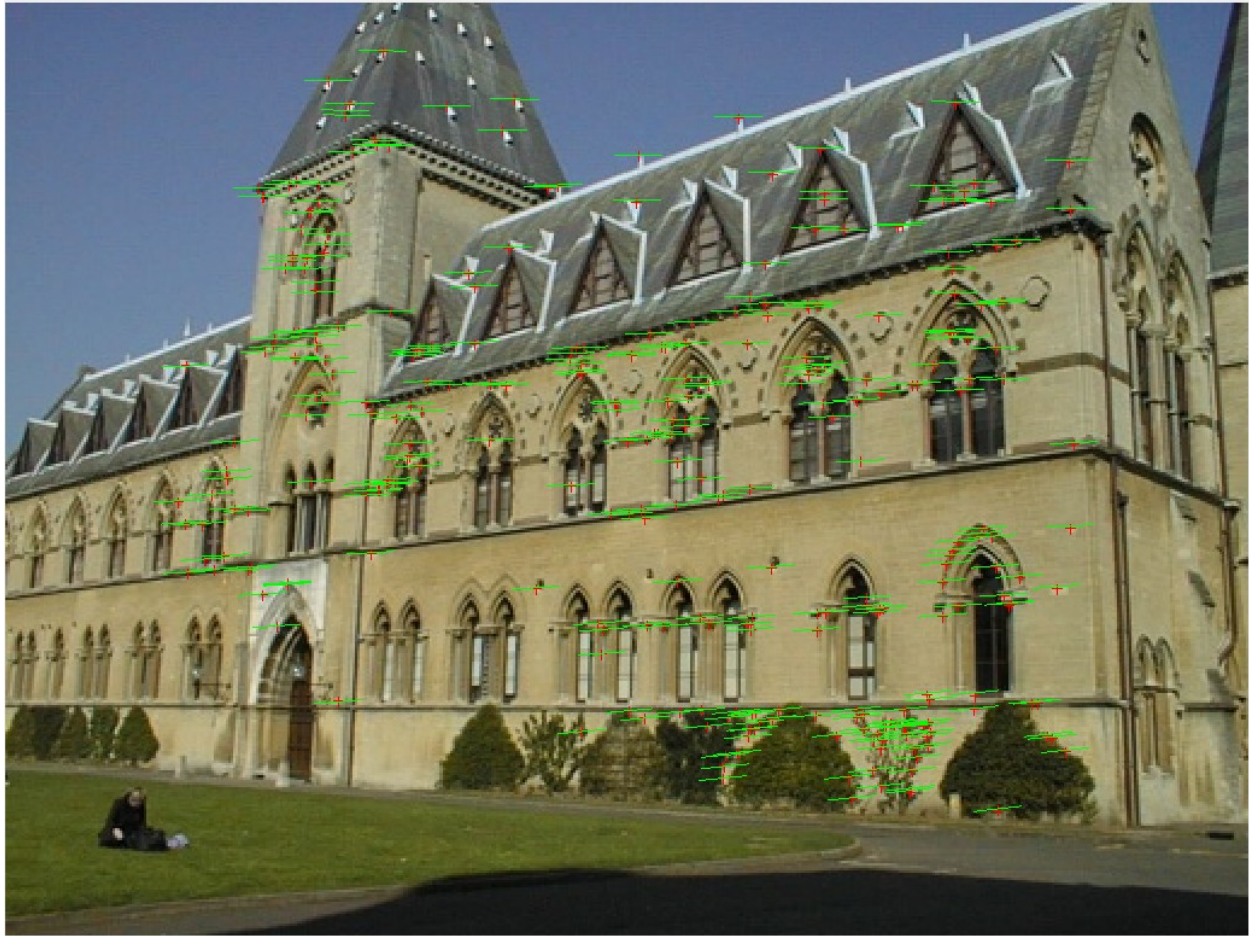
Normalized Algorithm:





Un-normalized Algorithm:





For Fundamental matrix using RANSAC and normalized algorithm, the following results were obtained based on different threshold values

Image	Num of Iterations	Threshold	RANSAC num of points	Num of Inliers	Mean Residual Error
House	10000	0.9	4	162	0.2479
		0.9	8	168	0.2103
		0.7	4	116	0.7870
		0.7	8	166	0.2167
Library	10000	0.9	4	287	0.4079
		0.9	8	309	0.1836
		0.7	4	293	0.3359
		0.7	8	305	0.1823

From the values in the table above you can sense that, for 8 random points and increasing the iteration to 10,000 can reduce the randomization effect and the mean residual error goes close to the one obtained by normalized algorithm.

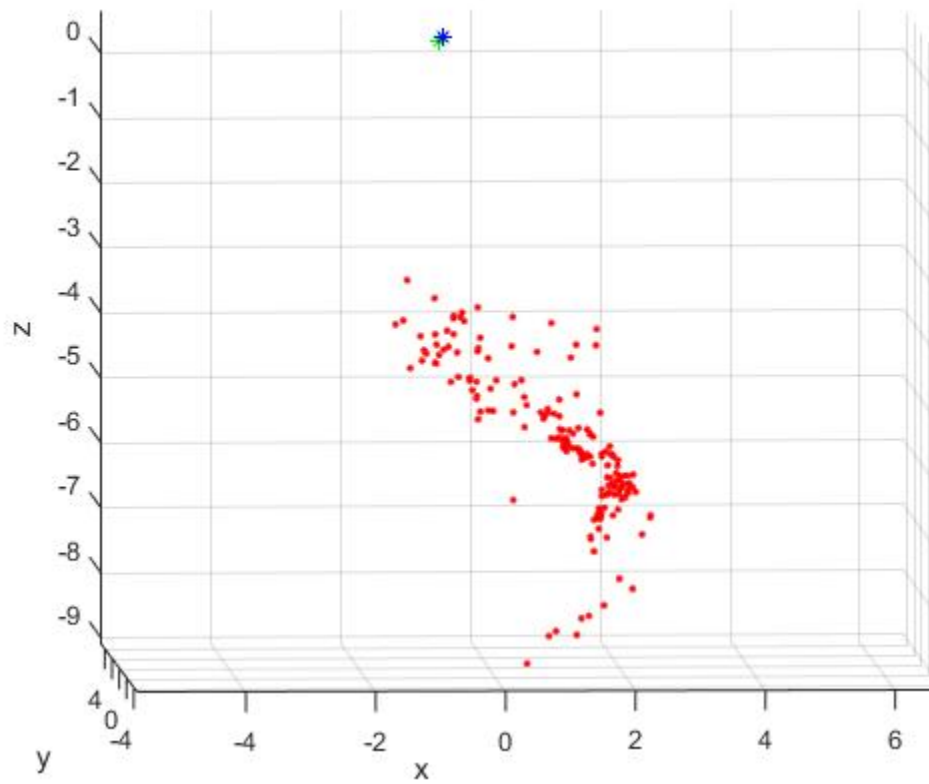
Mean residual error between 2D and 3D points for both images are given below,

Image	House 1 image	House 2 image	Library 1 image	Library 2 image
Mean between 2D and 3D points	0.0025	0.1566	0.0731	0.2677

The 3D plot of the images are attached below,

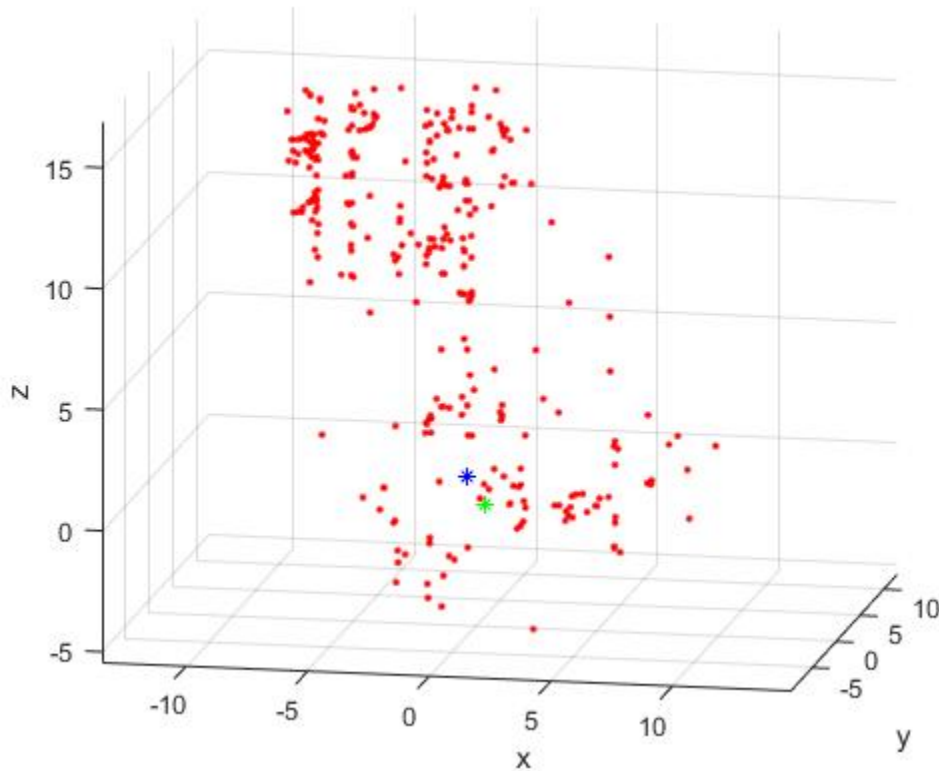
House Image:

Front facing angle.



Library Image:

Front facing angle.



References:

1. Lecture slides
2. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.186.5926&rep=rep1&type=pdf>
3. <http://home.deib.polimi.it/boracchi/teaching/IAS/Stitching/stitch.html>
4. https://en.wikipedia.org/wiki/Eight-point_algorithm
5. [https://en.wikipedia.org/wiki/Triangulation_\(computer_vision\)](https://en.wikipedia.org/wiki/Triangulation_(computer_vision))
6. <https://mliu.physics.ucsd.edu/estimation-fundamental-matrix.pdf>
7. <https://www.coursera.org/learn/robotics-perception/lecture/Bwk0d/epipolar-geometry-i>