FINAL REPORT

CIS580 SP2017 Project2

ABSTRACT

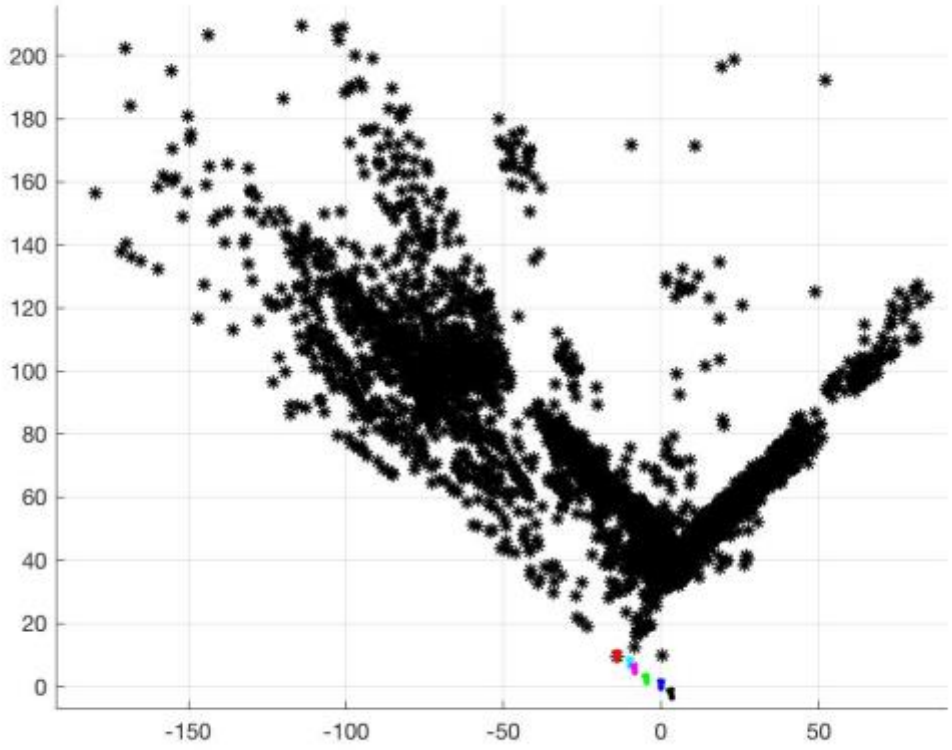
This report contains the final output of the 3D points cloud with camera poses, as well as the details of the effects of several functions, such as RANSAC, Nonlinear Triangulation, Nonlinear PNP and Bundle Adjustment. Also, 2D re-projections are shown with quantitative errors.

Presented by: Hantian Liu

lhantian@seas.upenn.edu

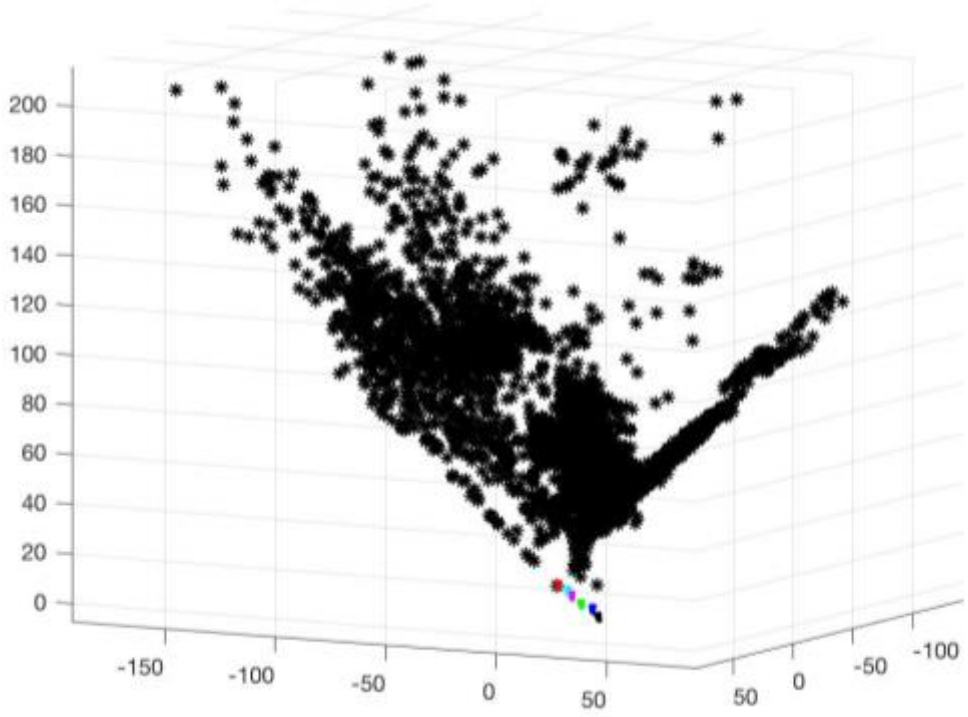
Results

Final 3D Point Cloud



It could be easily observed that in the right, the L-shaped pattern shows the corner of the building in the pictures. Also, the round pattern in the left refers to the tree beside the building.

Following are multiple views of the final 3D point cloud.


200
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-150
-100
-50
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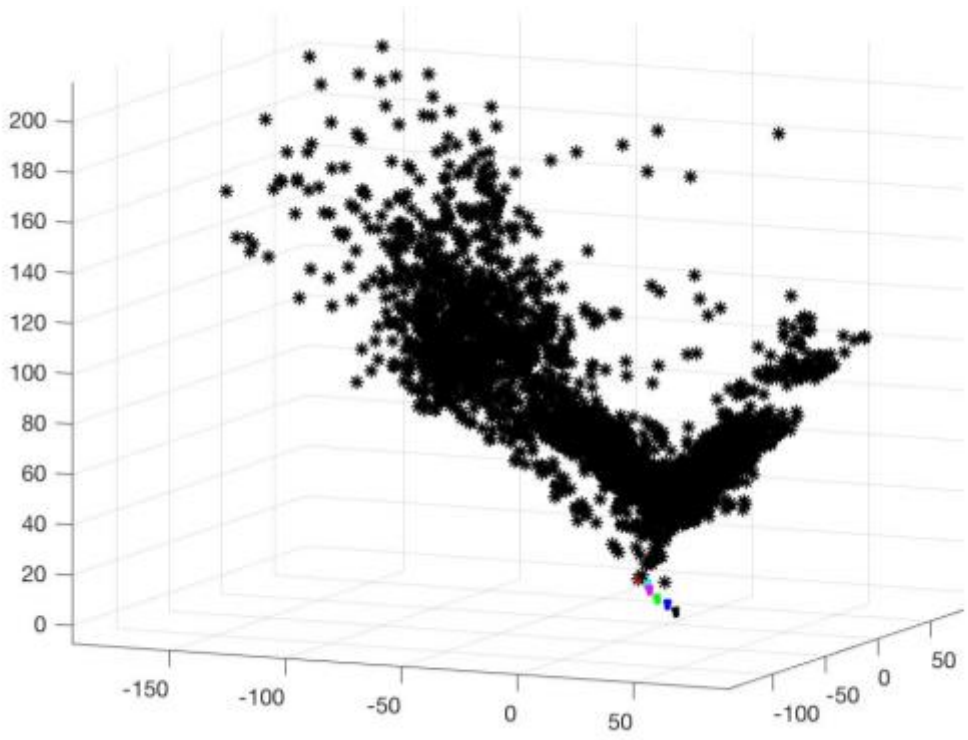
50
50
0
-50
-100


200
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-150
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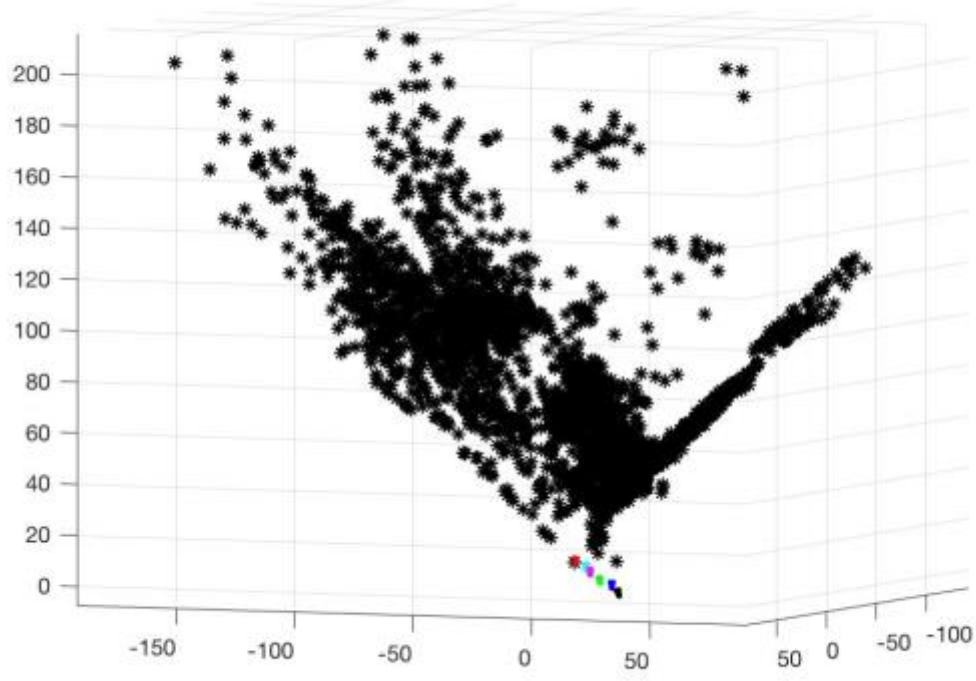
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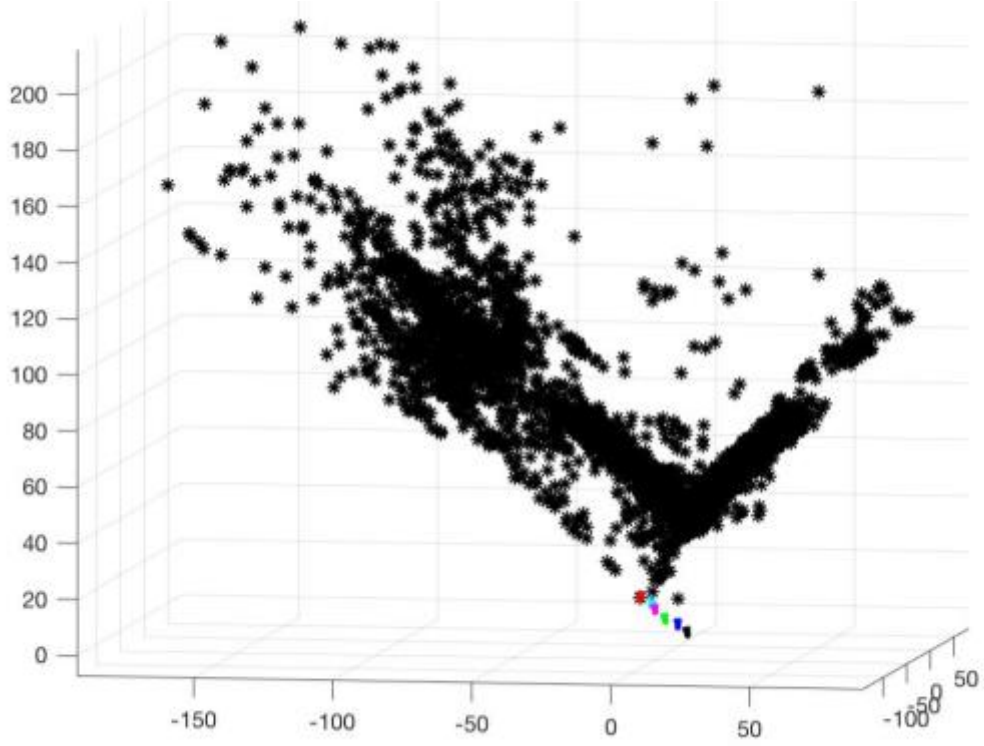
-100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0
-150
-100
-50
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50
-100
-50
0
50

Total Points Number

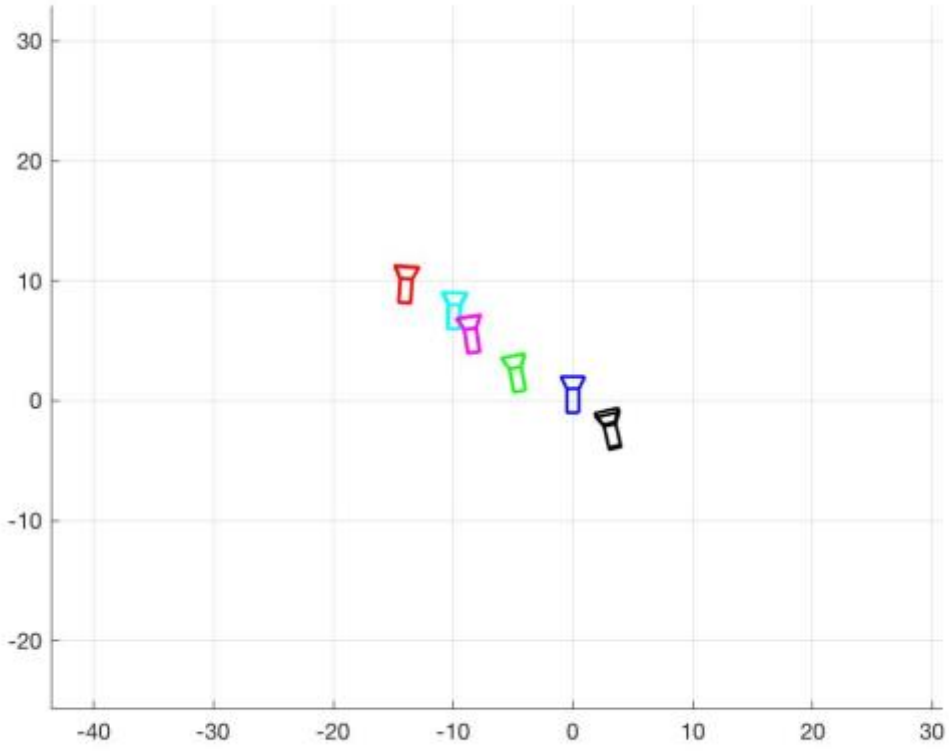
Xfinal

5199x3 double

	1	2	3
1	1.0159	1.3348	7.7833
2	1.9720	-4.0838	9.3762
3	-2.4727	1.9702	10.6246
4	-2.3850	-1.8575	11.0901
5	-12.3454	-6.6337	21.8213
6	-5.5417	2.2791	13.5653

Final Camera Poses

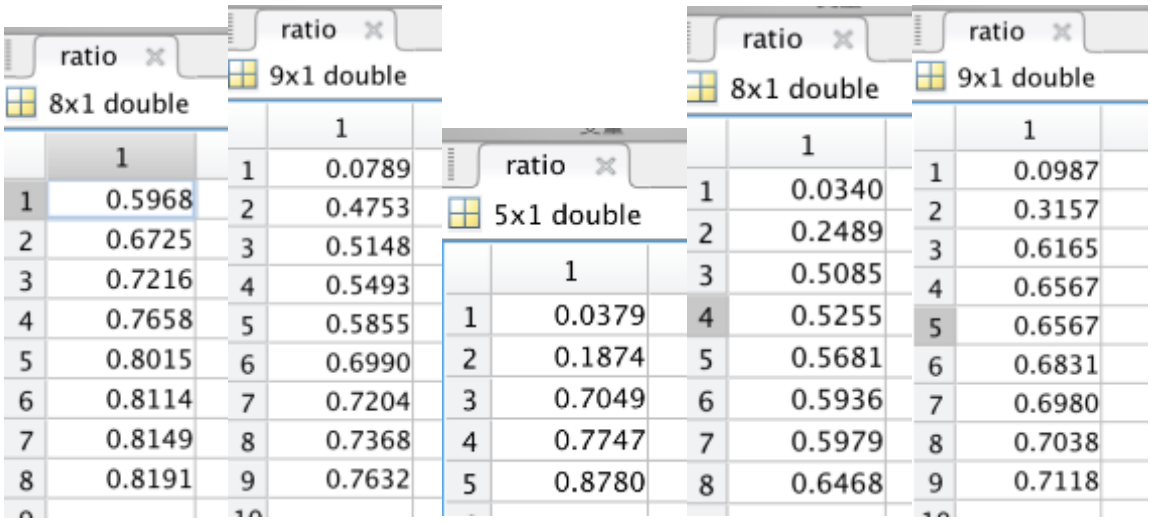
All of the Six Cameras



Function Details

GetInliers RANSAC

The ratio for each pair of image could generally achieve above 80%, as shown below.



ratio — 8x1 double

	1
1	0.5968
2	0.6725
3	0.7216
4	0.7658
5	0.8015
6	0.8114
7	0.8149
8	0.8191

ratio — 9x1 double

	1
1	0.0789
2	0.4753
3	0.5148
4	0.5493
5	0.5855
6	0.6990
7	0.7204
8	0.7368
9	0.7632

ratio — 5x1 double

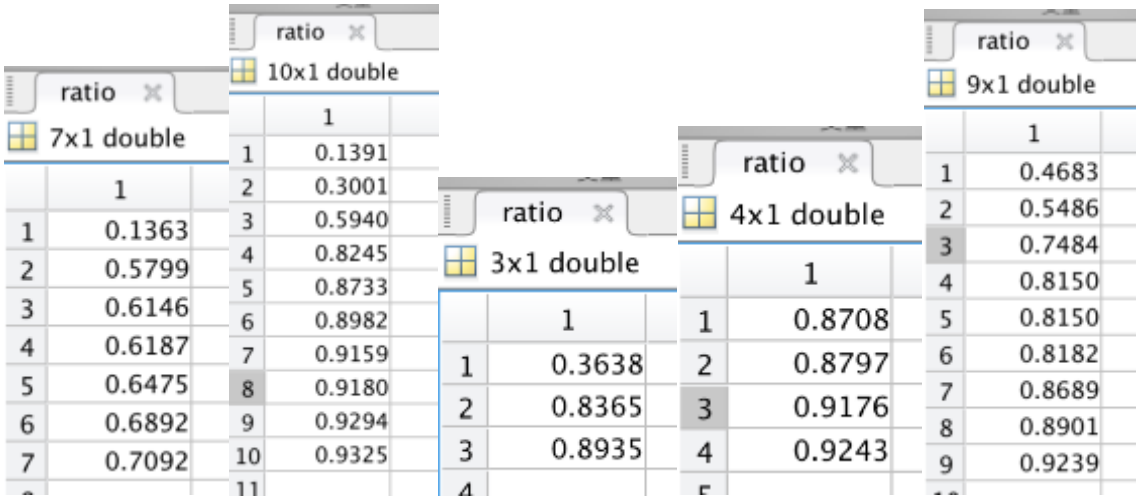
	1
1	0.0379
2	0.1874
3	0.7049
4	0.7747
5	0.8780

ratio — 8x1 double

	1
1	0.0340
2	0.2489
3	0.5085
4	0.5255
5	0.5681
6	0.5936
7	0.5979
8	0.6468

ratio — 9x1 double

	1
1	0.0987
2	0.3157
3	0.6165
4	0.6567
5	0.6567
6	0.6831
7	0.6980
8	0.7038
9	0.7118



ratio — 7x1 double

	1
1	0.1363
2	0.5799
3	0.6146
4	0.6187
5	0.6475
6	0.6892
7	0.7092

ratio — 10x1 double

	1
1	0.1391
2	0.3001
3	0.5940
4	0.8245
5	0.8733
6	0.8982
7	0.9159
8	0.9180
9	0.9294
10	0.9325

ratio — 3x1 double

	1
1	0.3638
2	0.8365
3	0.8935

ratio — 4x1 double

	1
1	0.8708
2	0.8797
3	0.9176
4	0.9243

ratio — 9x1 double

	1
1	0.4683
2	0.5486
3	0.7484
4	0.8150
5	0.8150
6	0.8182
7	0.8689
8	0.8901
9	0.9239

With the final ratio above, I save both the original matching from the txt file and the inliers after RANSAC. Over half of them are reserved for the further process.

frame | frame.matching | frame.inliers

frame.matching

	1	2	3	4	5
1	1426x4 double	[]	[]	[]	[]
2	608x4 double	1820x4 double	[]	[]	[]
3	470x4 double	871x4 double	1702x4 double	[]	[]
4	[]	[]	963x4 double	1737x4 double	[]
5	[]	[]	449x4 double	946x4 double	1365x4 double
6					
7					

frame | frame.matching | frame.inliers

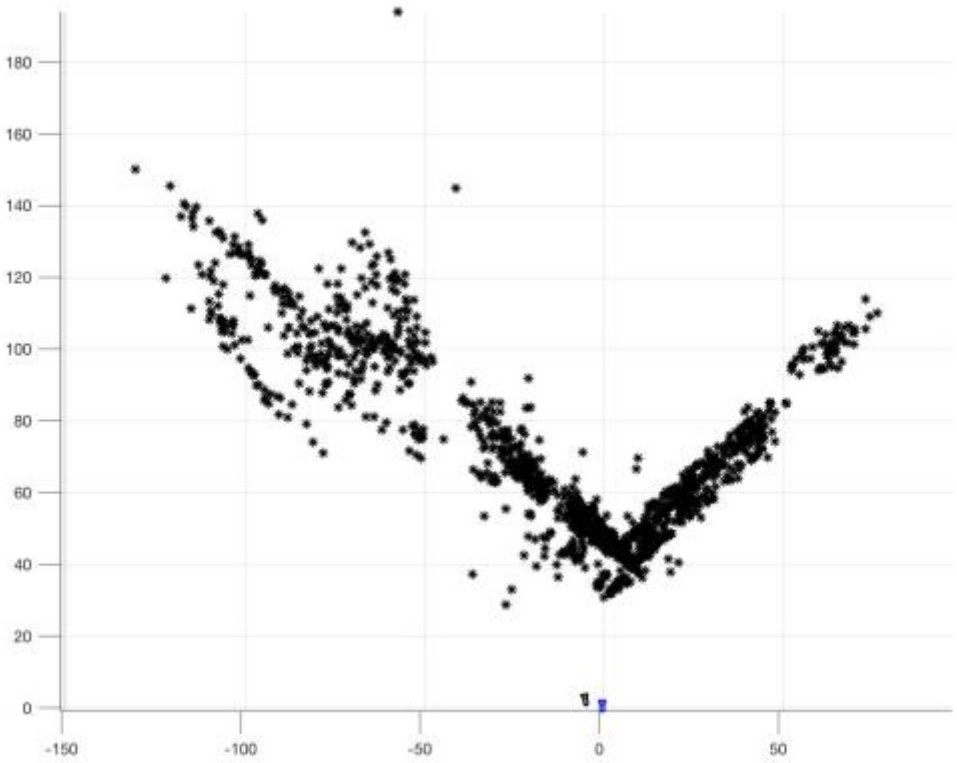
frame.inliers

	1	2	3	4	5
1	1168x4 double	[]	[]	[]	[]
2	464x4 double	1598x4 double	[]	[]	[]
3	304x4 double	620x4 double	1207x4 double	[]	[]
4	[]	[]	898x4 double	1552x4 double	[]
5	[]	[]	415x4 double	874x4 double	790x4 double
6					

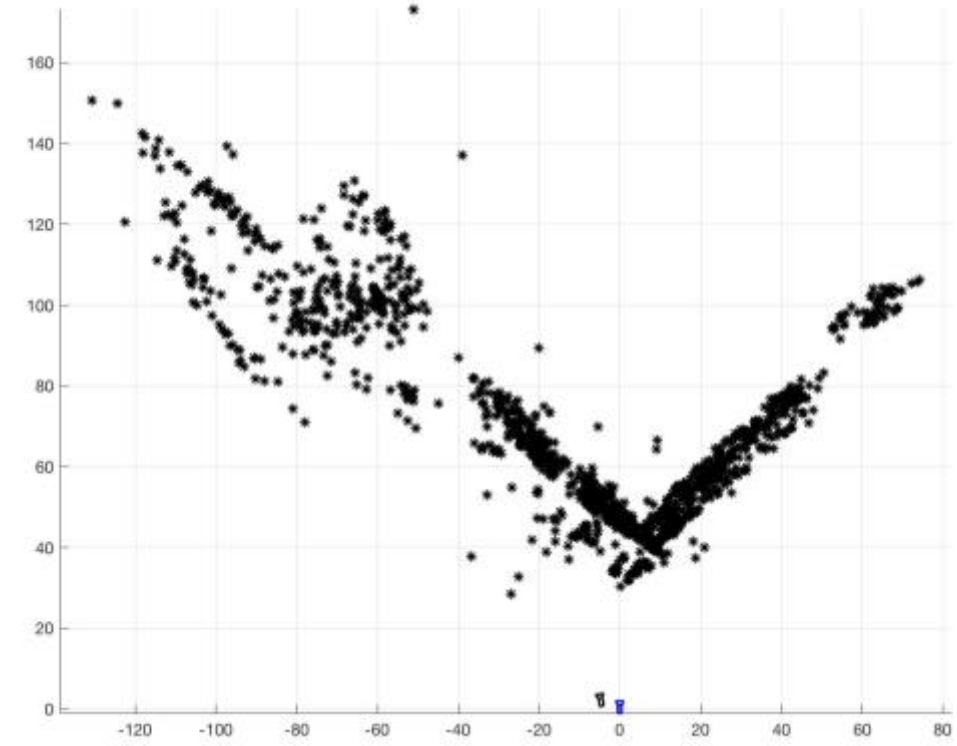
Effects of Nonlinear Triangulation

In 3D

Before:


180
160
140
120
100
80
60
40
20
0
-150
-100
-50
0
50

After:


160
140
120
100
80
60
40
20
0
-120
-100
-80
-60
-40
-20
0
20
40
60
80

It is obviously shown in the two figures above, that after nonlinear triangulation, the positions of 3D points become denser. Thus the point cloud resembles the shape of the corner of the building more and we could obtain a more regular pattern.

In 2D

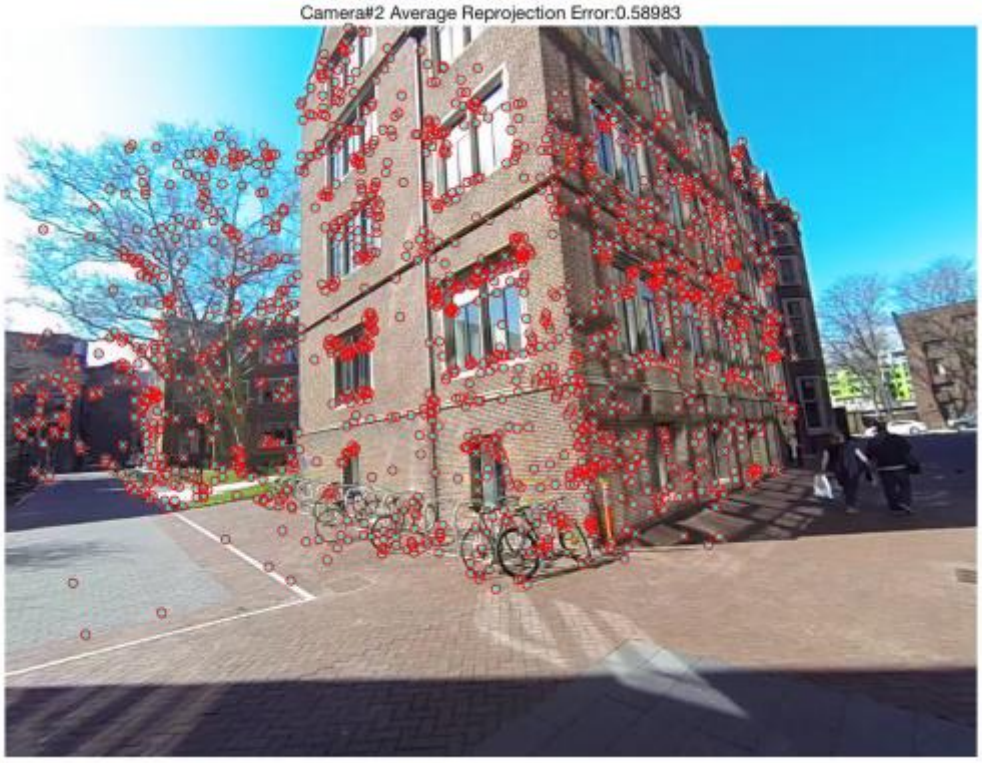
The re-projection error is largely reduced after nonlinear triangulation, for both cameras, as quantitatively shown below.

Before:

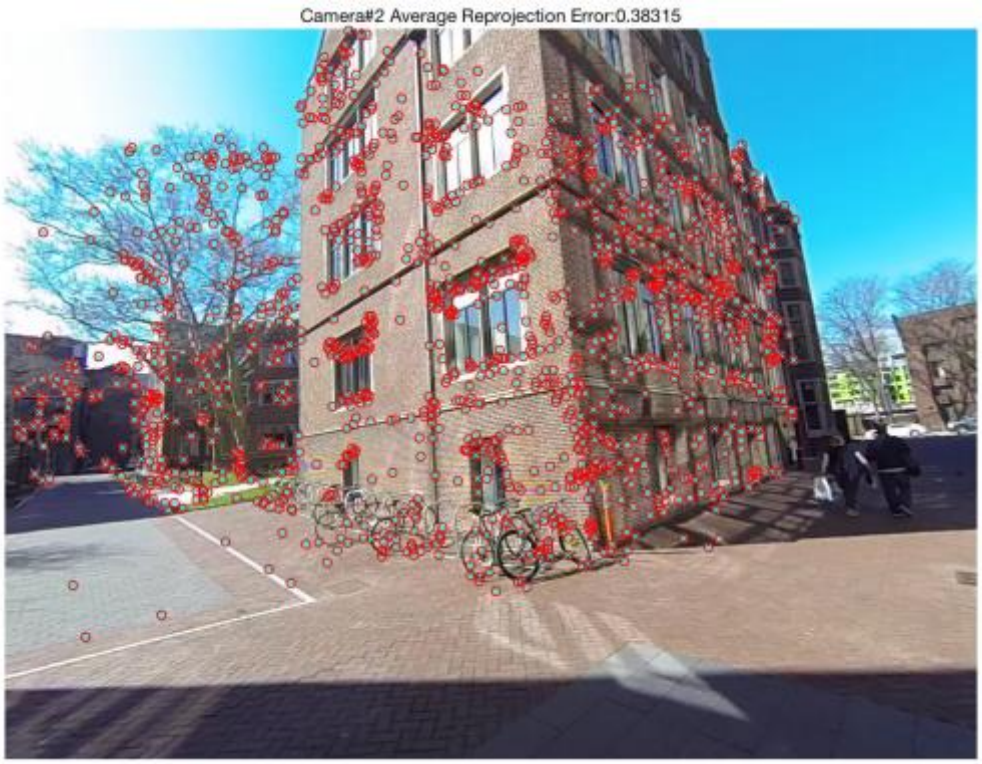
After:

Camera#1 Average Reprojection Error:0.60733

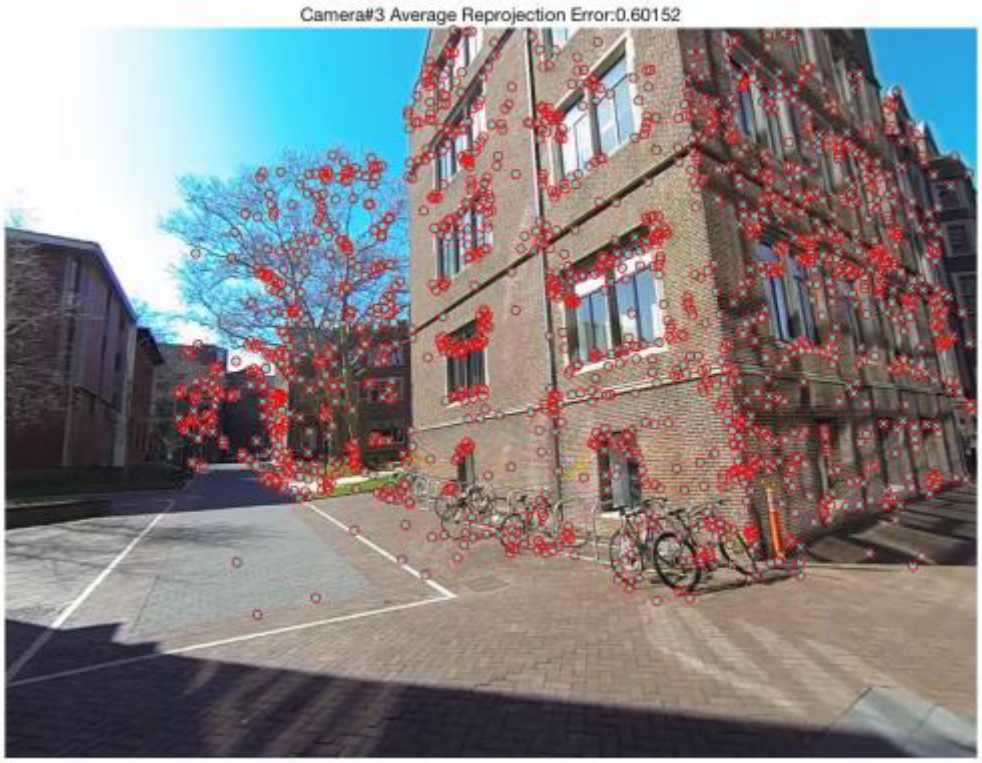
Before:


Camera#2 Average Reprojection Error:0.58983

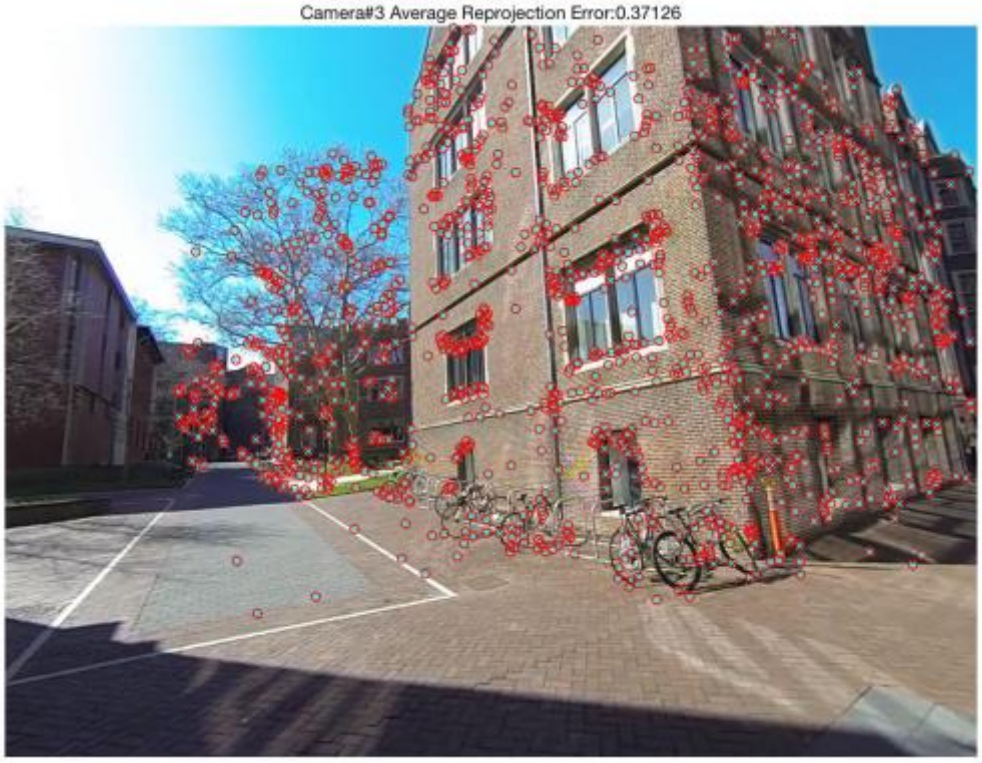
After:



Before:


Camera#3 Average Reprojection Error:0.60152

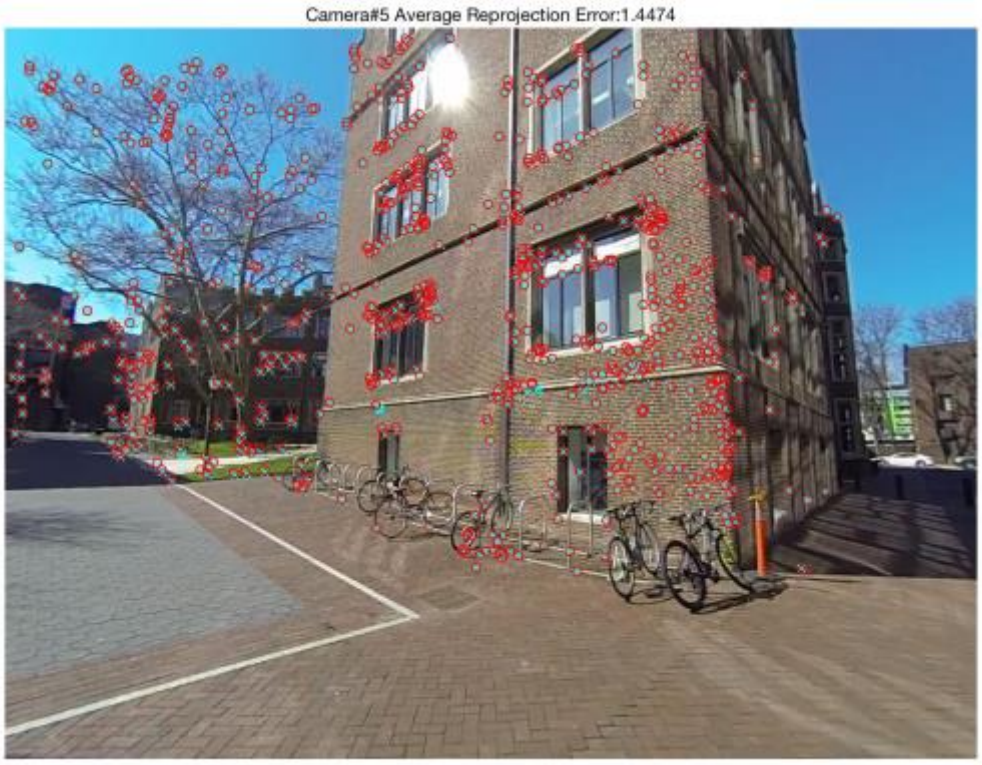
After:


Camera#3 Average Reprojection Error:0.37126

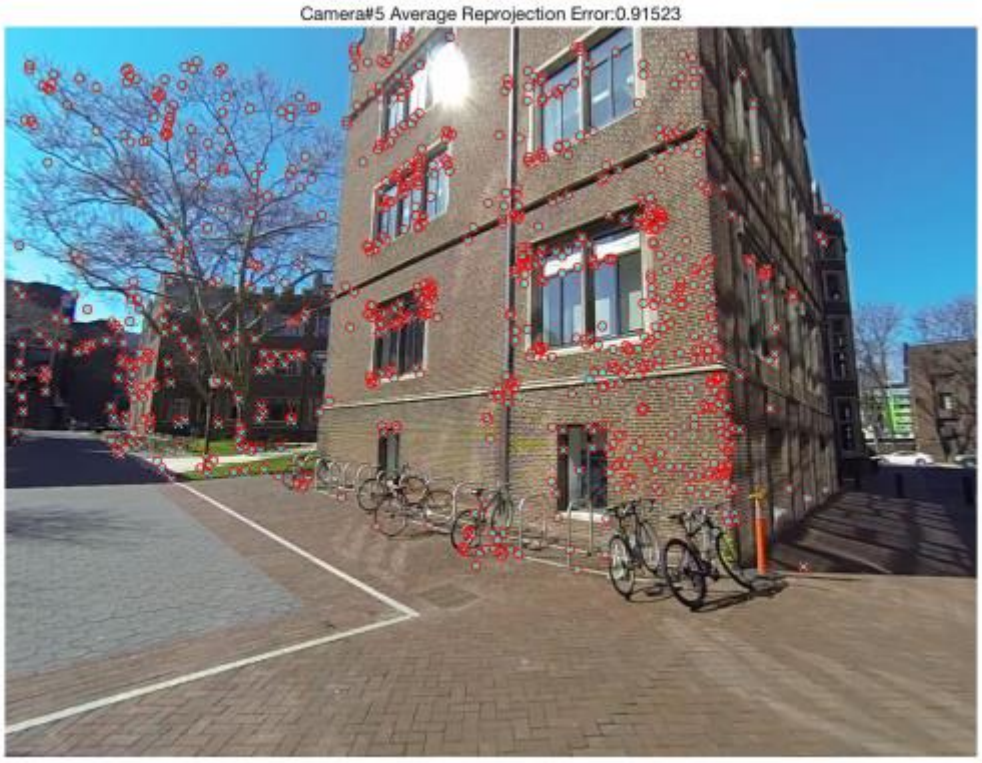
Before:

After:

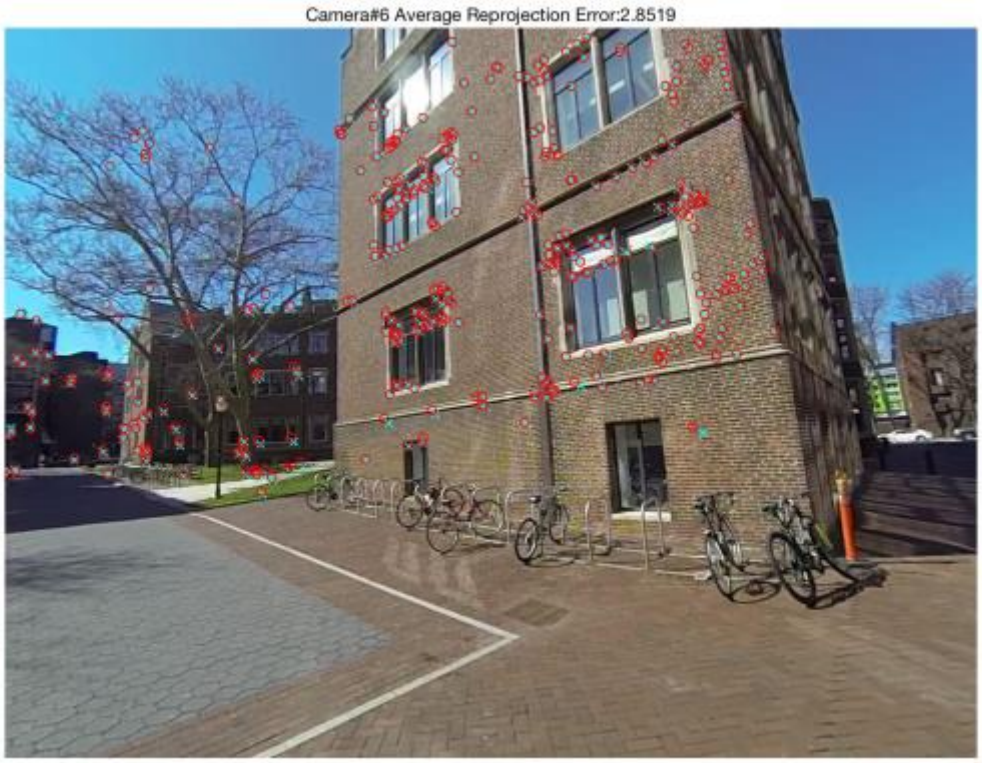
Before:


Camera#5 Average Reprojection Error:1.4474

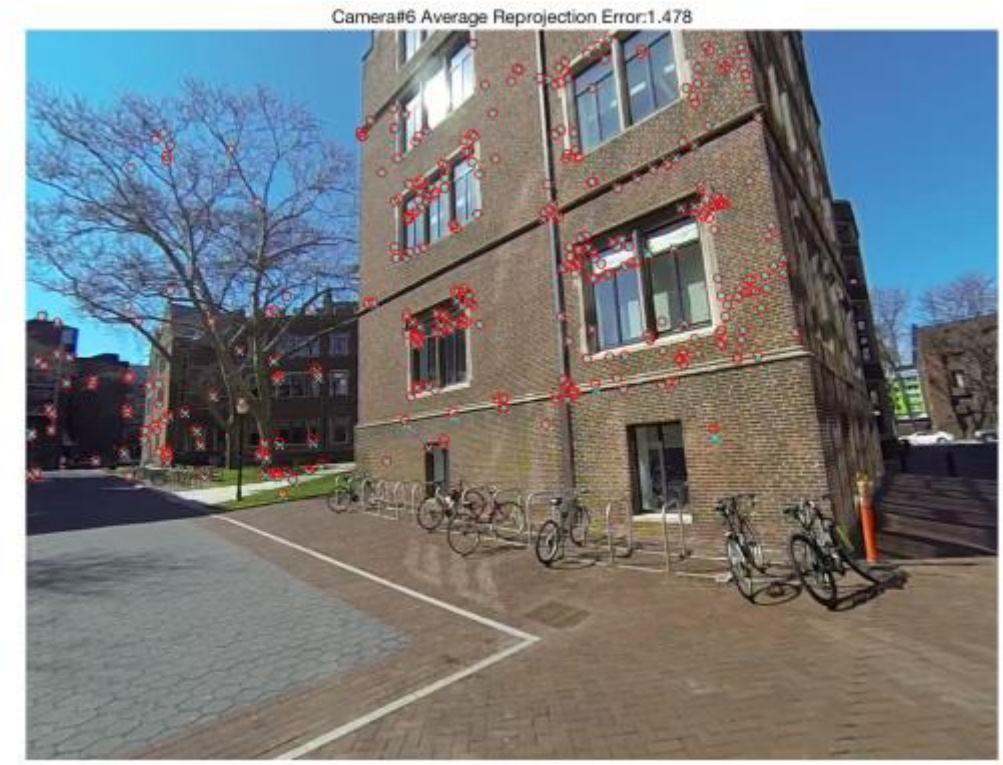
After:


Camera#5 Average Reprojection Error:0.91523

Before:

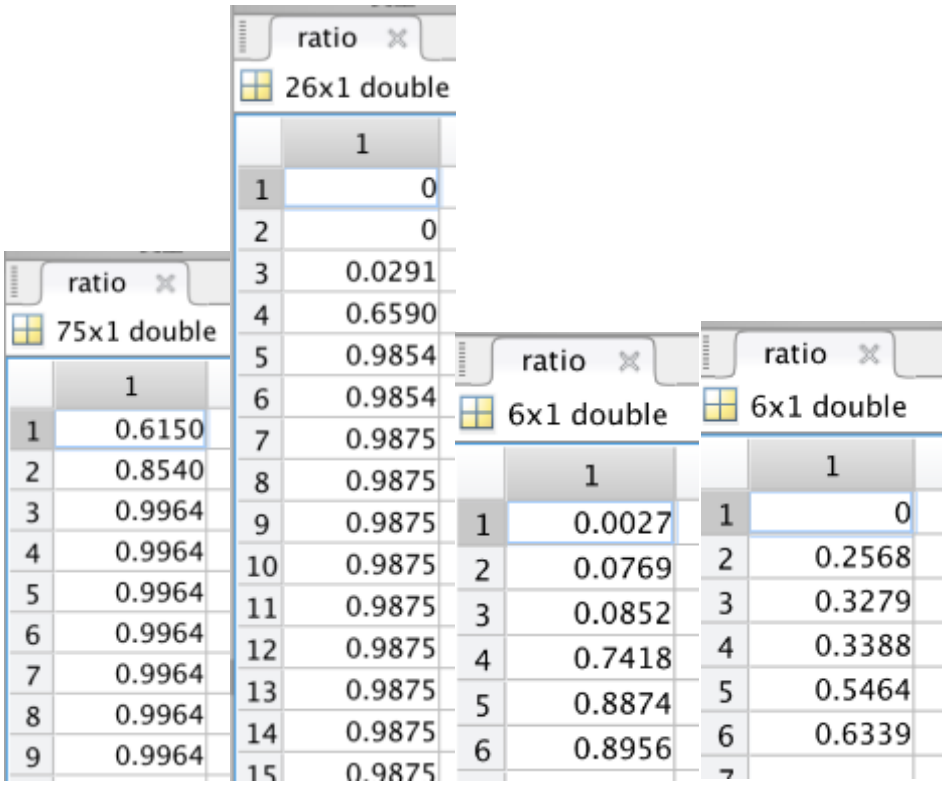


After:



PNP RANSAC

The inliers ratio for each image could generally achieve above 80%, as shown below.



ratio
75x1 double

	1
1	0.6150
2	0.8540
3	0.9964
4	0.9964
5	0.9964
6	0.9964
7	0.9964
8	0.9964
9	0.9964

ratio
26x1 double

	1
1	0
2	0
3	0.0291
4	0.6590
5	0.9854
6	0.9854
7	0.9875
8	0.9875
9	0.9875
10	0.9875
11	0.9875
12	0.9875
13	0.9875
14	0.9875
15	0.9875

ratio
6x1 double

	1
1	0.0027
2	0.0769
3	0.0852
4	0.7418
5	0.8874
6	0.8956

ratio
6x1 double

	1
1	0
2	0.2568
3	0.3279
4	0.3388
5	0.5464
6	0.6339

Effects of Nonlinear PNP

In 2D

The re-projection error is largely reduced after nonlinear triangulation, for both cameras, as quantitatively shown below.

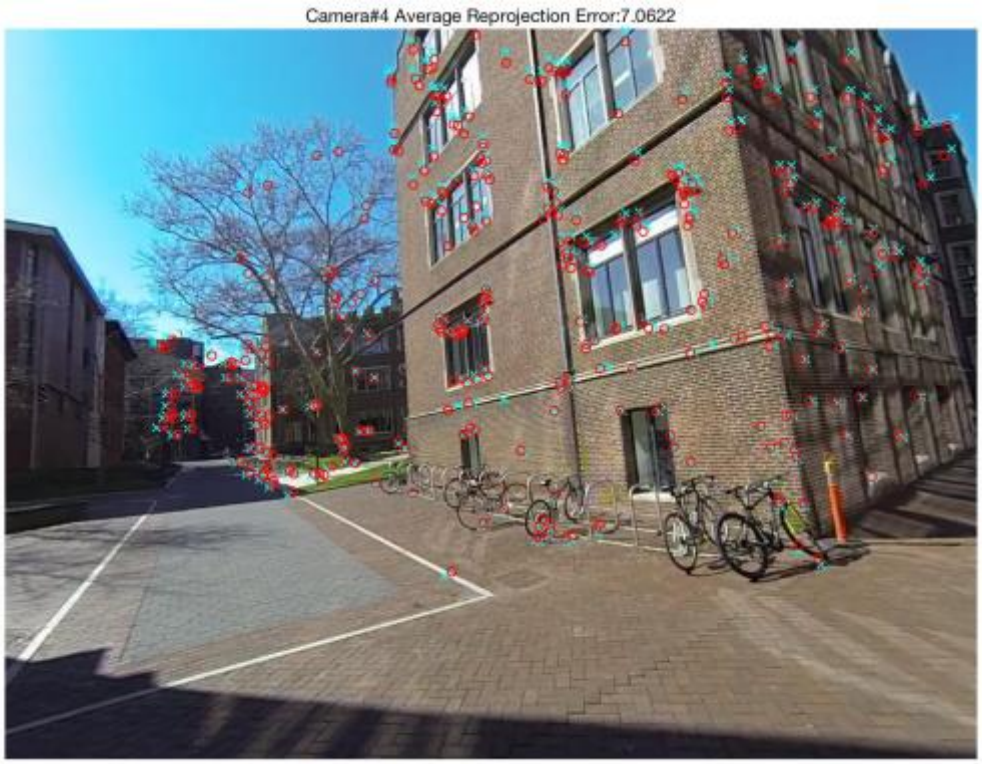
Before:

Camera#1 Average Reprojection Error:10.3795

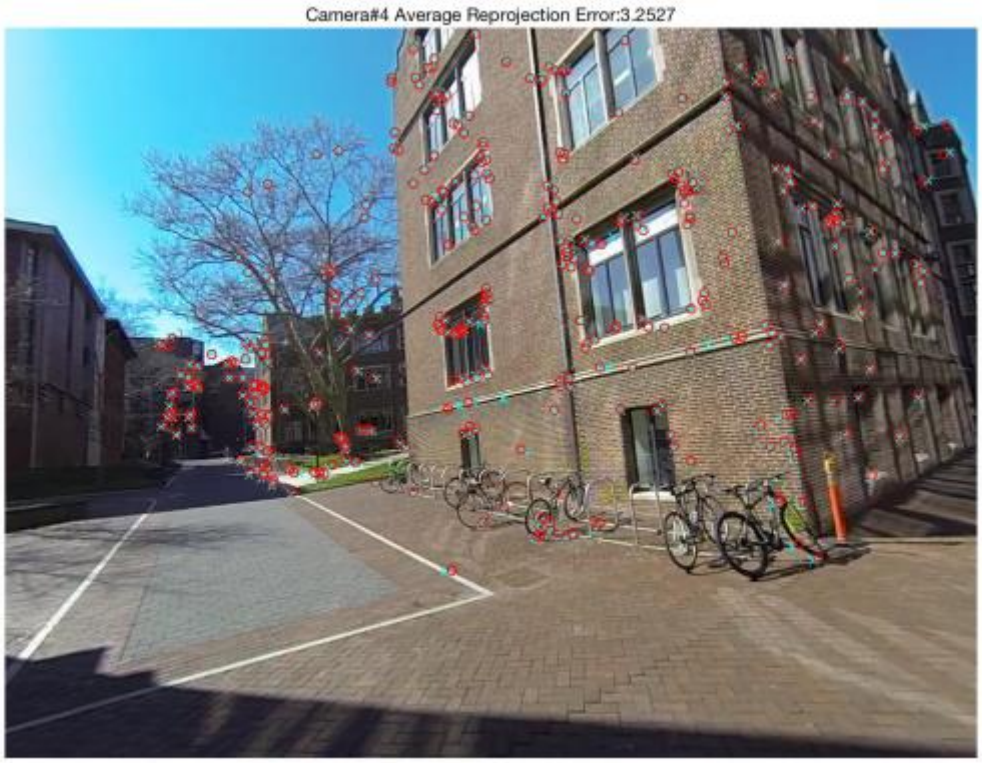
After:

Camera#1 Average Reprojection Error:2.6415

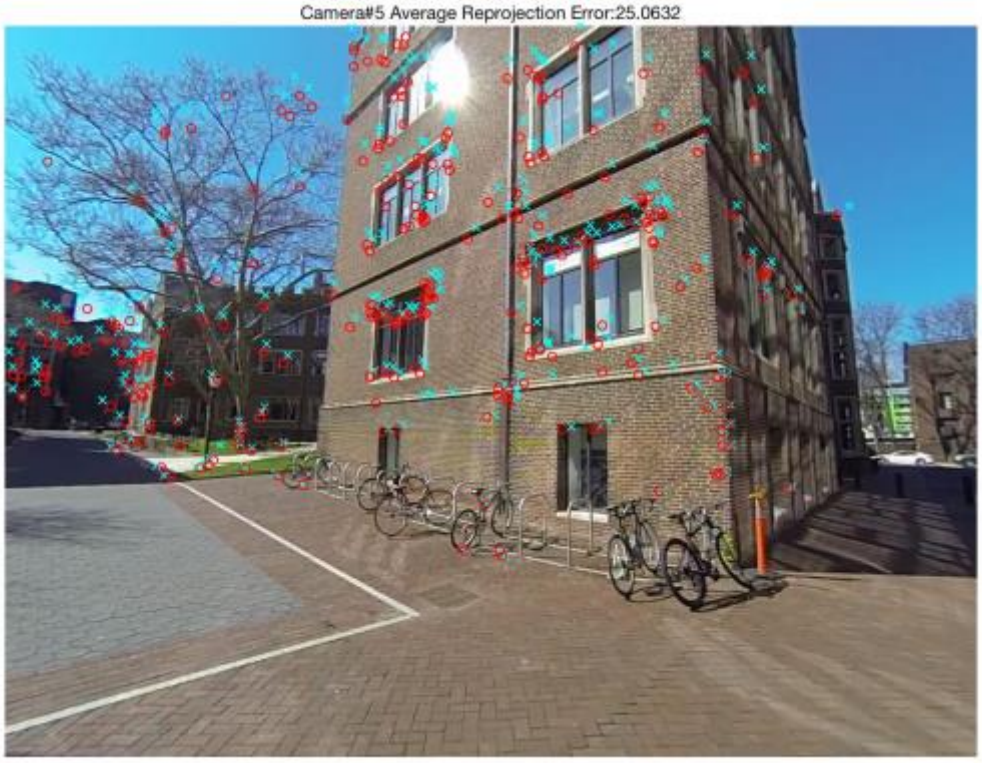
Before:



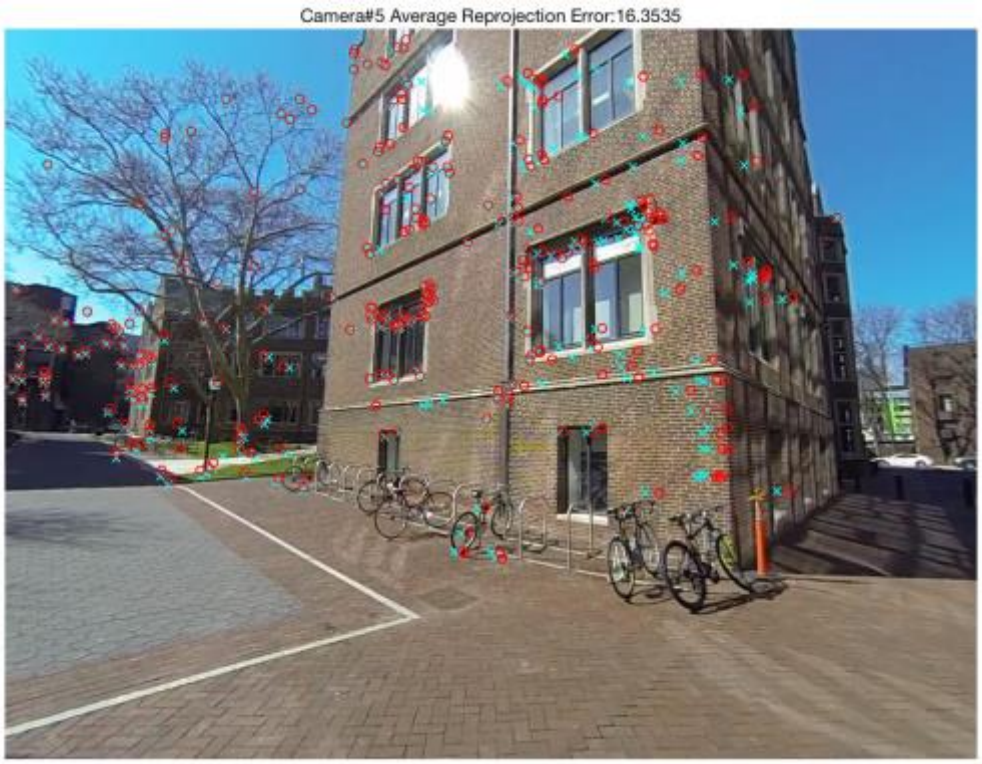
After:


Camera#4 Average Reprojection Error:3.2527

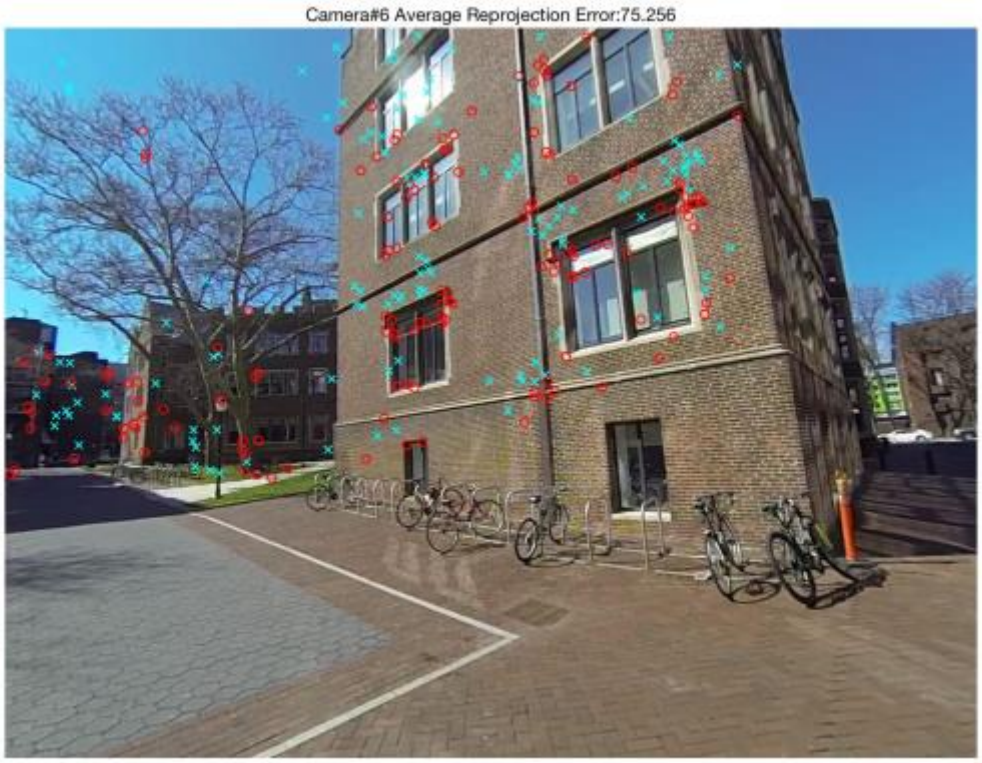
Before:


Camera#5 Average Reprojection Error:25.0632

After:



Before:

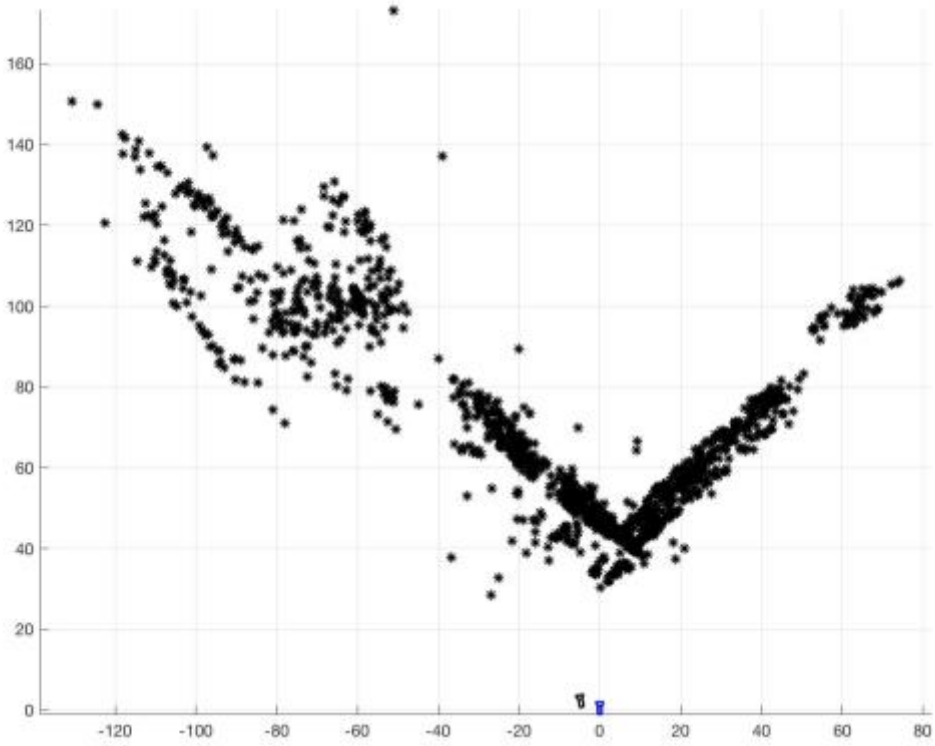

Camera#6 Average Reprojection Error:75.256

After:

Camera#6 Average Reprojection Error:22.4586

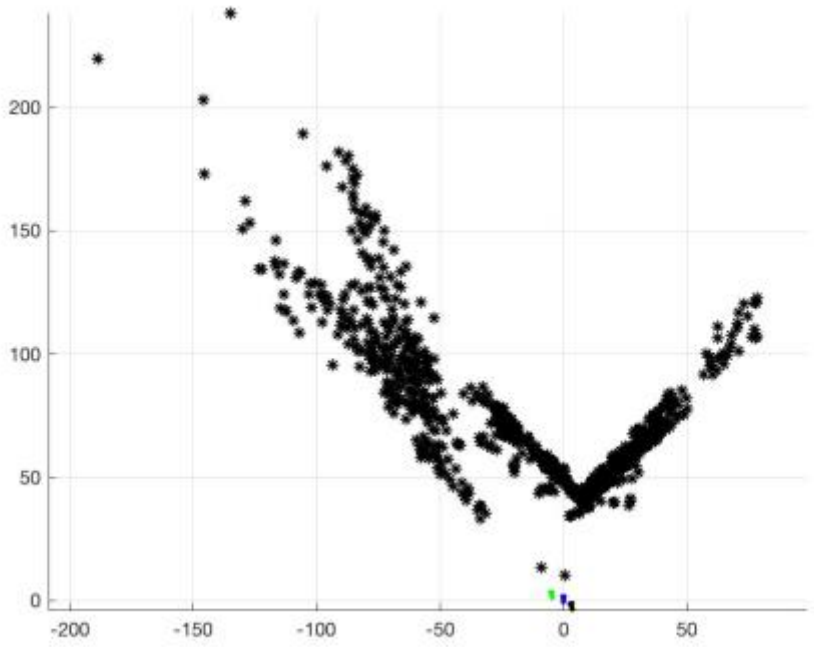
Adding 3D Points to the Points Cloud

The 3D Points Cloud of the first image pair (image 2 and 3)

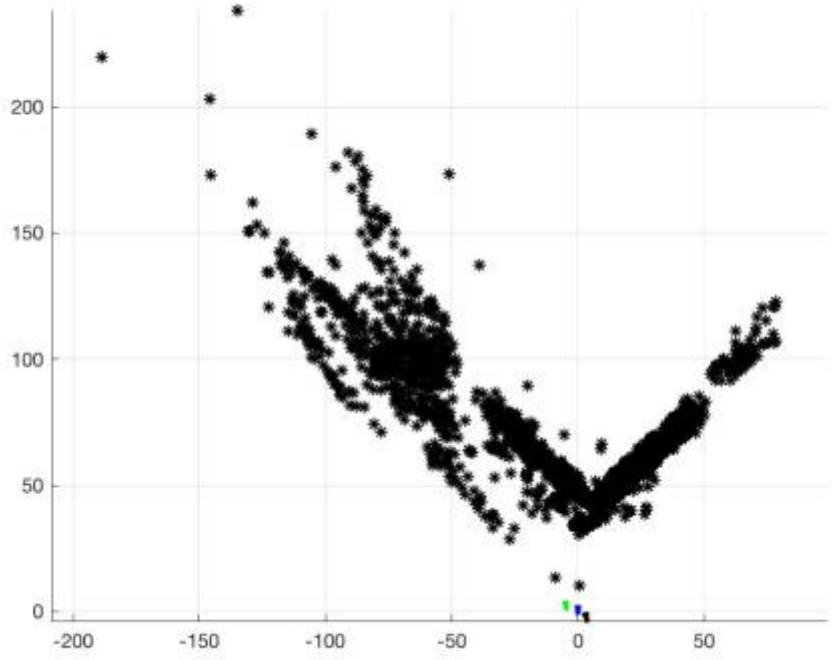


1st iteration (image 1)

Added Points:

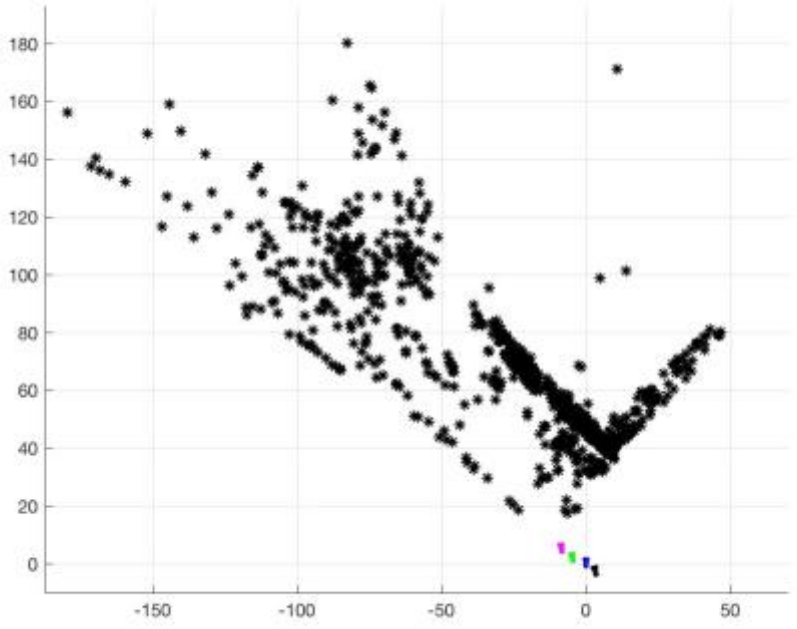


Total Points After Addition:

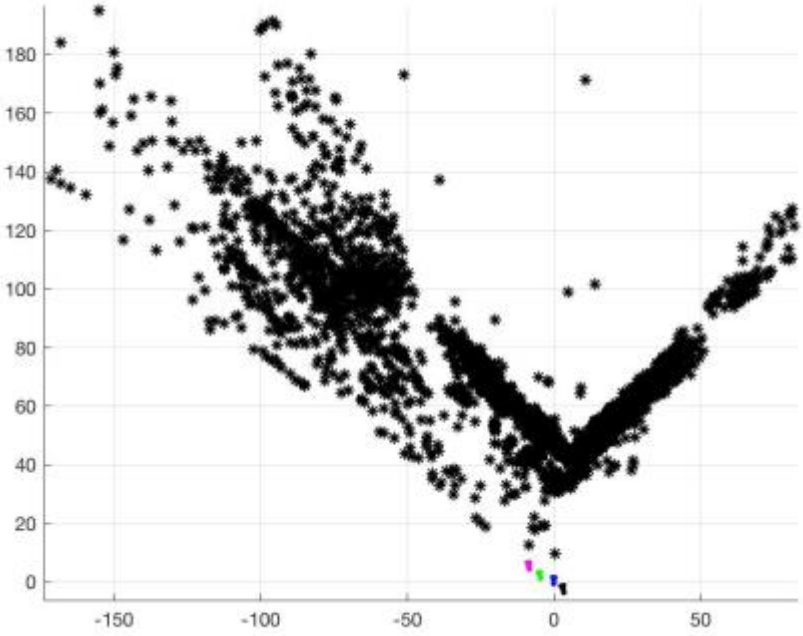


2nd iteration (image 4)

Added Points:

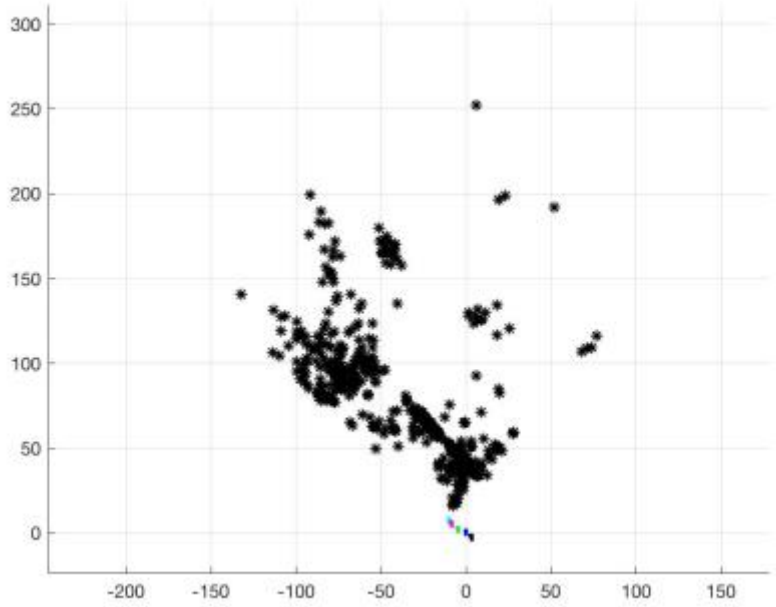


Total Points After Addition:

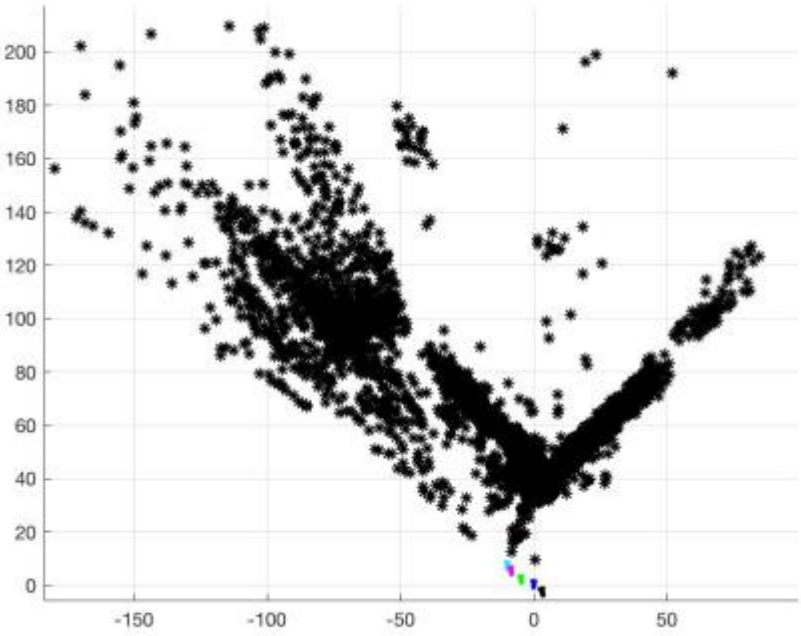


3rd iteration (image 5)

Added Points:

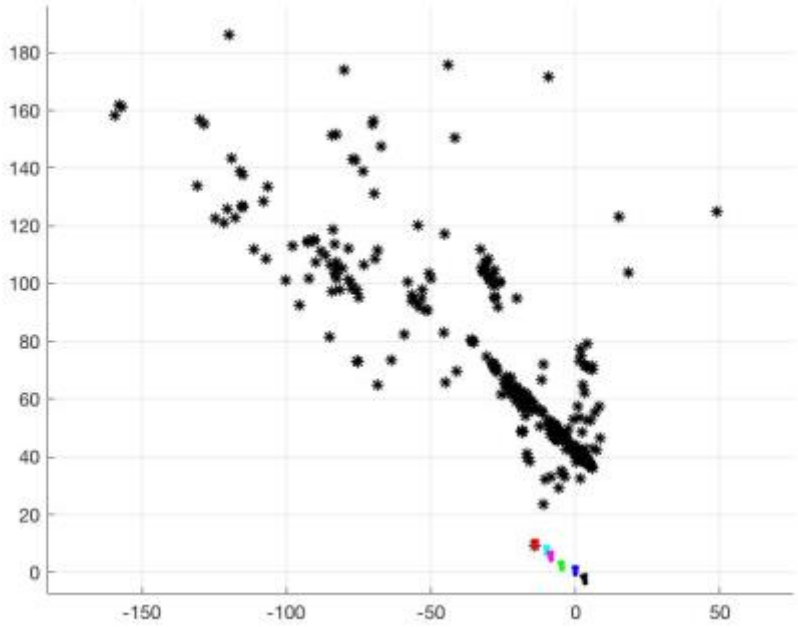


Total Points After Addition:

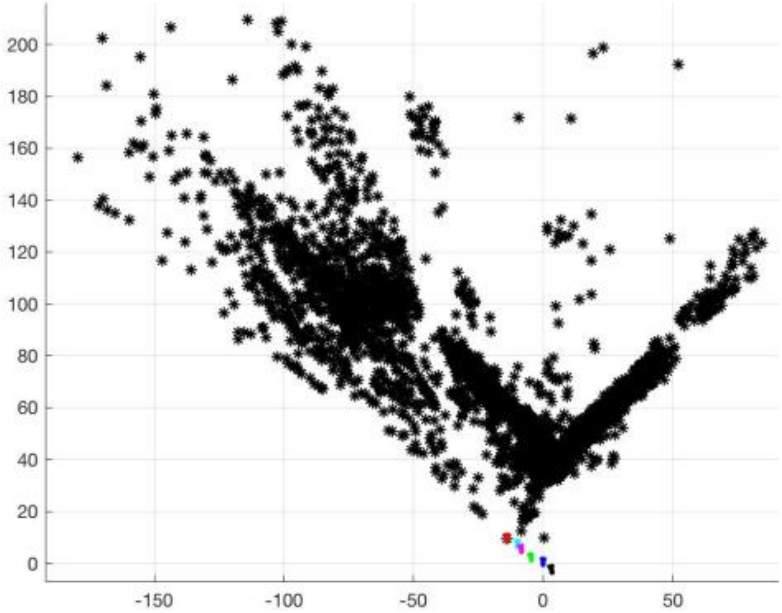


4th iteration (image 6)

Added Points:

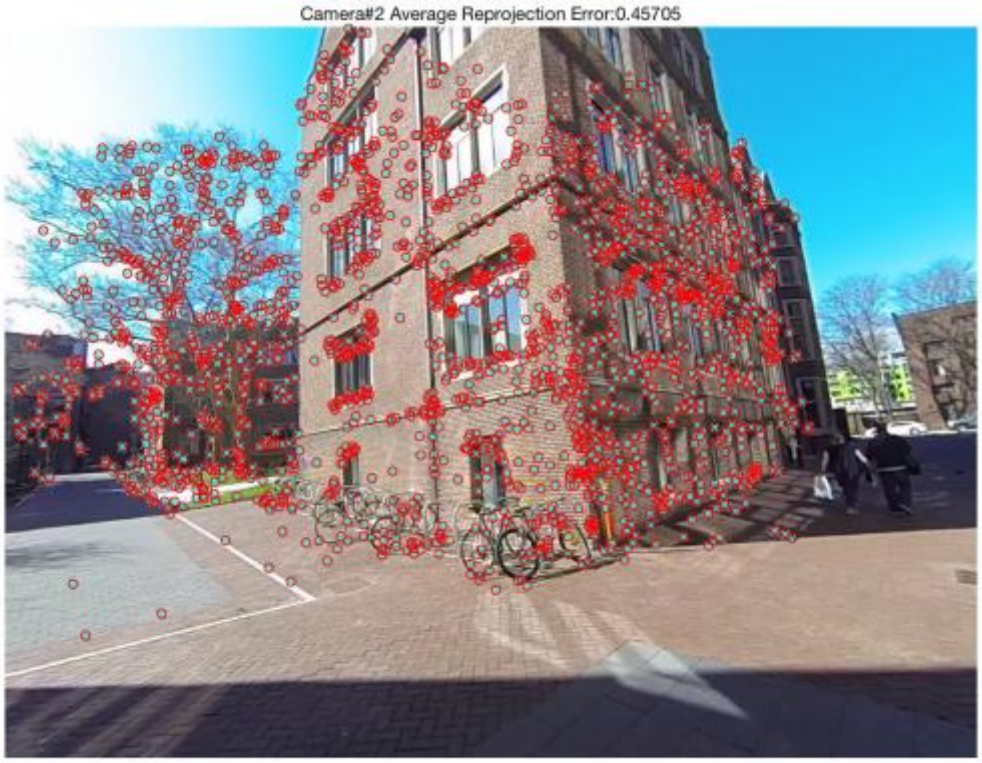


Total Points After Addition:



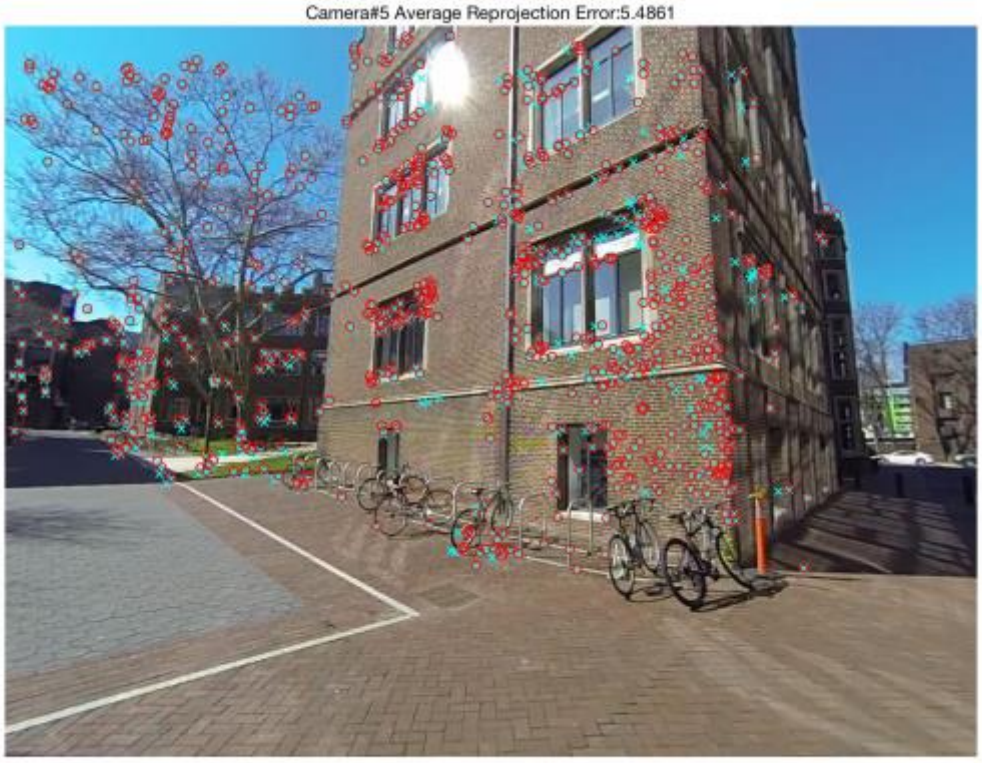
2D Reprojections of All 3D Points

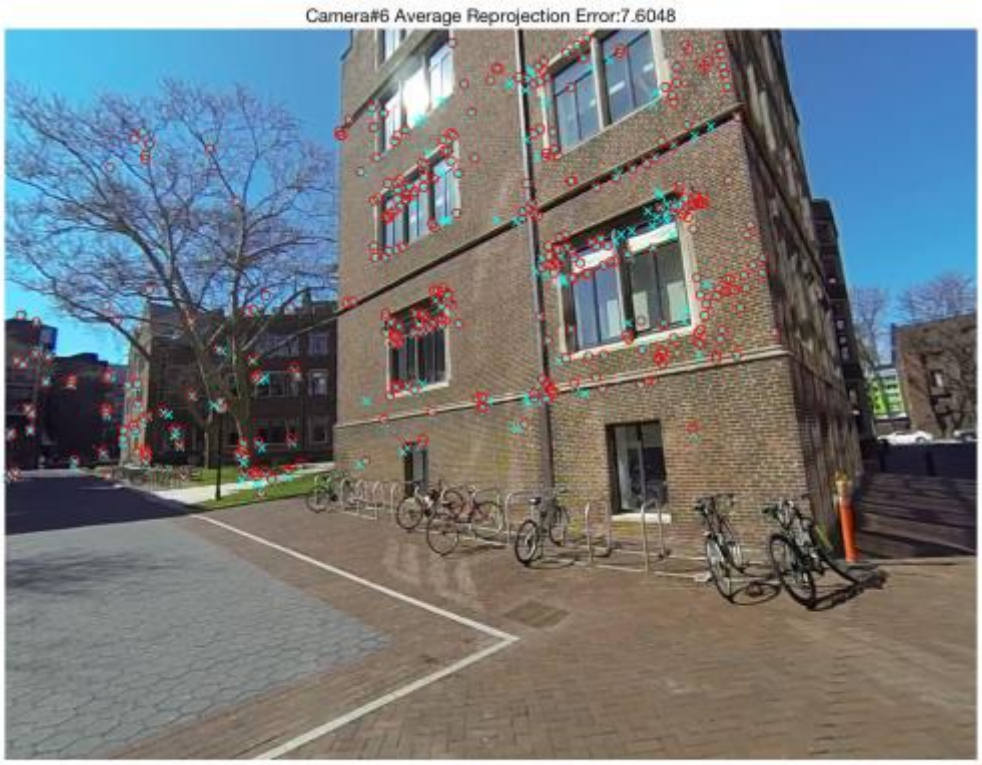
With the recorded trajectory of all 3D points in the 3D points cloud, their re-projections to each image are obtained as follows.


Camera#2 Average Reprojection Error:0.45705

Camera#3 Average Reprojection Error:0.79548

Camera#4 Average Reprojection Error:1.4308


Camera#5 Average Reprojection Error:5.4861


Camera#6 Average Reprojection Error:7.6048