TE1 $P_1 = [R_1\ t_1]$ $P_2 = [R_2\ t_2]$

Let Euclidean transformation $H = \begin{bmatrix} R_1^T & -R_1^T t_1 \\ 0^T & 1 \end{bmatrix}$

$P_1 H = [I\ 0]$ = new P_1
$P_2 H = [R\ t]$ = new P_2

Now, $E = [t]_\times R$ as did earlier.

TE2 Degrees of freedom = 5
Min. num. of pt correspondences = 5
Eight point solver requires atleast 8 points

$$T \geq \frac{\log(1-\alpha)}{\log(1-\varepsilon^s)} \qquad \alpha = 0.99,\ \varepsilon = 0.75,\ s = 8$$

$$T \geq \frac{\log(1-0.99)}{\log(1-0.75^8)} \geq 100.523$$

TE3 $r_i(x_j) =$

a)
$Z_{ij} = P_i x_j$

$r_i(Z_{ij}) = (x$

$\frac{dr_{i1}}{dZ_{ij}} = \left[\frac{-1}{Z^3_{ij}}\right.$

$\frac{dr_{i2}}{dZ_{ij}} = [0,$

$\frac{dZ_{ij}}{dx_j} = P_i$

$= \left[\begin{matrix} \frac{-P_i^1}{Z^3_{ij}} \\ \frac{-P_i^2}{Z^3_{ij}} \end{matrix}\right.$

$+_2]$

$H = \begin{bmatrix} R_1^T & -R_1^T t_1 \\ 0^T & 1 \end{bmatrix}$

earlier.

...ondences = 5

...res atleast

99

75

.523

TE3 $r_i(x_j) = \left(x_{ij,1} - \frac{P_i^1 x_j}{P_i^3 x_j}, x_{ij,2} - \frac{P_i^2 x_j}{P_i^3 x_j} \right)$

a)

$Z_{ij} = P_i x_j$

$r_i(Z_{ij}) = \left(x_{ij,1} - \frac{Z_{ij}^1}{Z_{ij}^3}, x_{ij,2} - \frac{Z_{ij}^2}{Z_{ij}^3} \right)$

$\frac{dr_{i1}}{dZ_{ij}} = \left[\frac{-1}{Z^3_{ij}}, 0, \frac{Z_{ij}^1}{(Z^3_{ij})^2} \right]$

$\frac{dr_{i2}}{dZ_{ij}} = \left[0, -\frac{1}{Z^3_{ij}}, \frac{Z_{ij}^2}{(Z^3_{ij})^2} \right]$

$P_i = \begin{bmatrix} P_i^1 \\ P_i^2 \\ P_i^3 \end{bmatrix}$

$\frac{dZ_{ij}}{dx_j} = P_i, \quad \frac{dr_{i\,1,2}}{dx_j} = \frac{dr_{i\,1,2}}{dZ_{ij}} \times \frac{dZ_{ij}}{dx_j}$

$= \begin{bmatrix} \frac{-P_i^1}{Z^3_{ij}} + \frac{Z_{ij}^1}{(Z^3_{ij})^2} P_i^3 \\ \frac{-P_i^2}{Z^3_{ij}} + \frac{Z_{ij}^2}{(Z^3_{ij})^2} P_i^3 \end{bmatrix}$

$$J_i(x_j) = \begin{bmatrix} \frac{P_i^1 x_j}{(P^3_i x_j)^2} \cdot P_i^3 - \frac{1}{P^3_i x_j} P_i^1 \\ \frac{P_i^2 x_j}{(P^3_i x_j)^2} P_i^3 - \frac{1}{P_i^3 x_j} P_i^2 \end{bmatrix}$$

b) $\|x\|^2 =$ L2 norm

$$= \left(\sqrt{x_1^2 + x_2^2 + x_3^2 \dots}\right)^2 = (x_1^2 + x_2^2 + x_3^2 \dots)$$

$\dim(x) = 4 \times 1$

$\dim(\delta x) = 4 \times 1$

$\dim(\alpha(x_j)) = 2m \times 1$

$\dim(J(x_j)) = 2m \times 4$

$\dim(J(x_j) \times \delta x) = 2m \times 1$

Thus all we are doing is moving from

$$\sum_{i=1}^{m} \|(2\times 1 \text{ vector}_1)\|^2 = \|2m\times 1 \text{ vector}_2\|^2$$

Both are equal to squaring all elements.

CE1

Root Mean Square (rms) value with all points = 155.9583

Root Mean Square (rms) value using RANSAC = 209.351

Do the plots look reasonable, are points close to the epipolar lines? Looks somewhat reasonable and the points are fairly close to the lines

The number of inliers found = 3487

RANSAC provides better results as it ignores the outliers or bad data.

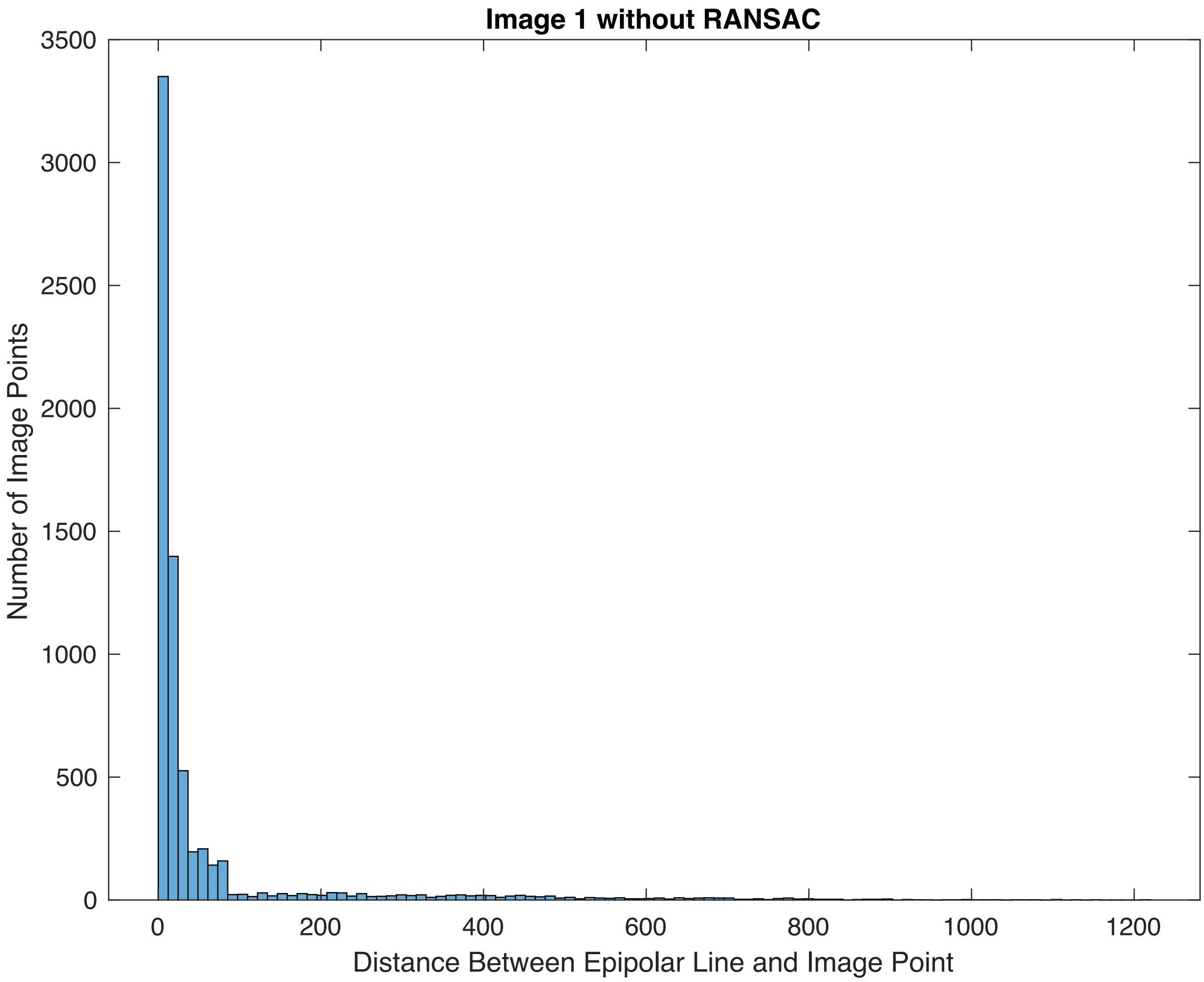


Image 1 without RANSAC
Number of Image Points
3500
3000
2500
2000
1500
1000
500
0
0
200
400
600
800
1000
1200
Distance Between Epipolar Line and Image Point

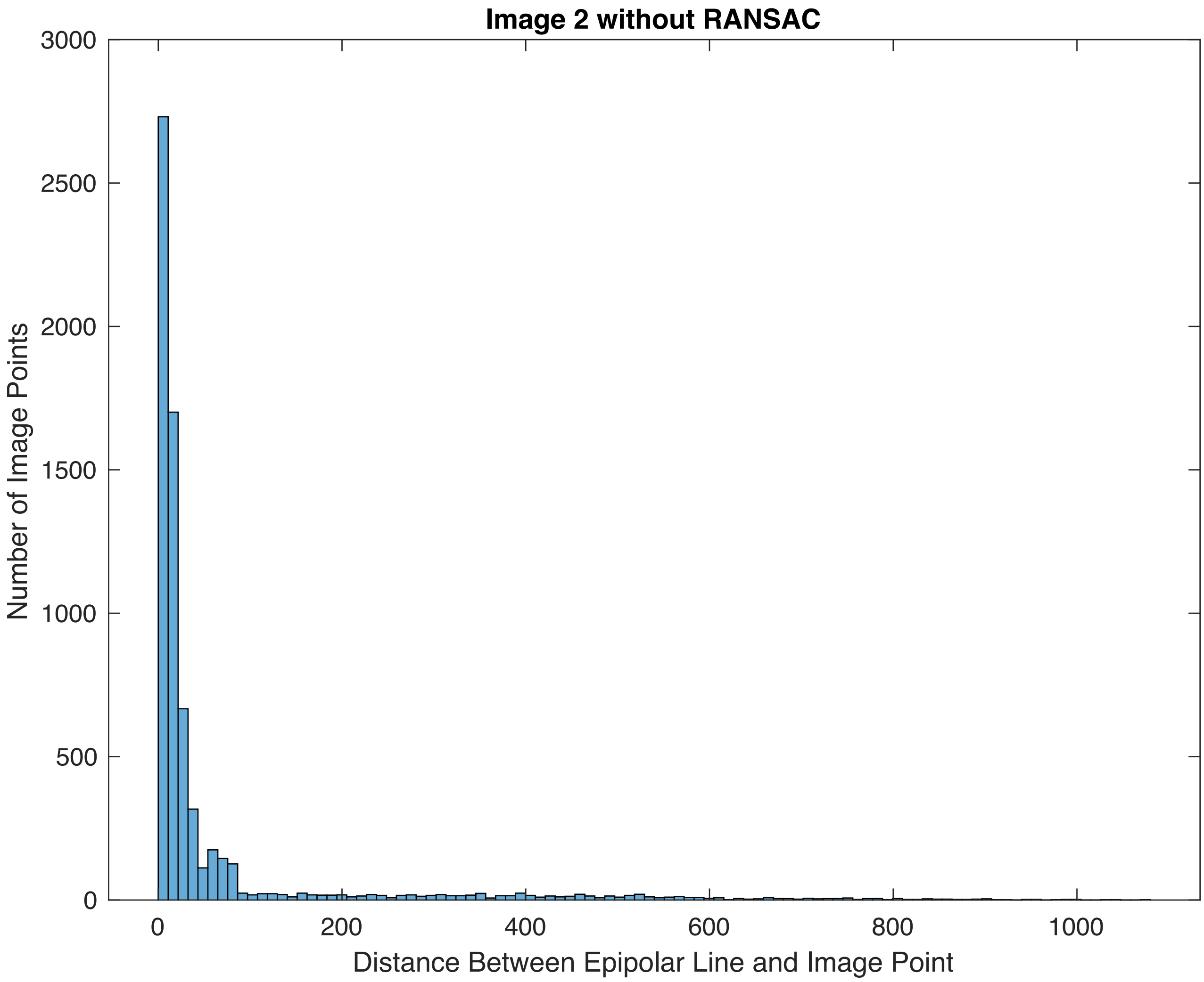


Image 2 without RANSAC
Number of Image Points
Distance Between Epipolar Line and Image Point
3000
2500
2000
1500
1000
500
0
0
200
400
600
800
1000

Image 1 without RANSAC

Image 2 without RANSAC

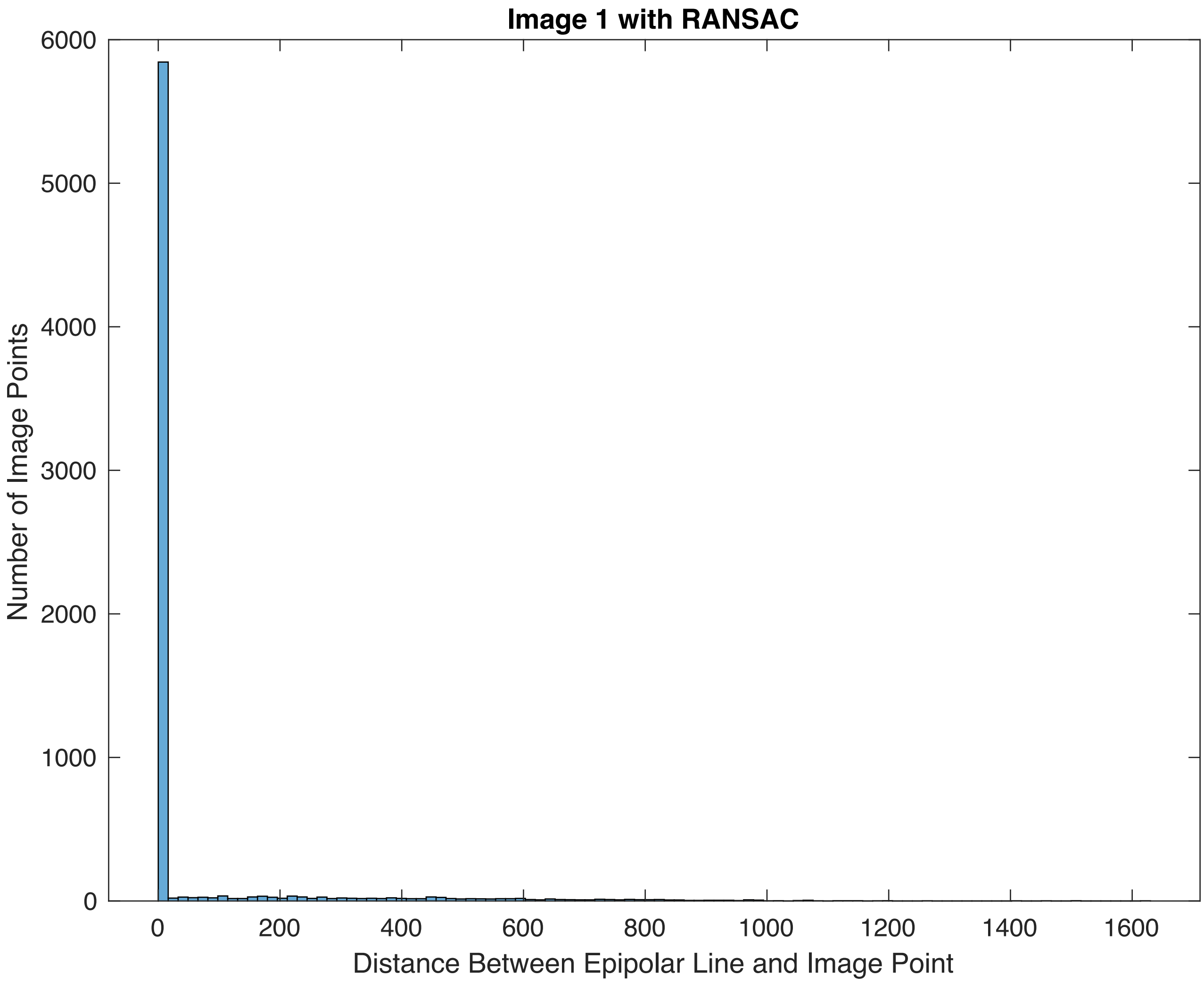


Image 1 with RANSAC
6000
5000
4000
3000
2000
1000
0
Number of Image Points
0
200
400
600
800
1000
1200
1400
1600
Distance Between Epipolar Line and Image Point

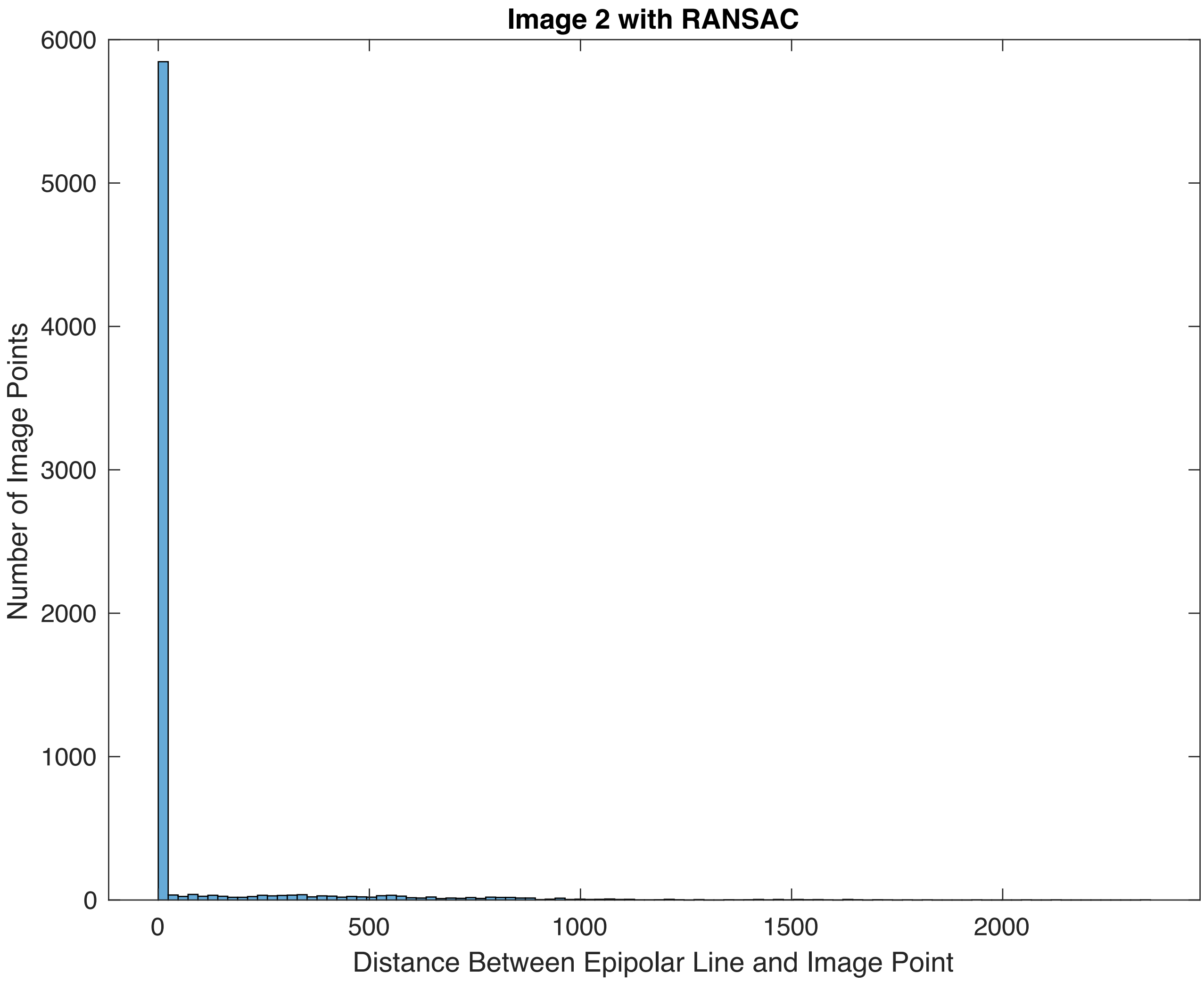


Image 2 with RANSAC
6000
5000
4000
3000
2000
1000
0
Number of Image Points
0
500
1000
1500
2000
Distance Between Epipolar Line and Image Point

Image 1 with RANSAC

Image 2 with RANSAC

CE2

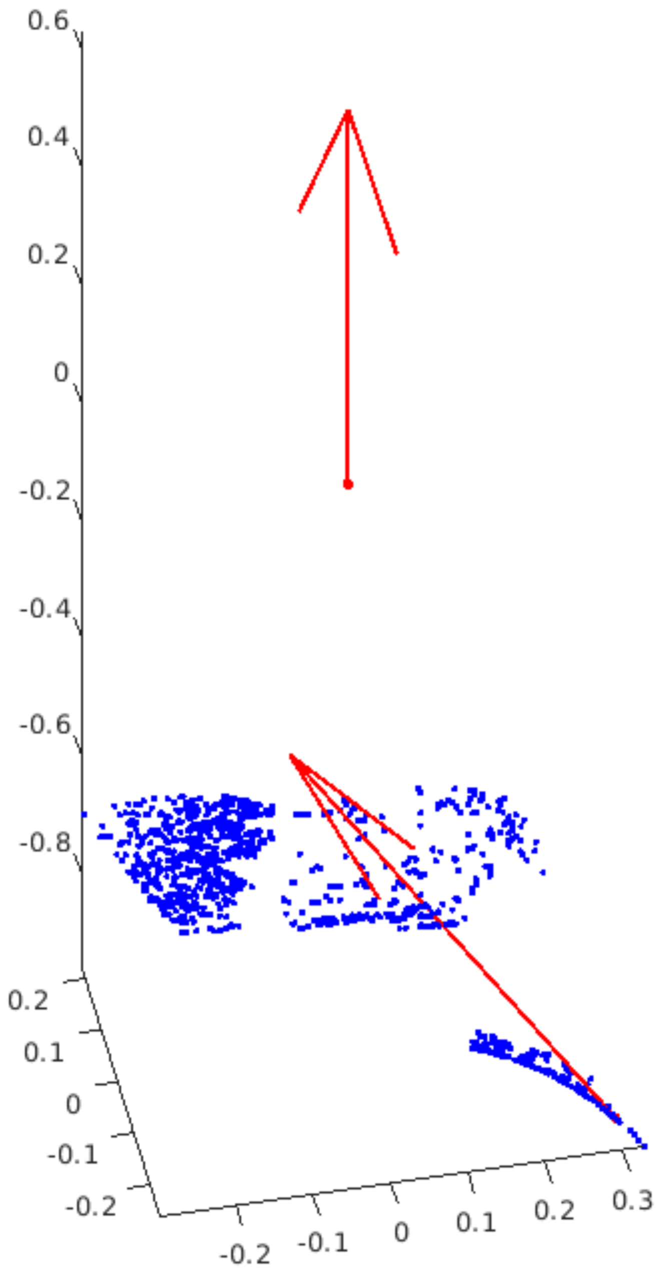
Number of SIFT features on both images around 38000

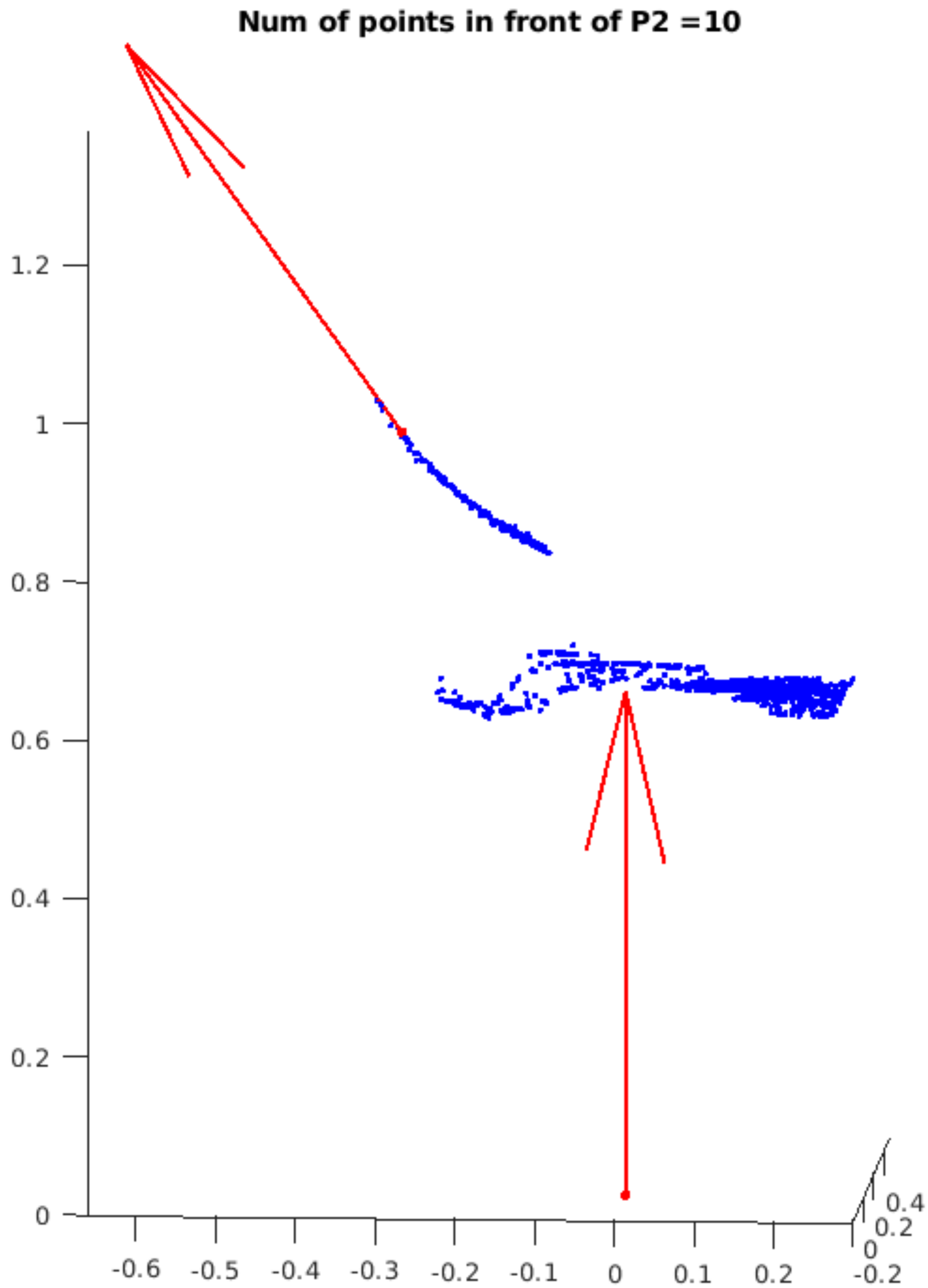
Number of matches = 2604

Number of inliers = 1173

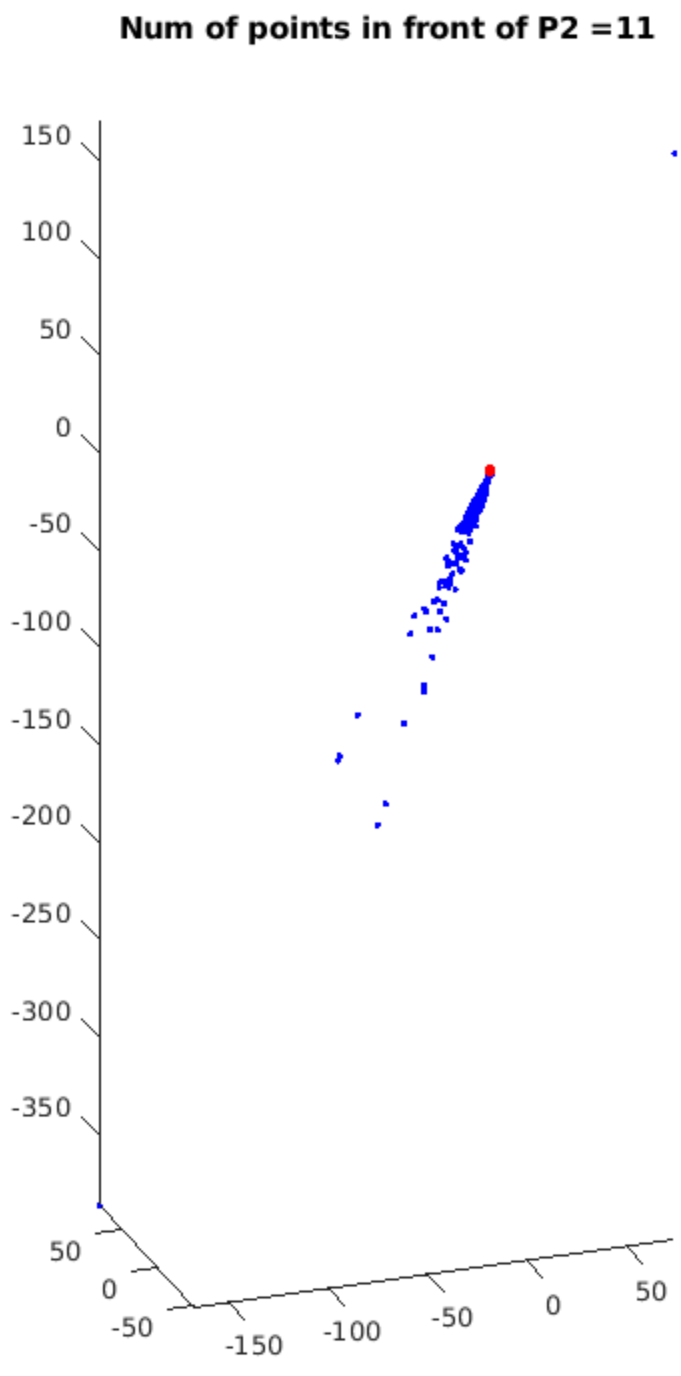
First P2 has best result P2{1}=[U*W*V',U(:,3)];

Num of points in front of P2 =1163

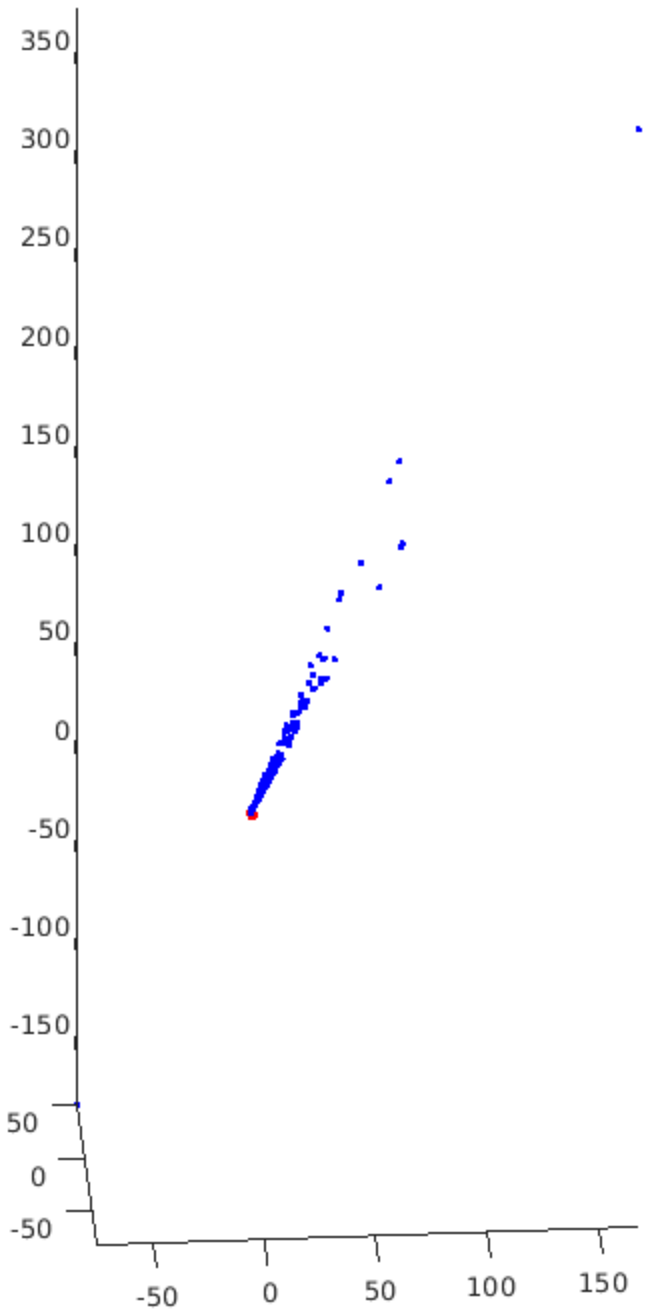




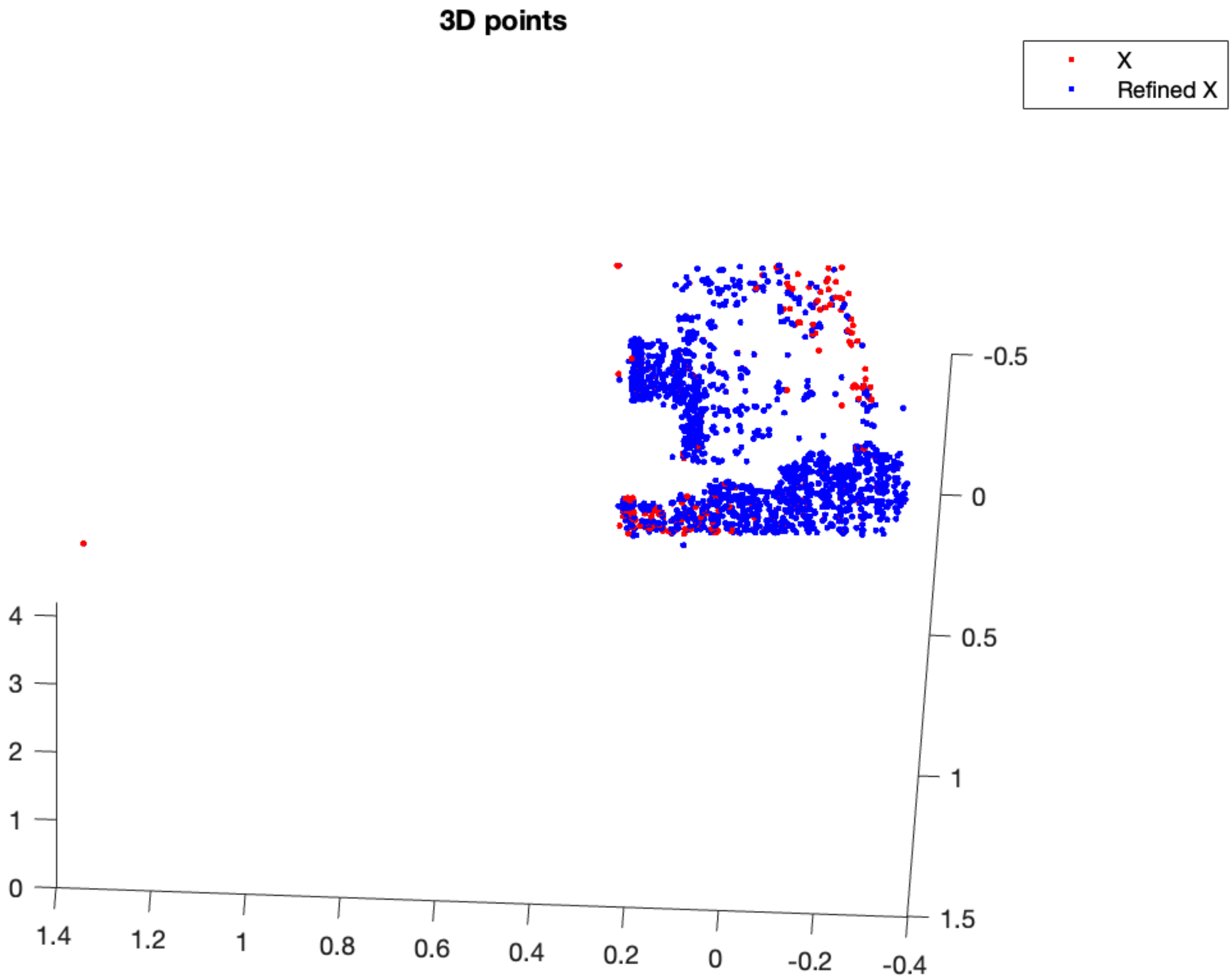
Num of points in front of P2 =10
1.2
1
0.8
0.6
0.4
0.2
0
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
-0.2
0
0.2
0.4


Num of points in front of P2 =11
150
100
50
0
-50
-100
-150
-200
-250
-300
-350
50
0
-50
-150
-100
-50
0
50

Num of points in front of P2 =1162



CE3
Total Error before = 22354.245
Total Error after = 21566.42
Median Error before = 11.6599
Median Error after = 11.1979


3D points
X
Refined X
-0.5
0
0.5
1
1.5
4
3
2
1
0
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4