R00182510 Machine Vision Assignment Report

Task 1

SubTask A

Output of Checkerboard calibrated images shown below.

Image 1

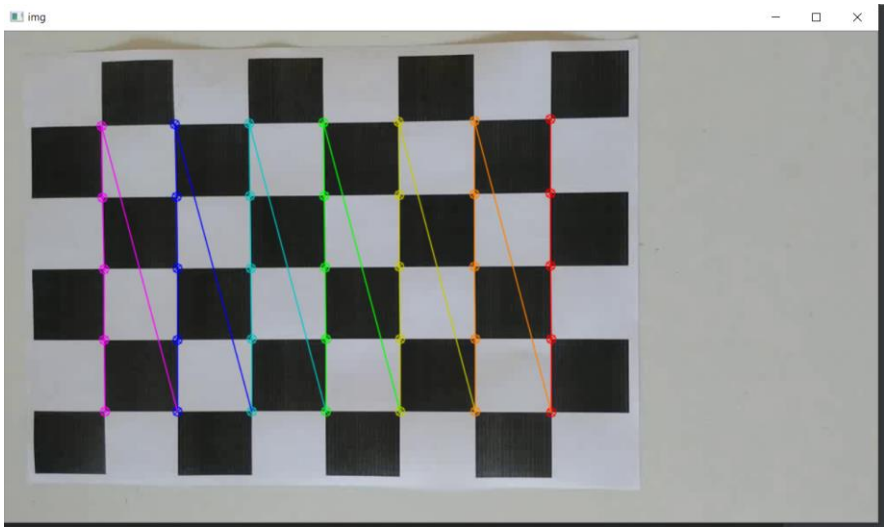


Image 2

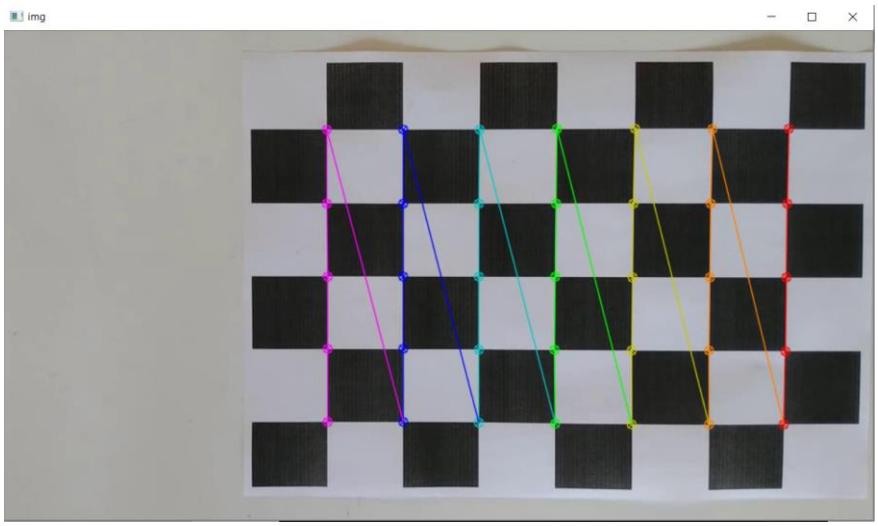


Image 3

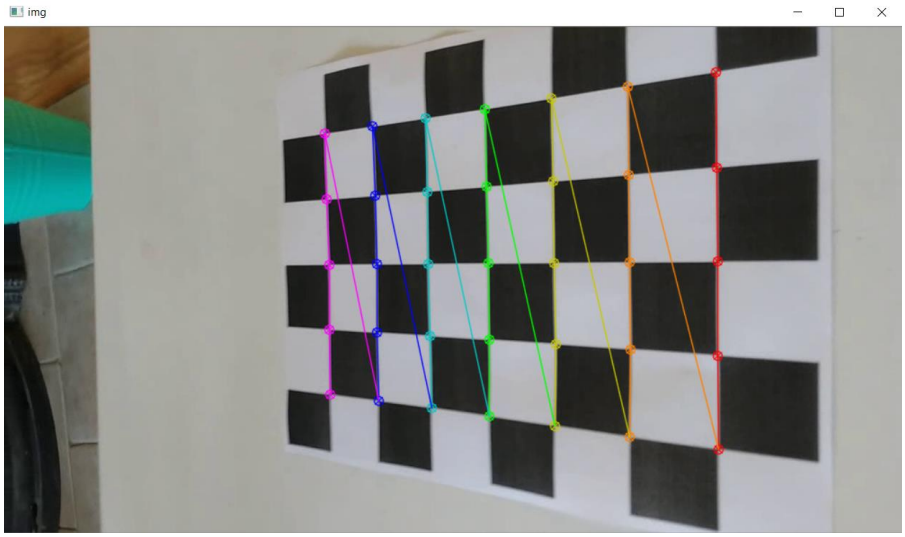


Image 4

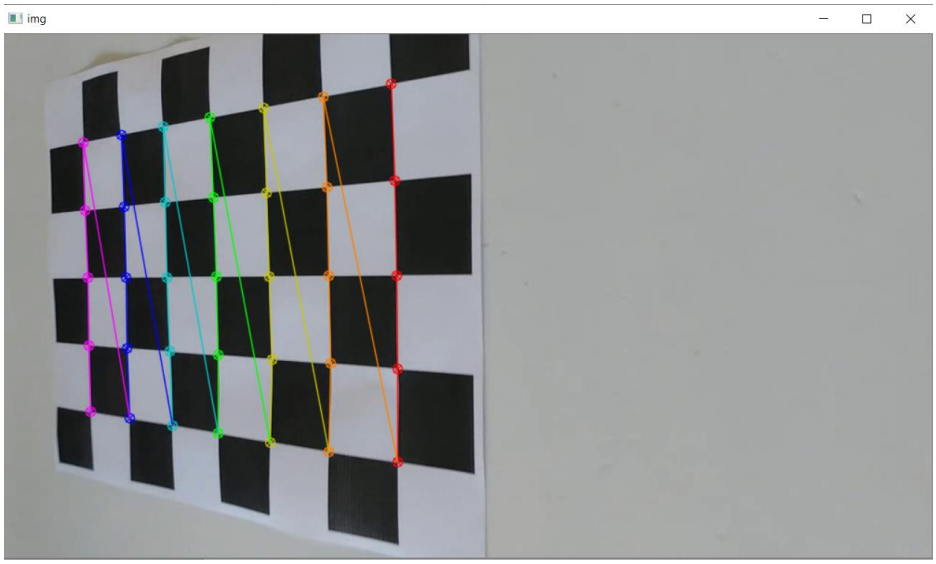


Image 5

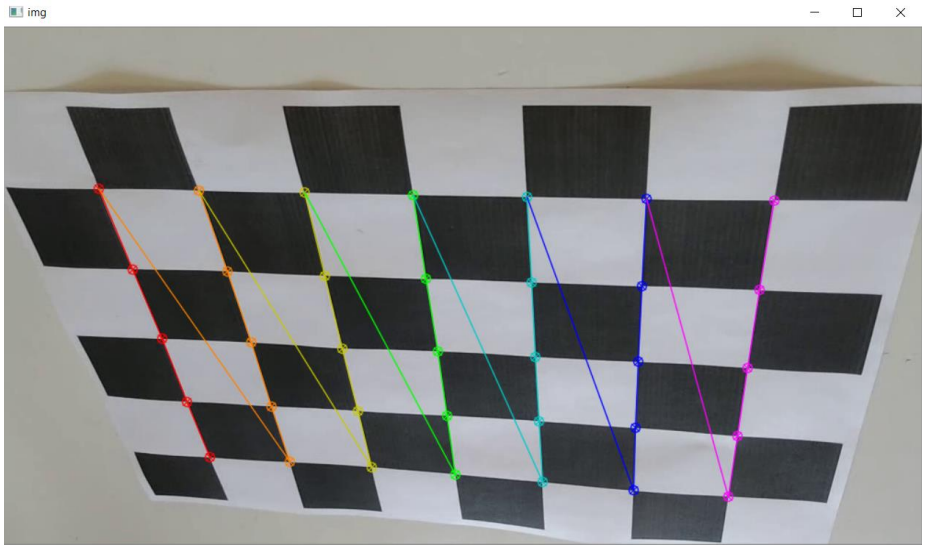
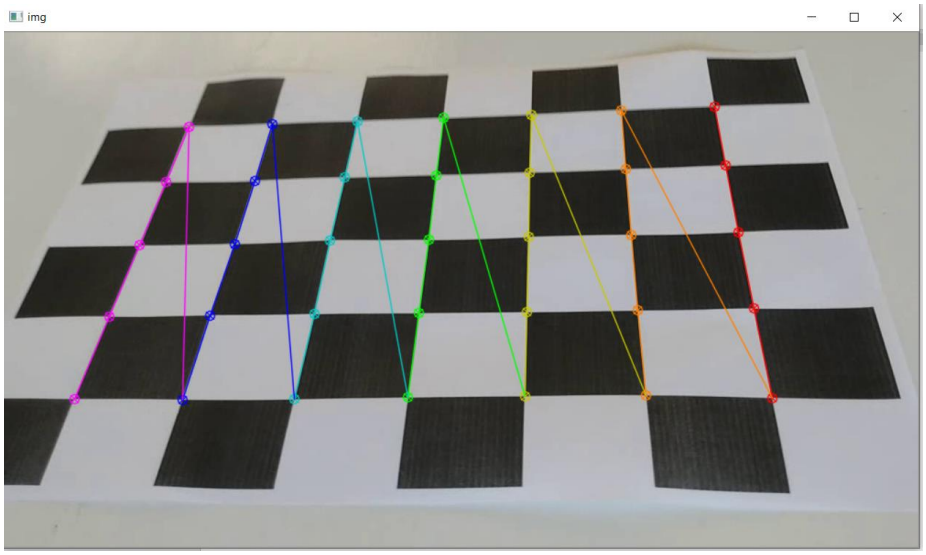


Image 6



SubTask B

Output Camera calibration matrix given below.

```
Camera calibration matrix:
[[994.92286808   0.         485.15648702]
 [  0.         953.82760946 286.17927722]
 [  0.           0.           1.        ]]
```

Subtask C

Good features to track were identified in the first frame.

Feature points were refined to Subpixel accuracy.

Refer code in function ‘get_tracks’.

Subtask D

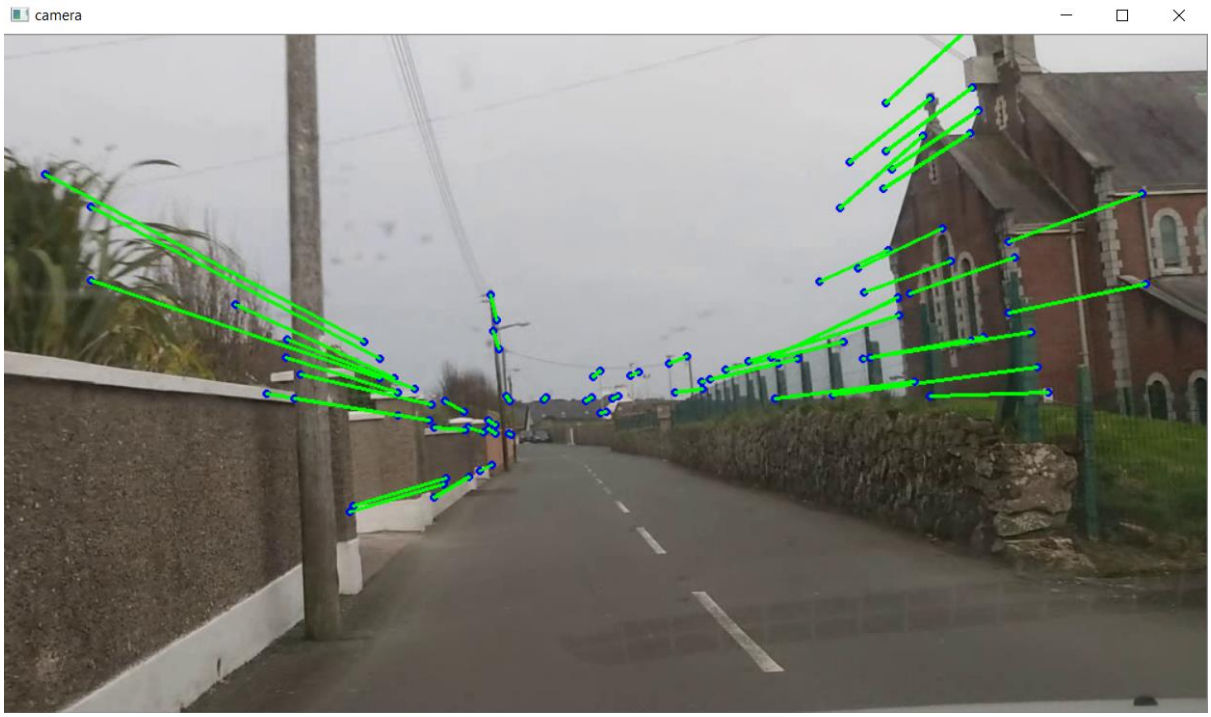
Features were tracked across the whole image sequence and was refined to sub pixel accuracy in each step.

Refer code in function ‘get_tracks’.

Task 2

SubTask A

Visualize feature tracks visible in both the first and the last frames to establish correspondences. The x and y coordinate were swapped as mentioned by Christian in lab.



SubTask B

The mean feature coordinates and the standard deviations were calculated. Normalized all feature coordinates by translating and scaling it. The swapped x and y coordinates were used accordingly.

Refer function calculate_fundamental_matrix in code.

SubTask C

A random selection of 8 points were made to build a matrix comprising the eight corresponding rows. This was used to calculate the fundamental matrix using 8-point DLT algorithm.

Refer function calculate_fundamental_matrix in code.

SubTask D

Using the 8 point DLT algorithm, the fundamental matrix was calculated. Refer function calculate_fundamental_matrix in code.

SubTask E

For the remaining feature correspondences not used in the 8-point algorithm gi and the variance were calculated using the covariance matrix. Refer lines 252 to 272 in function calculate_fundamental_matrix in code.

SubTask F

For these correspondences, calculate the test statistic to determine if its an outlier with a threshold greater than 6.635. Test statistics for inliers were summed up. Refer lines 272 to 281 in function calculate_fundamental_matrix in code.

SubTask G

The process from Subtask C to Subtask F was repeated 10000 times.

The fundamental matrix with the least number of outliers were determined. Ties were handled by looking at the sum of the test statistic over the inliers. Refer lines 282 to 297 in function calculate_fundamental_matrix in code.

SubTask H

Visualize the inliers and outliers in the same image from Subtask A. 11 outliers were detected. Outliers shown in red. Inliers in green.

Calculated Epipole Coordinates

```
Epipoles
[418.58197902 233.72013037   1.        ]
[436.68168606 168.56999935   1.        ]
```

Task 3

SubTask A

Calculate the essential matrix $\boldsymbol{E}$ with the identical non-zero singular values of $\boldsymbol{E}$. Ensured the rotation matrices of the singular value decomposition have positive determinants. Refer code in function ‘main’, lines 368 to 384.

SubTask B

Four potential combinations of Rotations and translations were determined. Scale of the baseline, beta was calculated. Refer code in function ‘main’, lines 386 to 415.

SubTask C

Calculated the directions $\boldsymbol{m}$and $\boldsymbol{m'}$of the 3d lines originating from the center of projection towards the 3d points.

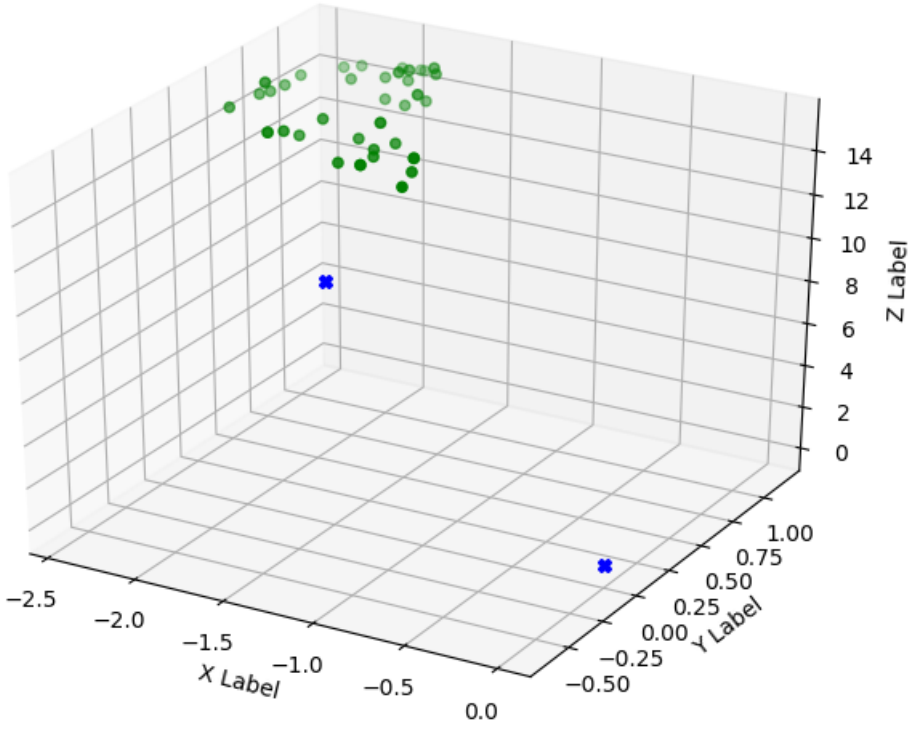
Calculated the unknown distances λ and μ to obtain the 3d coordinates of the scene points.

Calculate the 3d coordinate scene points for the one solution, where λ>0 and μ>0. Discard outliers.

Refer code in function ‘main’, lines 417 to 470.

SubTask D

3d plot to show the two camera centres and all 3d points. Refer code in function ‘main’, lines 472 to 486. Centers in blue. Green points indicate the 3d coordinates ((X_lambda + X_mu)/2).



SubTask E

Projected the 3d points into the first and the last frame and the corresponding features to visualize the reprojection error. Refer code in function ‘main’, lines 488 to 512.

3D points in blue. Feature correspondences in green.

First Frame

Last Frame