ASSIGNMENT 2

In the given assignment, three images are used i.e., 'img3.png', 'img4.png' and 'img5.png'.

The checker board points are detected using the function 'detectCheckerboardPoints'. The points obtained are as follows:

Image 3

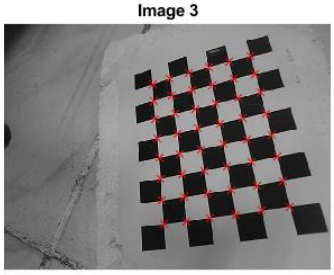


Image 4

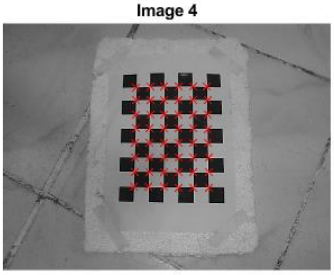
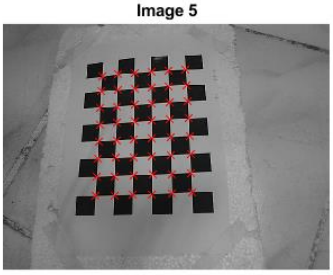


Image 5



Then the using the given dimension of each square, which is 2.4cm, the actual world coordinate points are obtained keeping in mind the correspondence of these points with the image points obtained previously.

We know homography matrix provides relation between world coordinate points and image points i.e.,

$$\begin{bmatrix} x_i \\ y_i \\ 1 \end{bmatrix} = [H] \times \begin{bmatrix} X_i \\ Y_i \\ 1 \end{bmatrix}$$

where (x_i, y_i) = Image point

(X_i, Y_i) = world coordinate point

Using the relation

$$a_{x_i}^T h = 0 \quad \text{and} \quad a_{y_i}^T h = 0$$

$$\text{where } h = [H_{11}; H_{12}; H_{13}; H_{21}; H_{22}; H_{23}; H_{31}; H_{32}; H_{33}]$$

$$a_{x_i}^T = [-X_i, -Y_i, -1, 0, 0, 0, x_i X_i, x_i Y_i, x_i]$$

$$a_{y_i}^T = [0, 0, 0, -X_i, -Y_i, -1, y_i X_i, y_i Y_i, y_i]$$

and set of four points which are non-collinear, eight equations were obtained which when solved gave ' h ' such that last element of ' h ' is 1. This ' h ' is then converted to required homography matrix. Using this method, three homography matrices are obtained using three images.

H matrix for image 1:

```
H_matrix_1 =

    2.9234   15.6078  272.6315
  -14.7392   -6.3350  447.8132
    0.0146   -0.0094    1.0000
```

H matrix for image 2:

```
H_matrix_2 =

    1.3313   11.8949  226.2835
  -11.1334   -0.2144  348.1325
    0.0039   -0.0010    1.0000
```

H matrix for image 3:

```
H_matrix_3 =

    2.6314   14.8984  142.2117
  -13.1096   -1.6159  377.1191
    0.0093   -0.0031    1.0000
```

K matrix is obtained by using the three homography matrices, calculating B matrix and then by performing Cholesky decomposition of B. The K matrix is normalized by making its last element of last row equal to 1.

```
K =

  569.4122   -0.4957  315.7275
         0  570.7036  219.1261
         0         0    1.0000
```

R1 and R2 are obtained from the calibration matrix and homography matrix. Whereas R3 is obtained using R1xR2. Similarly, translation is also found.

Rotation matrix 1:

```
r_1 =

   -0.0855    0.9382    0.3352
   -0.9039   -0.2151    0.3701
    0.4192   -0.2711    0.8664
```

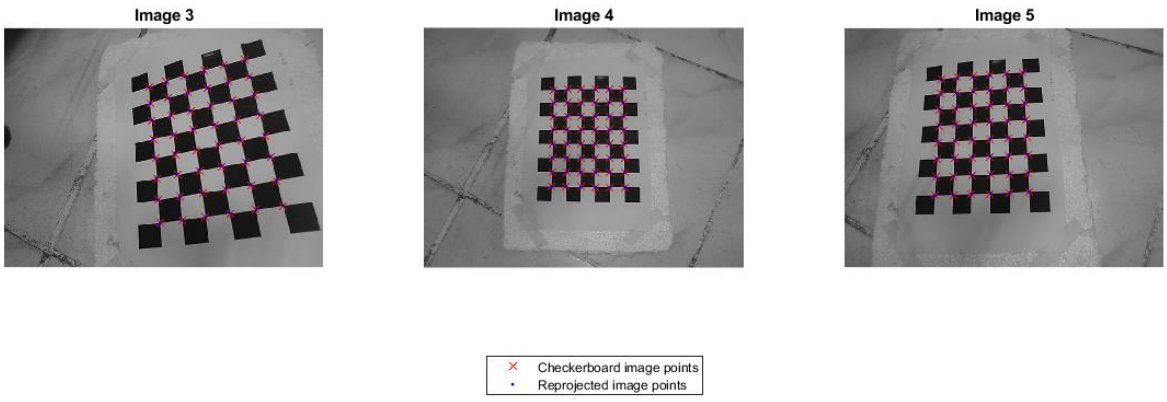
Rotation matrix 2:

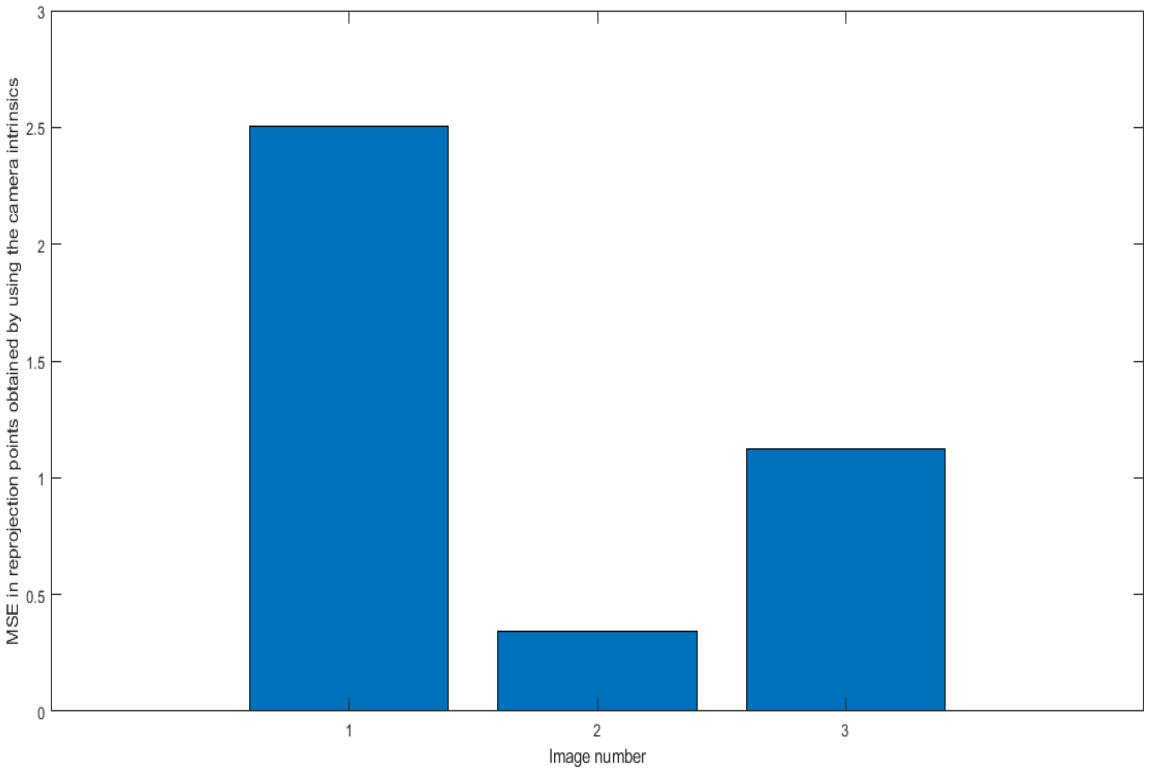
```
r_2 =

    0.0062    0.9989    0.0465
   -0.9828    0.0007    0.1845
    0.1844   -0.0475    0.9817
```

Rotation matrix 3:

```
r_3 =

   -0.0201    0.9923    0.1223
   -0.9434   -0.0590    0.3263
    0.3310   -0.1089    0.9373
```

To calculate the accuracy for the intrinsics obtained,mean square error is calculated for each image point reprojected using the intrinsics.




MSE in reprojection points obtained by using the camera intrinsics
3
2.5
2
1.5
1
0.5
0
1
2
3
Image number