

Q-1)

1.) Intrinsic matrix

```
[[3.48139685e+03 0.00000000e+00 2.03304552e+03]
 [0.00000000e+00 3.45022626e+03 1.48873367e+03]
 [0.00000000e+00 0.00000000e+00 1.00000000e+00]]
```

Fx = 3.48139685e+03

Fy = 3.45022626e+03

skew = 0

(Xo, Yo) = (2.03304552e+03, 1.48873367e+03)

2.) Extrinsic matrix

```
[array([[ 9.97320598e-01, -4.50668169e-03, -7.30158587e-02,
        -3.57717241e+00],
       [ 1.64795346e-02,  9.86286447e-01,  1.64217752e-01,
        -2.96461140e+00],
       [ 7.12744747e-02, -1.64981014e-01,  9.83718056e-01,
        1.30247655e+01],
       [ 0.00000000e+00,  0.00000000e+00,  0.00000000e+00,
        1.00000000e+00]]),
 array([[ 0.64529083, -0.75315159, -0.12791571, -0.27428305],
       [ 0.55571071,  0.34788061,  0.7550925 , -3.97661742],
       [-0.52419973, -0.5583384 ,  0.64301857, 17.49498821],
       [ 0.        ,  0.        ,  0.        ,  1.        ]]),
 array([[ 1.16912886e-02, -9.99767531e-01,  1.81162125e-02,
        2.91041633e+00],
       [ 9.91799124e-01,  9.28832219e-03, -1.27468524e-01,
        -2.29574359e+00],
       [ 1.27270622e-01,  1.94579150e-02,  9.91677154e-01,
        1.51457253e+01],
       [ 0.00000000e+00,  0.00000000e+00,  0.00000000e+00,
        1.00000000e+00]]),
 array([[ 7.68908708e-03, -9.98258237e-01,  5.84924737e-02,
        8.76788972e-01],
       [ 7.67308948e-01,  4.33994125e-02,  6.39807369e-01,
        4.30540018e-01],
       [-6.41231516e-01,  3.99622639e-02,  7.66306180e-01,
        1.49824147e+01],
       [ 0.00000000e+00,  0.00000000e+00,  0.00000000e+00,
        1.00000000e+00]]),
 array([[ 0.67288471, -0.70312194, -0.22988192,  0.29846827],
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[ 0.73946982, 0.64784152, 0.18299111, -4.44039174],
[ 0.02026199, -0.29312266, 0.95586011, 15.74585214],
[ 0.      , 0.      , 0.      , 1.      ]]],
array([[ 0.63013208, -0.77581561, 0.03230654, -0.85192061],
[ 0.74101304, 0.61325506, 0.27352862, -4.78129565],
[-0.23201992, -0.14841959, 0.96132117, 15.80788404],
[ 0.      , 0.      , 0.      , 1.      ]]),
array([[ 0.76380477, -0.57413517, -0.29490859, -3.03242559],
[ 0.60510324, 0.47794515, 0.63672482, 0.26857544],
[-0.22461598, -0.6647836 , 0.71246784, 18.00142422],
[ 0.      , 0.      , 0.      , 1.      ]]),
array([[ 0.68330914, -0.68641719, -0.24883739, -0.14318744],
[ 0.7292631 , 0.65823336, 0.1868266 , -4.47597285],
[ 0.03555208, -0.30912825, 0.9503556 , 14.67631447],
[ 0.      , 0.      , 0.      , 1.      ]]),
array([[ 0.65965416, -0.70828053, -0.25138633, -1.79217157],
[ 0.61530436, 0.31687803, 0.72179558, -1.22198689],
[-0.43157495, -0.63081456, 0.64483801, 16.79648298],
[ 0.      , 0.      , 0.      , 1.      ]]),
array([[ -0.23685364, -0.9490879 , 0.20768368, 3.91008152],
[ 0.59899386, 0.02565014, 0.80034269, -2.84696478],
[-0.76492268, 0.31396533, 0.5624225 , 13.97331744],
[ 0.      , 0.      , 0.      , 1.      ]]),
array([[ 0.75285985, -0.55175315, 0.35884608, -1.3849865 ],
[ 0.26361371, 0.75234508, 0.60372568, -3.96849855],
[-0.60308363, -0.35992407, 0.7118601 , 15.39015917],
[ 0.      , 0.      , 0.      , 1.      ]]),
array([[ 0.66892645, 0.73128542, -0.13326304, -3.86526868],
[-0.51935047, 0.58805667, 0.62005197, -1.53560697],
[ 0.53180119, -0.34555894, 0.77316008, 11.72310004],
[ 0.      , 0.      , 0.      , 1.      ]]),
array([[ -0.61475099, 0.64156251, -0.45877965, 0.92041101],
[-0.73612714, -0.25785445, 0.62580182, 1.87946974],
[ 0.28319261, 0.72243244, 0.63078786, 8.39496394],
[ 0.      , 0.      , 0.      , 1.      ]]),
array([[ -0.17506078, -0.93829526, 0.29825448, 1.38650679],
[ 0.64037079, 0.12158927, 0.75838071, 0.07222047],
[-0.74784957, 0.32375617, 0.57957136, 13.25609878],
[ 0.      , 0.      , 0.      , 1.      ]]),
array([[ 0.09865535, -0.99475628, -0.0269643 , 2.79863949],
[ 0.79061614, 0.0618971 , 0.60917556, -3.59340715],
[-0.6043122 , -0.08141684, 0.79257685, 12.28203681],
[ 0.      , 0.      , 0.      , 1.      ]]),
array([[ -4.29898119e-01, -7.63786849e-01, 4.81474046e-01,

```

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9.77092659e-01],
[ 7.43470078e-01, 3.10969408e-03, 6.68761970e-01,
-1.33974490e+00],
[-5.12288834e-01, 6.45461060e-01, 5.66515817e-01,
1.15099285e+01],
[ 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
1.00000000e+00]]),
array([[ 1.07588268e-03, -9.99872224e-01, 1.59492477e-02,
2.34685839e+00],
[ 7.64233905e-01, 1.11084142e-02, 6.44843502e-01,
-3.95502703e+00],
[-6.44938277e-01, 1.14951799e-02, 7.64148205e-01,
1.35701978e+01],
[ 0.00000000e+00, 0.00000000e+00, 0.00000000e+00,
1.00000000e+00]]))

```

3.) distortion coefficient

```

(r1, r2, t1, t2, r3)
([ 0.03022814, -1.00161046, -0.00574196, 0.01133526, 1.56754933])

```

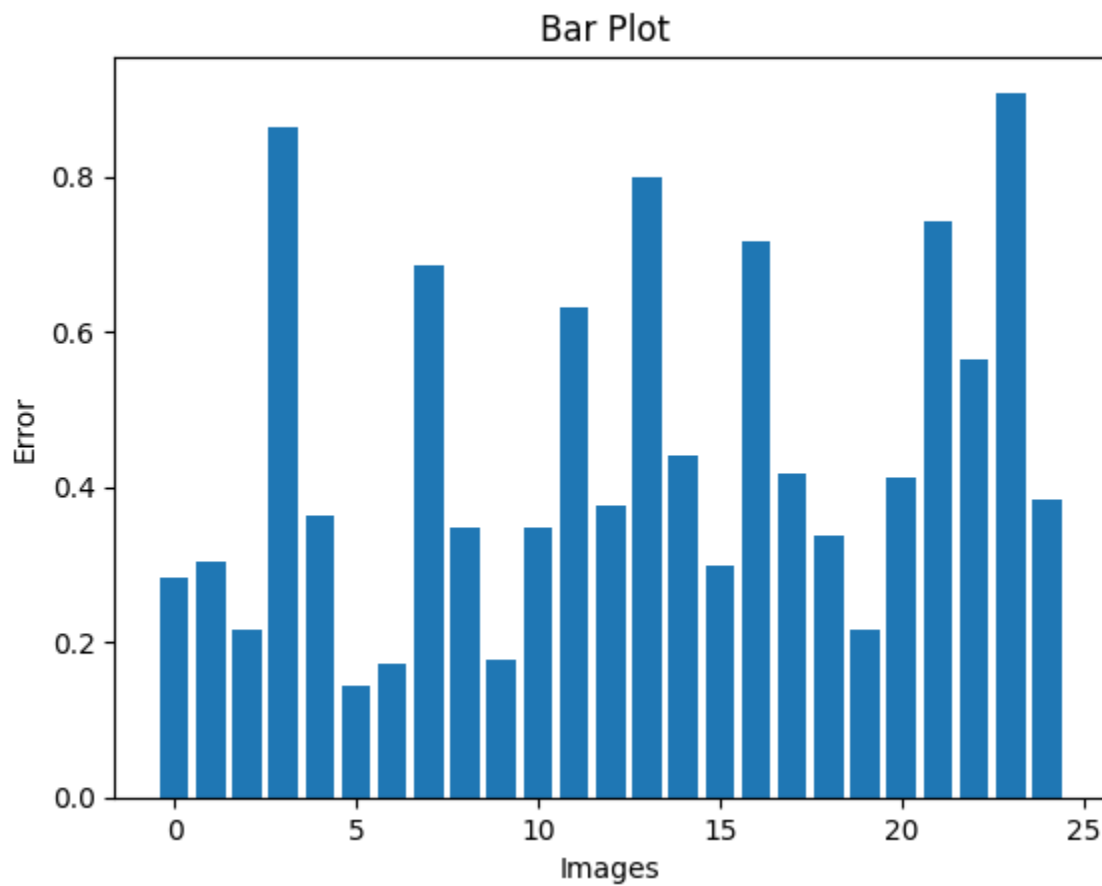
4.)

```

Reprojection error = [0.28313628476681857,
0.30354757019021816,
0.216083011460273,
0.8641361045552156,
0.3637160957639492,
0.1431474066152988,
0.17333721257931273,
0.6848072388404054,
0.34697585183508145,
0.17682567273497415,
0.3468667187508156,
0.6302558952834524,
0.3769585341625484,
0.7998681189014595,
0.43919343641416647,
0.2982958634810755,
0.7162396313943489,
0.4160050303007578,
0.335947515847005,
0.2160489114522208,
0.4129069542772283,

```

0.7418866250580337,
0.5638306458827289,
0.9080293898227301,
0.3830605998023611]



mean: 0.4456442528068992
standard deviation: 0.22281357810921024

5.)

Reprojection error is calculated by using root mean squared between the projected point and the actual points

Q-2)

2)

To calculate the rotation matrix and translation matrix, we can firstly choose a matrix of our own choice and then using the least squares error we will keep updating the value to the near for some loop so that we can reach at some least error.

4)

Some of the point were out of the boundary.