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In [ ]:

```
%matplotlib inline
import numpy as np
import cv2 as cv
from scipy.linalg import null_space
import matplotlib.pyplot as plt

f = open(r'C:\Python39\cv\exercices\lec 8\templeSparseRing\templeSR_par.txt','r')
assert f is not None

n = int(f.readline())

#reading the information on the first image
l=f.readline().split()
im1_fn = l[0]
K1 = np.array([float(i) for i in l[1:10]]).reshape(3,3)
R1 = np.array([float(i) for i in l[10:19]]).reshape(3,3)
t1 = np.array([float(i) for i in l[19:22]]).reshape(3,1)

#reaing the information on the second image
l=f.readline().split()
im2_fn = l[0]
K2 = np.array([float(i) for i in l[1:10]]).reshape(3,3)
R2 = np.array([float(i) for i in l[10:19]]).reshape(3,3)
t2 = np.array([float(i) for i in l[19:22]]).reshape(3,1)

#read the two images and show
im1 =cv.imread(r'C:\Python39\cv\exercices\lec 8\templeSparseRing/'+im1_fn, cv.IMREA
im2 =cv.imread(r'C:\Python39\cv\exercices\lec 8\templeSparseRing/'+im2_fn, cv.IMREA
assert im1 is not None
assert im2 is not None
```

In [ ]:

```
sift= cv.xfeatures2d.SIFT_create()
kp1, decs1= sift.detectAndCompute(im1,None)
kp2, decs2= sift.detectAndCompute(im2,None)

FLANN_INDEX_KDTREE = 1
index_params = dict(algorithm = FLANN_INDEX_KDTREE, trees=5)
search_params = dict(checks=100)
flann = cv.FlannBasedMatcher(index_params, search_params)
matches= flann.knnMatch(decs1,decs2,k=2)

good = []
pts1 = []
pts2 = []
for i,(m,n) in enumerate(matches):
    if m.distance <0.7*n.distance:
        good.append(m)
        pts1.append(kp1[m.queryIdx].pt)
        pts2.append(kp2[m.trainIdx].pt)
pts1=np.array(pts1)
pts2=np.array(pts2)

F, mask = cv.findFundamentalMat(pts1,pts2,cv.FM_RANSAC)
print("Fundamenatl matrix = ",F)
E = K2.T @ F @ K1 #essential matrix
print("Essential matrix matrix = ",E)
retval,R,t,mask = cv.recoverPose(E, pts1, pts2, K1)
```

```
R_t_1 = np.concatenate((R1,t1),axis=1)
R2_ = R1 @ R
t2_ = R1 @ t
R_t_2 = np.concatenate((R2_,t2_),axis=1)

P1 = K1 @ np.hstack((R1,t1))
P2_ = K2 @ R_t_2
print("Camera matrix = ",P2_)
```

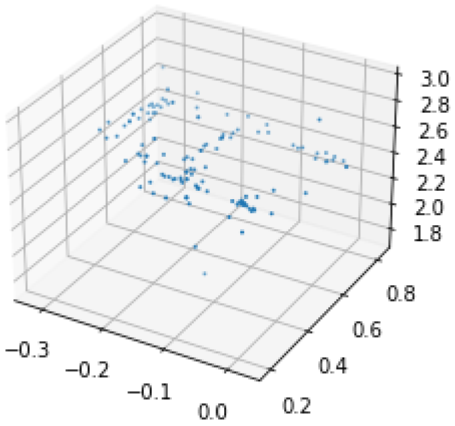
```
Fundamenatl matrix =  [[ 1.49034037e-06  1.44154168e-05 -2.53948320e-02]
 [-8.25788252e-06  8.67005344e-08  4.00767127e-03]
 [ 2.27526901e-02 -7.28270380e-03  1.00000000e+00]]
Essential matrix matrix =  [[ 3.44509489e+00  3.34434549e+01 -3.25145725e+01]
 [-1.91581088e+01  2.01870994e-01  2.33852108e+00]
 [ 3.21786978e+01 -4.43004055e+00 -6.22266684e-03]]
Camera matrix =  [[ 1.58524669e+02  1.53324446e+03 -1.64453374e+02 -9.53099575e+0
2]
 [ 1.53407871e+03 -1.25194936e+02 -1.42282633e+02  4.27897189e+01]
 [ 7.55162306e-02  8.27859886e-02 -9.93702057e-01  6.49896959e-01]]
```

In [ ]:

```
points4d = cv.triangulatePoints(P1,P2_,pts1.T,pts2.T)
points4d/= points4d[3,:]
X = points4d[0,:]
Y = points4d[1,:]
Z = points4d[2,:]

fig = plt.figure()
ax = fig.add_subplot(111,projection='3d')

ax.scatter(X,Y,Z,s=1,cmap='gray')
plt.show()
```


3.0
2.8
2.6
2.4
2.2
2.0
1.8
0.8
0.6
0.4
0.2
−0.3
−0.2
−0.1
0.0