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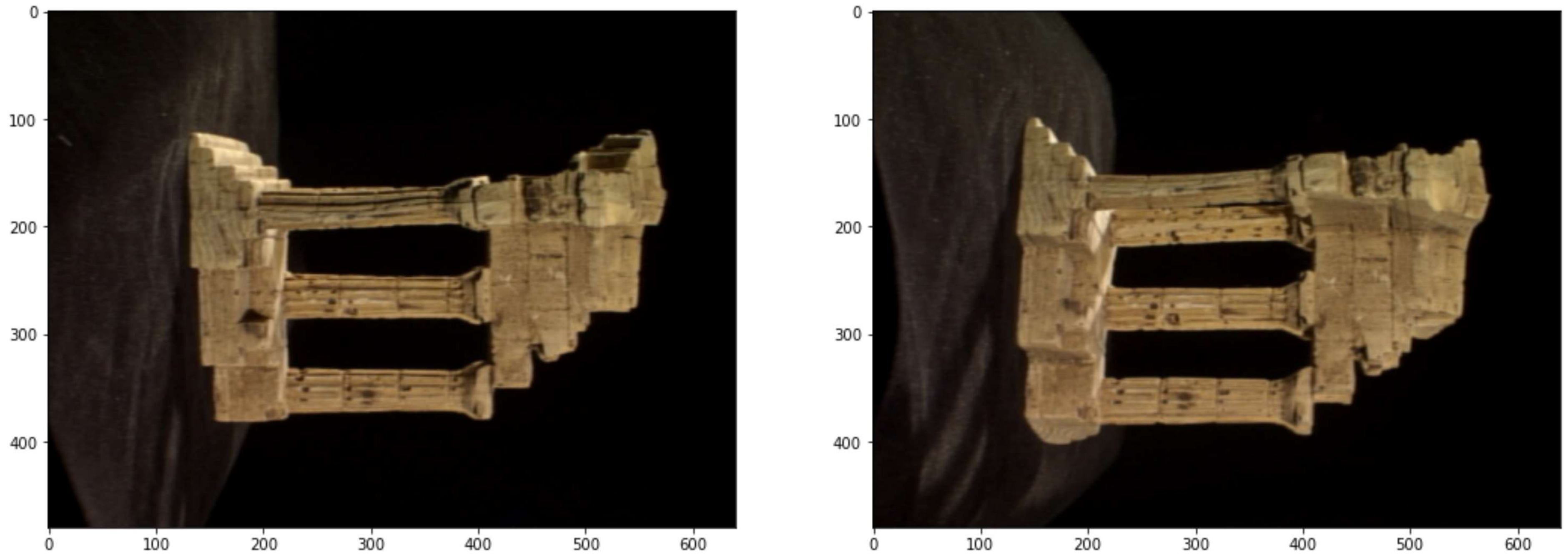
In [ ]:

```
#Q1 & Q2
import numpy as np
import matplotlib.pyplot as plt
import cv2 as cv
f = open(r'templeSparseRing/templeSR_par.txt', 'r')
assert f is not None

#first image
n = int(f.readline())
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))

#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))

fig, ax = plt.subplots( 1, 2, figsize = (18, 8))

im_1 = cv.imread(r'templeSparseRing/' + im1_fn, cv.IMREAD_COLOR)
im_2 = cv.imread(r'templeSparseRing/' + im2_fn, cv.IMREAD_COLOR)
ax[0].imshow(cv.cvtColor(im_1, cv.COLOR_BGR2RGB))
ax[1].imshow(cv.cvtColor(im_2, cv.COLOR_BGR2RGB))
plt.show()

#P1 and P2
P1 = K1 @ np.hstack((R1, t1))
P2 = K2 @ np.hstack((R2, t2))
```



In [ ]:

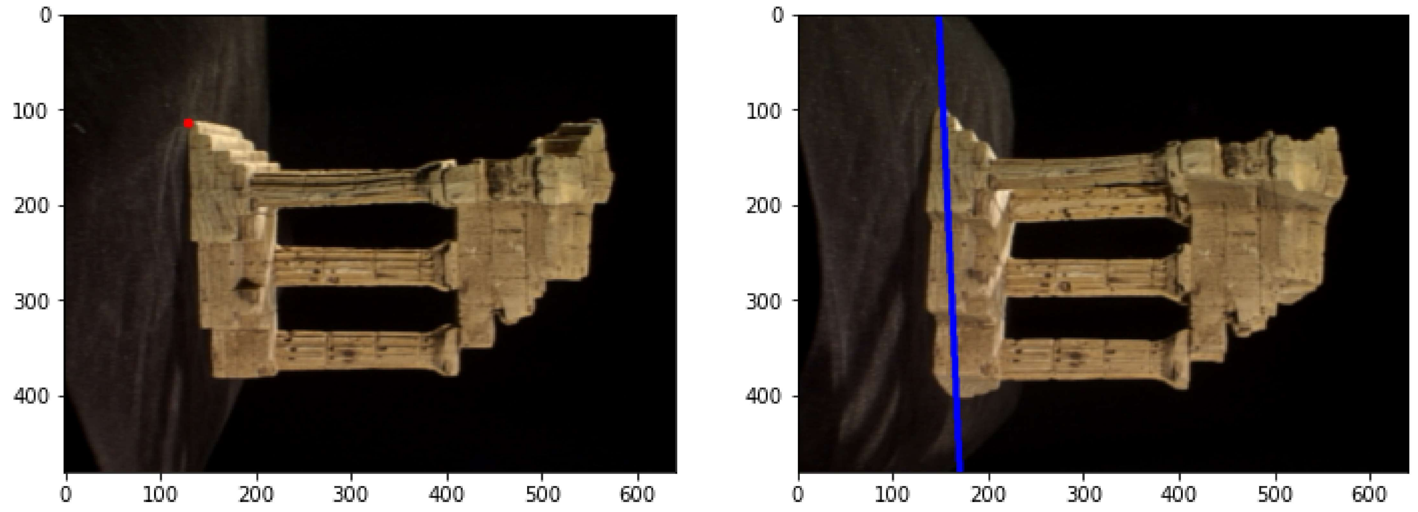
```
#Q3
from scipy.linalg import null_space
def skew(x):
    x = x.ravel()
    return np.array ([[0, -x[2], x[1]], [x[2], 0, -x[0]], [-x[1], x[0], 0]])

C = null_space(P1)
C = C * np.sign(C[0,0])
e2 = P2 @ C
e2x = skew(e2)

F = e2x @ P2 @ np.linalg.pinv(P1)
print(F)
```

```
[[-2.87071497e-04 -3.96261289e-02  2.94221686e+02]
 [-3.55039713e-02  1.65329260e-04  1.78860854e+01]
 [-2.76702814e+02  2.12942175e+01 -9.06669374e+03]]
```

In [ ]:

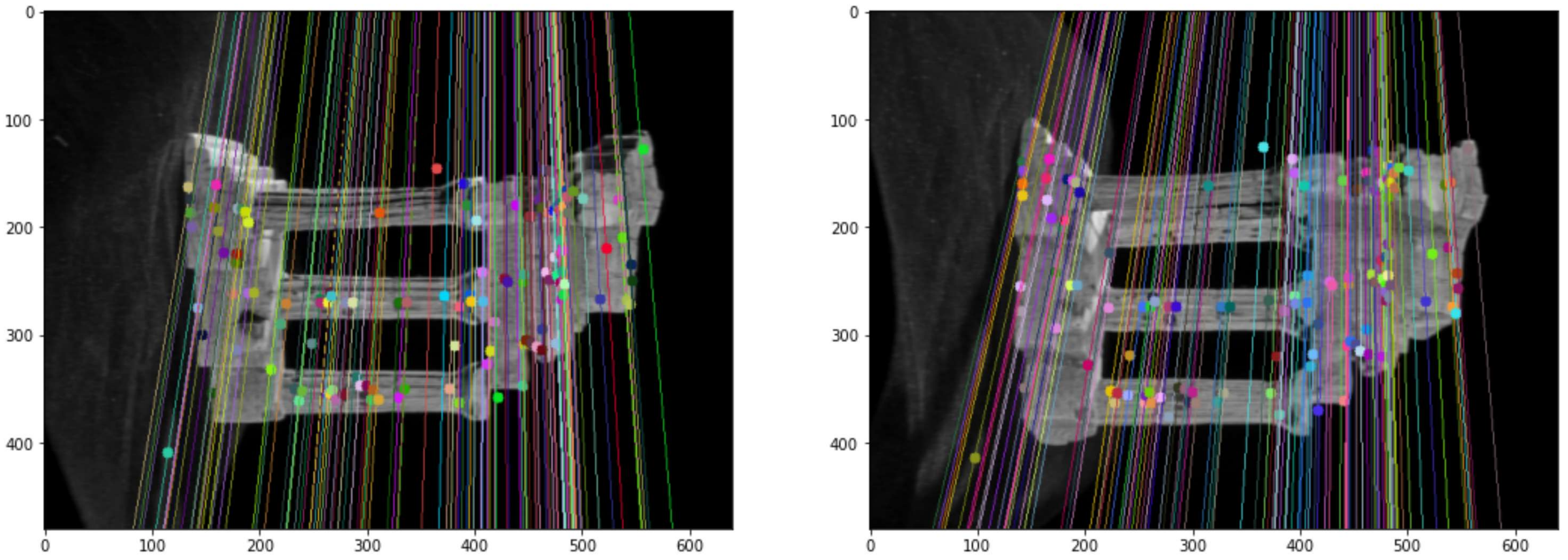
```
import matplotlib.patches as patches

x = np.array([130, 115, 1])

x = np.array([130,115,1])
cv.circle(im_1,(x[0],x[1]),5,(0,0,255),-1)

l2 = F @ x.T
```

```python
p1 = np.array([0,(l2[0]*0+l2[2])/l2[1]]).astype(int)
p2 = np.array([500,(l2[0]*500+l2[2])/l2[1]]).astype(int)
cv.line(im_2,(p1[0],p1[1]),(p2[0],p2[1]),(255,0,0),5)

fig,ax = plt.subplots(1,2,figsize=(12,10))
ax[0].imshow(cv.cvtColor(im_1,cv.COLOR_BGR2RGB))
ax[1].imshow(cv.cvtColor(im_2,cv.COLOR_BGR2RGB))
# cv.namedWindow('Im')
plt.show()
```



In [ ]:

```python
#Q4
im_1 = cv.imread(r'./templeSparseRing/'+im1_fn,0)
im_2 = cv.imread(r'./templeSparseRing/'+im2_fn,0)
sift = cv.SIFT_create()

keypoint1, descriptor1 = sift.detectAndCompute(im_1,None)
keypoint2, descriptor2 = sift.detectAndCompute(im_2,None)

FLANN_INDEX_KDTREE = 1
index_params = dict(algorithm = FLANN_INDEX_KDTREE, trees = 5)
search_params = dict(checks=50)
flann = cv.FlannBasedMatcher(index_params,search_params)
matches = flann.knnMatch(descriptor1,descriptor2,k=2)
pts1 = []
pts2 = []

for i,(m,n) in enumerate(matches):
    if m.distance < 0.8*n.distance:
        pts2.append(keypoint2[m.trainIdx].pt)
        pts1.append(keypoint1[m.queryIdx].pt)
pts1 = np.int32(pts1)
pts2 = np.int32(pts2)
F, mask = cv.findFundamentalMat(pts1,pts2,cv.FM_LMEDS)

pts1 = pts1[mask.ravel()==1]
pts2 = pts2[mask.ravel()==1]

def drawlines(im_1,im_2,lines,pts1,pts2):
    r,c = im_1.shape
    im_1 = cv.cvtColor(im_1,cv.COLOR_GRAY2BGR)
    im_2 = cv.cvtColor(im_2,cv.COLOR_GRAY2BGR)
    for r,pt1,pt2 in zip(lines,pts1,pts2):
        color = tuple(np.random.randint(0,255,3).tolist())
        x0,y0 = map(int, [0, -r[2]/r[1] ])
        x1,y1 = map(int, [c, -(r[2]+r[0]*c)/r[1] ])
        im_1 = cv.line(im_1, (x0,y0), (x1,y1), color,1)
        im_1 = cv.circle(im_1,tuple(pt1),5,color,-1)
        im_2 = cv.circle(im_2,tuple(pt2),5,color,-1)
    return im_1,im_2

lines1 = cv.computeCorrespondEpilines(pts2.reshape(-1,1,2), 2,F)
lines1 = lines1.reshape(-1,3)
im_5,img6 = drawlines(im_1,im_2,lines1,pts1,pts2)

lines2 = cv.computeCorrespondEpilines(pts1.reshape(-1,1,2), 1,F)
lines2 = lines2.reshape(-1,3)
im_3,im_4 = drawlines(im_2,im_1,lines2,pts2,pts1)
plt.figure(figsize=(18,16))
plt.subplot(121),plt.imshow(im_5)
plt.subplot(122),plt.imshow(im_3)
plt.show()
```


0
100
200
300
400
0
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200
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400
500
600
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200
300
400
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100
200
300
400
500
600