EN2550 - Fundamentals of Image Processing and Machine Vision
Assignment 2

Index Number : 190280N

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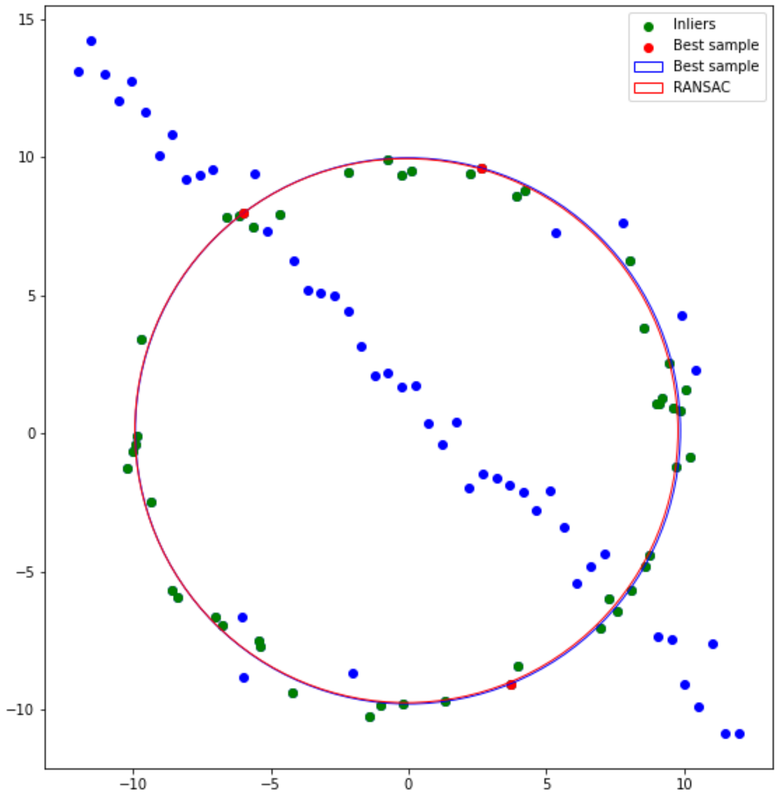
Github Link : https://github.com/Poogitha/Codings.git

In [ ]:
```
#Question 1
import numpy as np
from scipy . optimize import minimize
from scipy import linalg
import matplotlib . pyplot as plt
from skimage.measure import CircleModel, ransac
import cv2 as cv
# np.random.seed(0)
N = 100
half_n = N//2
r = 10
s = r/16
t = np.random.uniform(0,2*np.pi,half_n)
n = s*np.random.randn(half_n)
x , y = (r+n)*np.cos(t),(r+n)*np.sin(t)
X_circ = np.hstack((x.reshape(half_n,1),y.reshape(half_n,1)))
m, b = -1,2
x = np.linspace(-12,12,half_n)
y = m*x+b+s*np.random.randn(half_n)
X_line = np.hstack((x.reshape(half_n,1),y.reshape(half_n,1)))
X = np.vstack((X_circ,X_line))
```

In [ ]:
```
# RANSAC Function
class RANSAC:
        def __init__(self, x_data, y_data, n):
                self.x_data = x_data
                self.y_data = y_data
                self.n = n # n: how many times try sampling
                self.dmin = 99999
                self.bestModel = None
        def random_sampling(self):
                sample = []
                save_ran = []
                count = 0
                # get three points from data
                while True:
                        random = np.random.randint(len(self.x_data))
                        if random not in save_ran:
                                sample.append((self.x_data[random], self.y_data[random]))
                                save_ran.append(random)
                                count += 1
                                if count == 3:
                                        break
                return sample

        def make_model(self, sample): # calculate A, B, C value from three points by using matrix
                pt1 = sample[0]
                pt2 = sample[1]
                pt3 = sample[2]
                A = np.array([[pt2[0] - pt1[0], pt2[1] - pt1[1]], [pt3[0] - pt2[0], pt3[1] - pt2[1]]])
                B = np.array([[pt2[0]**2 - pt1[0]**2 + pt2[1]**2 - pt1[1]**2], [pt3[0]**2 - pt2[0]**2 + pt3[1]**2 - pt2[1]**2]])
                inv_A = np.linalg.inv(A)
                cx, cy = np.dot(inv_A, B) / 2
                cx, cy = cx[0], cy[0]
                r = np.sqrt((cx - pt1[0])**2 + (cy - pt1[1])**2)
                return cx, cy, r

        def evalModel(self, model):
                d = 0
                cx, cy, r = model
                for i in range(len(self.x_data)):
                        dis = np.sqrt((self.x_data[i]-cx)**2 + (self.y_data[i]-cy)**2)
                        if dis >= r:
                                d += dis - r
                        else:
                                d += r - dis
                return d

        def execute_ransac(self):
                for i in range(self.n):
                        sample=self.random_sampling()
                        model = self.make_model(sample)
                        dtemp = self.evalModel(model)
                        if self.dmin > dtemp:
```

```
                    self.bestModel = model
                    self.dmin = dtemp
                    best_sample=sample
        return best_sample
```

In [ ]:
```
size=len(X[:,0])
ransac = RANSAC(X[:,0],X[:,1], 80)
sample = ransac.execute_ransac()# execute ransac algorithm
a, b, r = ransac.bestModel[0], ransac.bestModel[1], ransac.bestModel[2] # get best model from ransac
threshold=0.8
inliers=[]
for i in range(size):
        if np.sqrt((X[i,0]-a)**2+(X[i,1]-b)**2)<r+threshold and np.sqrt((X[i,0]-a)**2+(X[i,1]-b)**2)>r-threshold:
                inliers.append(np.array(X[i]))
inliers=np.array(inliers)
# show result
plt.figure(figsize=(10,10)),plt.scatter(X[:,0],X[:,1],c='blue', marker='o')
plt.scatter(inliers[:,0],inliers[:,1],c='g',marker='o',label='Inliers')

ransac = RANSAC(inliers[:,0],inliers[:,1], 80)
sample2 = ransac.execute_ransac()
for i in range(len(sample2)):
        sample2[i]=np.array(sample2[i])
sample2=np.array(sample2)
plt.scatter(sample2[:,0],sample2[:,1],c='r',marker='o',label='Best sample')
# get best model from ransac
a_best, b_best, r_best = ransac.bestModel[0], ransac.bestModel[1], ransac.bestModel[2]
circle = plt.Circle((a_best, b_best), radius=r_best, color='b', fc='y', fill=False,label='Best sample')
plt.gca().add_patch(circle)
circle = plt.Circle((a, b), radius=r, color='r', fc='y', fill=False,label='RANSAC')
plt.gca().add_patch(circle),plt.axis('scaled'),plt.legend(),plt.show()
```



Out[ ]:
```
(<matplotlib.patches.Circle at 0x21a57e49cc0>,
 (-13.2, 13.2, -12.124720958059287, 15.50228513710837),
 <matplotlib.legend.Legend at 0x21a57e4a170>,
 None)
```

In [ ]:
```
# Question 2
count=1
def click_event(press, x, y, flags, params):
    global count
    if press == cv.EVENT_LBUTTONDOWN:
        print('Point ',count,'= [',x, ',', y,']')
        count+=1
        cv.imshow('image', background)
    if press==cv.EVENT_RBUTTONDOWN:
        print('Point ',count,'= [',x, ',', y,']')
        count+=1
        cv.imshow('image', background)
background = cv.imread(r"Images/images/001.jpg",cv.IMREAD_ANYCOLOR)
```

```
print('Four points in the architectural image')
cv.imshow('image', background),cv.setMouseCallback('image', click_event),cv.waitKey(0),cv.destroyAllWindows()
```

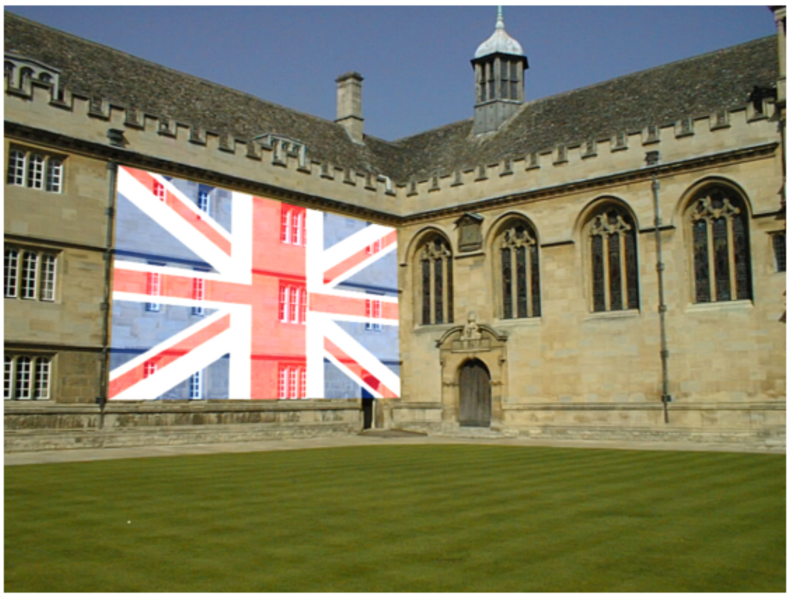
```
Four points in the architectural image
Point  1 = [ 151 , 209 ]
Point  2 = [ 514 , 292 ]
Point  3 = [ 138 , 516 ]
Point  4 = [ 519 , 513 ]
```

Out[ ]:

```
(None, None, 48, None)
```

In [ ]:

```
def ImageBoarder(image):
    boarder = np.zeros((4, 1, 2), dtype=np.float32)
    (width, length, _) = image.shape
    boarder[0] = (0, 0)
    boarder[1] = (0, width)
    boarder[2] = (length, 0)
    boarder[3] = (length, width)
    return boarder
rows,cols,ch = background.shape
img = cv.imread(r"Images/Flag_of_the_United_Kingdom.svg.png",cv.IMREAD_ANYCOLOR)
pts1=np.float32(ImageBoarder(img))
pts2 = np.float32([[151 , 209],[514 , 292],[138 , 516],[519 , 513]]) # Change the coordinates here
M = cv.getPerspectiveTransform(pts1,pts2)
dst = cv.warpPerspective(img,M,(cols,rows))
overlay = cv.add(background, dst)
plt.figure(figsize=(10,10)),plt.imshow(cv.cvtColor(overlay,cv.COLOR_BGR2RGB)),plt.axis('off'),plt.show()
```



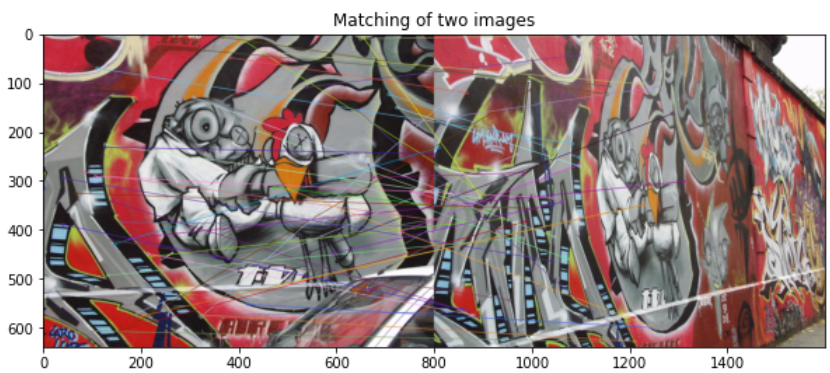
Out[ ]:

```
(<Figure size 720x720 with 1 Axes>,
 <matplotlib.image.AxesImage at 0x21a59f07280>,
 (-0.5, 1023.5, 767.5, -0.5),
 None)
```

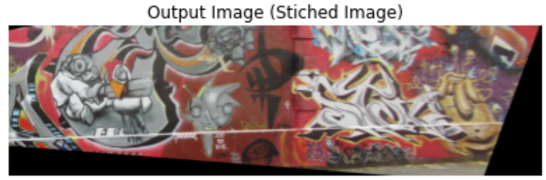
In [ ]:

```
# Question 3
img1 = cv.imread(r"Images/graf/img1.ppm",cv.IMREAD_ANYCOLOR)
img5 = cv.imread(r"Images/graf/img5.ppm",cv.IMREAD_ANYCOLOR)
sift = cv.SIFT_create() #sift
keypoints_1, descriptors_1 = sift.detectAndCompute(img1,None)
keypoints_5, descriptors_5 = sift.detectAndCompute(img5,None)

#feature matching
bf = cv.BFMatcher(cv.NORM_L1, crossCheck=True)
matches = bf.match(descriptors_1,descriptors_5)
matches = sorted(matches, key = lambda x:x.distance)
img = cv.drawMatches(img1, keypoints_1, img5, keypoints_5, matches[:50], img5, flags=2)
plt.figure(figsize=(10,10))
plt.imshow(cv.cvtColor(img,cv.COLOR_BGR2RGB))
plt.title('Matching of two images'),plt.show()

# find the Homography matrix given in the dataset
H=[]
with open(r"Images/graf/H1to5p") as f:
    H=np.array([[float(h) for h in line.split()] for line in f])

# Compute Homography matrix using RANSAC
def warpImages(img1, img2, H):
  rows1, cols1 = img1.shape[:2]
  rows2, cols2 = img2.shape[:2]
  list_of_points_1 = np.float32([[0,0], [0, rows1],[cols1, rows1], [cols1, 0]]).reshape(-1, 1, 2)
  temp_points = np.float32([[0,0], [0,rows2], [cols2,rows2], [cols2,0]]).reshape(-1,1,2)
```

```
  # When we have established a homography we need to warp perspective
  list_of_points_2 = cv.perspectiveTransform(temp_points, H) # Change field of view
  list_of_points = np.concatenate((list_of_points_1,list_of_points_2), axis=0)
  [x_min, y_min] = np.int32(list_of_points.min(axis=0).ravel() - 0.5)
  [x_max, y_max] = np.int32(list_of_points.max(axis=0).ravel() + 0.5)
  translation_dist = [-x_min,-y_min]
  H_translation = np.array([[1, 0, translation_dist[0]], [0, 1, translation_dist[1]], [0, 0, 1]])
  output_img = cv.warpPerspective(img2, np.linalg.inv(H_translation.dot(H)), (2500,700))#(x_max-x_min, y_max-y_min)
  output_img[translation_dist[1]:rows1+translation_dist[1], translation_dist[0]:cols1+translation_dist[0]] = img1
  return output_img,H_translation.dot(H)
img1_gray = cv.cvtColor(img1,cv.COLOR_BGR2GRAY)
img5_gray = cv.cvtColor(img5,cv.COLOR_BGR2GRAY)
sift = cv.xfeatures2d.SIFT_create()
kp1, des1 = sift.detectAndCompute(img1_gray,None)
kp2, des2 = sift.detectAndCompute(img5_gray,None)
bf = cv.BFMatcher()
matches = bf.knnMatch(des1,des2, k=2)
good = []
for m in matches:
    if (m[0].distance < 0.6*m[1].distance):
        good.append(m)
matches = np.asarray(good)
if (len(matches[:,0]) >= 4):
    src = np.float32([ kp1[m.queryIdx].pt for m in matches[:,0] ]).reshape(-1,1,2)
    dst = np.float32([ kp2[m.trainIdx].pt for m in matches[:,0] ]).reshape(-1,1,2)
    H1, masked = cv.findHomography(src, dst, cv.RANSAC, 5.0)
else:
    raise AssertionError('Can’t find enough keypoints.')
output,H_ransac=warpImages(img1, img5,H1)
fig,ax=plt.subplots(1,2,figsize=(15,15))
ax[0].imshow(cv.cvtColor(output,cv.COLOR_BGR2RGB))
ax[0].set_title("Output Image (Stiched Image) using RANSAC")
ax[0].axis('off')
im1to5=cv.warpPerspective(img5,np.linalg.inv(H),(2500,700)) # Stitch img1 onto img5
ax[1].imshow(cv.cvtColor(im1to5,cv.COLOR_BGR2RGB))
ax[1].set_title("Output Image (Stiched Image)")
ax[1].axis('off'),plt.show()
print("Homography matrix given in the data set = :","\n",H)
print("Homography matrix using RANSAC = :","\n",H_ransac)
print("Difference between two homography matrices = ","\n",H-H_ransac)
```




Output Image (Stiched Image) using RANSAC


Output Image (Stiched Image)

```
Homography matrix given in the data set = :
 [[ 6.2544644e-01  5.7759174e-02  2.2201217e+02]
 [ 2.2240536e-01  1.1652147e+00 -2.5605611e+01]
 [ 4.9212545e-04 -3.6542424e-05  1.0000000e+00]]
Homography matrix using RANSAC = :
 [[-3.23108707e-01 -2.85732797e+00  3.77353418e+02]
 [-3.33565684e-01 -4.82169028e+00  5.08855022e+02]
 [-7.62678679e-04 -1.00593131e-02  1.00000000e+00]]
Difference between two homography matrices =
 [[ 9.48555147e-01  2.91508715e+00 -1.55341248e+02]
 [ 5.55971044e-01  5.98690498e+00 -5.34460633e+02]
 [ 1.25480413e-03  1.00227706e-02  0.00000000e+00]]
```