Lab Instructions - session 12

Feature-based Image Alignment, RANSAC

Robust estimation with RANSAC

Remember how SIFT feature points were matched in two images. Look at the code below to remind yourself. Run the file and see the result.

File: **sift_match_ransac.py**

```
import numpy as np
import cv2

I1 = cv2.imread('obj3.jpg')
G1 = cv2.cvtColor(I1,cv2.COLOR_BGR2GRAY)

I2 = cv2.imread('scene.jpg')
G2 = cv2.cvtColor(I2,cv2.COLOR_BGR2GRAY)

sift = cv2.xfeatures2d.SIFT_create() # opencv 3
# use "sift = cv2.SIFT()" if the above fails

# detect keypoints and compute their descriptor vectors
keypoints1, desc1 = sift.detectAndCompute(G1, None); # opencv 3
keypoints2, desc2 = sift.detectAndCompute(G2, None); # opencv 3

print("No. of keypoints1 =", len(keypoints1)
print("No. of keypoints2 =", len(keypoints2)

print("Descriptors1.shape =", desc1.shape
print("Descriptors2.shape =", desc2.shape

# stop here!!
exit() # comment this line out to move on!

# brute-force matching
bf = cv2.BFMatcher()

# for each descriptor in desc1 find its
# two nearest neighbors in desc2
matches = bf.knnMatch(desc1,desc2, k=2)

good_matches = []
alpha = 0.75
for m1,m2 in matches:
    # m1 is the best match
    # m2 is the second best match
    if m1.distance < alpha *m2.distance:
        good_matches.append(m1)
```

- RANdom SAmple Consensus: randomly pick some points to define your line (model). Repeat enough times until you find a good line (model) – on with many inliers.

cv2.findHomography() estimating the homography matrix (H) using RANSAC Algorithm to robustly find the transformation between two sets of corresponding points in two images.

```
# apply RANSAC
# points1 = [keypoints1[m.queryIdx].pt for m in good_matches]
# points1 = np.array(points1,dtype=np.float32)

# points2 = [keypoints2[m.trainIdx].pt for m in good_matches]
# points2 = np.array(points2,dtype=np.float32)
# H, mask = cv2.findHomography(points1, points2, cv2.RANSAC,5.0) # 5 pixels margin
# mask = mask.ravel().tolist()
# print(mask)

good_matches = [m for m,msk in zip(good_matches,mask) if msk == 1]

I = cv2.drawMatches(I1,keypoints1,I2,keypoints2, good_matches, None)

cv2.imshow('sift_keypoints1',I)
cv2.waitKey(0)
```

As you can see, even after removing a number of false matches using the distance ratio test (`m1.distance < alpha *m2.distance`), some of the mismatches still persist. We want to remove them using RANSAC. Since we know that the transformation between the source and target objects is a **homography,** we can use the function `cv2.findHomography` with the option `cv2.RANSAC` to remove the outliers and estimate a homography `H`. Uncomment the following lines from the code. It redefines the list **good_matches** by further removing the outliers using RANSAC. Rerun the code to draw the new "good_matches" and see the result.

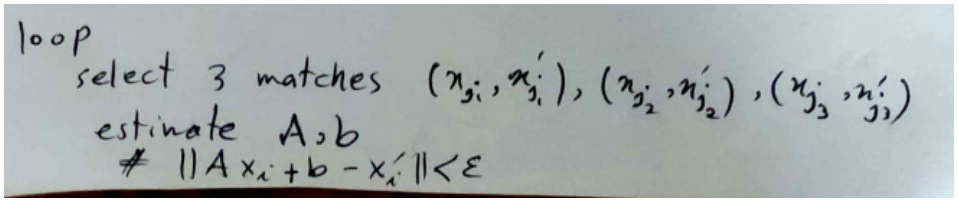
```
# apply RANSAC
points1 = [keypoints1[m.queryIdx].pt for m in good_matches]
points1 = np.array(points1,dtype=np.float32)

points2 = [keypoints2[m.trainIdx].pt for m in good_matches]
points2 = np.array(points2,dtype=np.float32)

H, mask = cv2.findHomography(points1, points2, cv2.RANSAC,5.0)

mask = mask.ravel().tolist()

good_matches = [m for m,msk in zip(good_matches,mask) if msk == 1]
```

- Remember, for every member **m** of the list **good_matches**, **m.queryIdx** and **m.trainIdx** were the indices of the key points in the first and second images respectively. What is `keypoints1[m.queryIdx].pt`? What are the shapes of `points1` and `points2`?
- Print the variable `mask`. What does it represent? A mask indicating which points are inliers after RANSAC estimation.
- What does the following line do?

```
good_matches = [m for m,msk in zip(good_matches,mask) if msk == 1]
```

cv2.RANSAC: A flag indicating the robust estimation method to be used. In this case, RANSAC is selected.

5.0: A parameter indicating the maximum allowed reprojection error (in pixels) to consider a point an inlier during RANSAC estimation.



Task 1: Image alignment

We want to transform the first image to its location in the second image. This can be done using the **cv2.warpPerspective** function you used before and the transformation matrix **H** obtained using RANSAC. Complete the following code to do this. The code alternatingly displays the second image and the transformed source object. In the current code, the homography **H** is just the identity matrix. You need to set it to the correctly estimated homography.

File: **task1.py**

```
import numpy as np
import cv2
import glob

sift = cv2.xfeatures2d.SIFT_create() # opencv 3
# use "sift = cv2.SIFT()" if the above fails

I2 = cv2.imread('scene.jpg')
G2 = cv2.cvtColor(I2,cv2.COLOR_BGR2GRAY)

keypoints2, desc2 = sift.detectAndCompute(G2, None); # opencv 3

fnames = glob.glob('obj?.jpg')
fnames.sort()
for fname in fnames:
    I1 = cv2.imread(fname)
    G1 = cv2.cvtColor(I1,cv2.COLOR_BGR2GRAY)
    keypoints1, desc1 = sift.detectAndCompute(G1, None); # opencv 3

    H = np.eye(3,dtype=np.float32) # this needs to be changed!!

    J = cv2.warpPerspective(I1, H, (I2.shape[1],I2.shape[0]) )

    # alternatingly show images I2 and J
    ind = 0;
    imgs = [I2, J]
    while 1:
        ind = 1-ind

        cv2.imshow('Reg',imgs[ind])
        key =  cv2.waitKey(800)

        if key & 0xFF == ord('q'):
            exit()
        elif key & 0xFF != 0xFF:
           break
```

Task 2: Draw object outline

In this task, we want to draw the outline of each object in the scene. The outline (a quadrilateral) can be drawn by drawing four lines with the **cv2.line** function. The four corners of the first image can be transformed to their locations in the second image using the function **cv2.perspectiveTransform** (look at the code). Notice that this function accepts the points in the form of **(x,y)** and not **(y,x)**. Complete the following to perform Task 2.

File: **task2.py**

```
import numpy as np
import cv2
import glob

sift = cv2.xfeatures2d.SIFT_create() # opencv 3
# use "sift = cv2.SIFT()" if the above fails

I2 = cv2.imread('scene.jpg')
G2 = cv2.cvtColor(I2,cv2.COLOR_BGR2GRAY)
keypoints2, desc2 = sift.detectAndCompute(G2, None); # opencv 3

fnames = glob.glob('obj?.jpg')
fnames.sort()
for fname in fnames:

    I1 = cv2.imread(fname)
    G1 = cv2.cvtColor(I1,cv2.COLOR_BGR2GRAY)
```

```
keypoints1, desc1 = sift.detectAndCompute(G1, None); # opencv 3

# brute-force matching
bf = cv2.BFMatcher()

# for each descriptor in desc1 find its
# two nearest neighbors in desc2
matches = bf.knnMatch(desc1,desc2, k=2)

# distance ratio test
alpha = 0.75
good_matches=[m1 for m1,m2 in matches if m1.distance < alpha *m2.distance]

points1 = [keypoints1[m.queryIdx].pt for m in good_matches]
points1 = np.array(points1,dtype=np.float32)

points2 = [keypoints2[m.trainIdx].pt for m in good_matches]
points2 = np.array(points2,dtype=np.float32)

H, mask = cv2.findHomography(points1, points2, cv2.RANSAC,5.0)

H = np.eye(3,dtype=np.float32) # this needs to be changed
pts = np.float32([[100,100],
                  [100,400],
                  [400,400],
                  [400,100] ]).reshape(-1,1,2) # this needs to be changed

dst = cv2.perspectiveTransform(pts,H).reshape(4,2)

J = I2.copy()
cv2.line(J, (dst[0,0], dst[0,1]), (dst[1,0], dst[1,1]), (255,0,0),3)
cv2.line(J, (dst[1,0], dst[1,1]), (dst[2,0], dst[2,1]), (255,0,0),3)
cv2.line(J, (dst[2,0], dst[2,1]), (dst[3,0], dst[3,1]), (255,0,0),3)
cv2.line(J, (dst[3,0], dst[3,1]), (dst[0,0], dst[0,1]), (255,0,0),3)


I = cv2.drawMatches(I1,keypoints1,J,keypoints2,good_matches, None)

cv2.imshow('keypoints',I)

if cv2.waitKey() & 0xFF == ord('q'):
    break
```