Introduction to Image Understanding Homework 3

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By turning in this assignment, I agree by the Stanford honor code and declare that all of this is my own work.

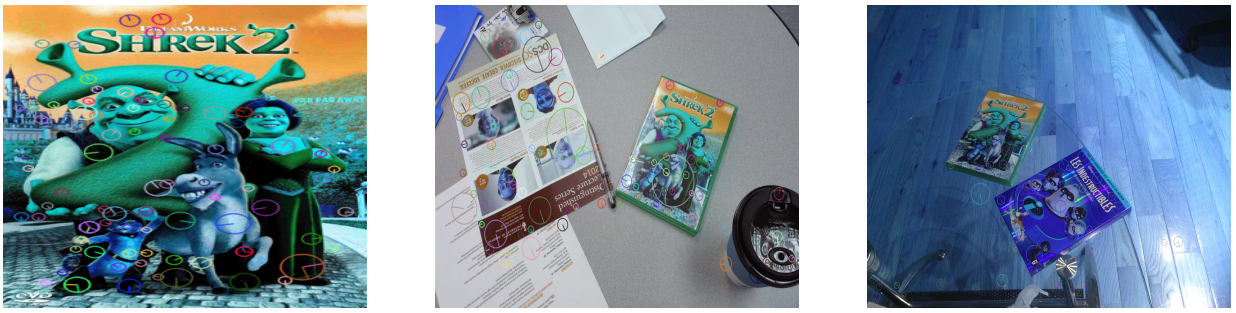
Problem 1

(a) **Feature Extraction**: Write a function to extract *Sift features*.

```
def get_sift_features(Img):
"""
Wrapper function to get the SIFT features on the image
"""

if Img.ndim == 3:
#convert the image to grayscale
Img = cv2.cvtColor(Img, cv2.COLOR_BGR2GRAY)

#¢reating the sift instance
sift = cv2.xfeatures2d.SIFT_create()

#getting the keypoints
kp = sift.detect(Img, None)

return kp



def q1():
"""
Question 1 compute the SIFT keypoints
"""

#filenames
names = ["reference.png", "test.png", "test2.png"]
sift_names  = ['ref_sift.png', 'test_sift.png', 'test2_sift.png']

#images
Imgs = list(map(cv2.imread, names))

for img, siftname in zip(Imgs, sift_names):
print("Processing img : {}".format(siftname))
kp = get_sift_features(img)
out = img[0].copy()
cv2.drawKeypoints(img, kp[-100:], outImage = out, flags=cv2.DRAW_MATCHES_FLAGS_DRAW_RICH_KEYPOINTS)
```

(b) Propose a simple **matching** algorithm:

I will use the simple matching algorithm that compute the **distances** between referenced image and the template. A match is detected is the ratio between the **closest** and next **closest** is inferior to a given constant C. Also the matches will be sorted according to distances to their associated points.



(a) reference (b) test1 (c) test2

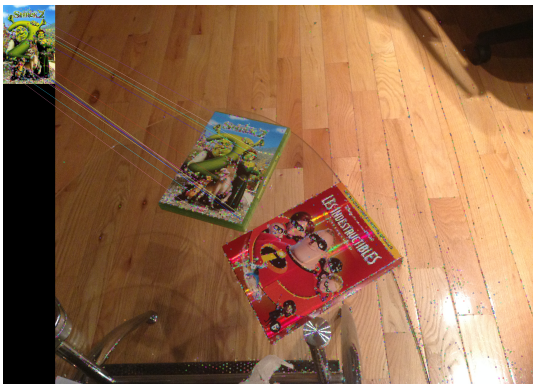
Figure 1: Features Extraction by the SIFT method

```python
def match_descriptors(desc1, desc2, threshold=0.5):
    """
    Match the feature descriptors by finding distances between them. A match is formed
    when the distance to the closest vector is much smaller than the distance to the
    second-closest, that is, the ratio of the distances should be smaller
    than the threshold. Return the matches as pairs of vector indices.

    Args:
        desc1: an array of shape (M, P) holding descriptors of size P about M keypoints
        desc2: an array of shape (N, P) holding descriptors of size P about N keypoints

    Returns:
        matches: an array of shape (Q, 2) where each row holds the indices of one pair
        of matching descriptors
    """
    matches = []

    N = desc1.shape[0]
    dists = cdist(desc1, desc2)

    for i in range(N):
        #getting the indices for the smallest distance
        m1,m2 = np.argsort(dists[i,:])[:2]

        # computing the ratio
        ratio = dists[i,m1]/dists[i,m2]

        #adding the match
        if(ratio<threshold):
            matches.append((i,m1))

    return np.array(matches)
```

(c) Find the affine transform between the matches

```python
def find_affine_transform(kp1, kp2, matchs):
    """
    Function to find the affine transform between the set of kp1 and kp2
    """

    X = np.array([kp1[i].pt for i in matchs[:3,0]]).T
    #padding X
```

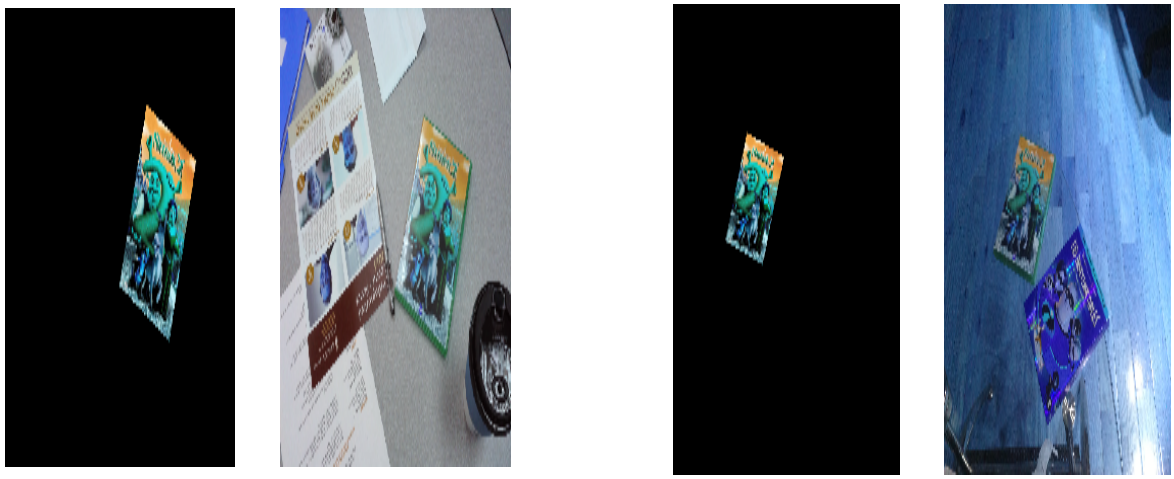
(a) Test1



(b) Test2

Figure 2: Matching with distances

```
    X = np.r_[X, np.ones((1,3))]
    Y = np.array([kp1[i].pt for i in matchs[:3,1]]).T
    Y = np.r_[Y, np.ones((1,3))]

    #compute the transofmration matrix
    H = np.linalg.lstsq(X,Y, rcond=None)[0]
    return H

def q3():
    """
    Find affine transformation between template and figure
    """

    template = cv2.imread("./reference.png")
    kp1,desc1 = get_sift_features(template)

    #reference
    ref = cv2.imread("./test.png")
    kp2, desc2 = get_sift_features(ref)



    #matching desciptors
    matchs = match_descriptors(desc1, desc2)

    #getting the keypoints as (x, y)
    H = find_affine_transform(kp1, kp2, matchs)


    return H
```



(a) Test 1 (b) Test 2

Figure 3: Transformation by the first matches