

Spring 2023 – CMPE 362/CS563 Digital Image Processing  
Assignment 4

Due Date: June 11th, 2023 at 23:59

This assignment is to be done either individually or in pairs.

If you work in pairs, only one group member should do the submission. Names of both members should be included both in the codes and in the report.

In this assignment, you will implement image stitching which is the process of combining multiple photographic images with overlapping fields of view to produce a panorama image.

### Preparing data

Download the image stitching data (`input_set1.zip` and `input_set2.zip`) from Moodle.

For each input set, first display the pair of input images.



### Detection and description of local features

Run Scale Invariant Feature Transform (SIFT) on each image to obtain a set of interest points along with a 128-dimensional feature vector describing each interest point. Each image can contain a different number of interest points.

- First, initiate SIFT detector using `create` method of `SIFT` class with its default parameters.
- Then, use `detectAndCompute` method of `SIFT` class for computing keypoints and descriptors of each image. In this step, you should use grayscale versions of the images.

### Feature matching

Find the matching between the interest points you have found in the previous step.

- First, initiate **BFMatcher** with its default parameters. Then, use **knnMatch** method of **BFMatcher** by choosing **k=2**. In this way, for each keypoint **k\_f** in the first image, you find the closest two keypoints **k\_s\_1** and **k\_s\_2** in the second image.
- Apply ratio test and determine good matches as follows. For each keypoint **k\_f** in the first image, if its distance to the first matched point **k\_s\_1** is smaller than half of its distance to the second matched point **k\_s\_2**, then the matching between the keypoint **k\_f** and the first matched point **k\_s\_1** is added to the list of good matches.
- Visualize the good matches between the two images using **drawMatchesKnn** function.



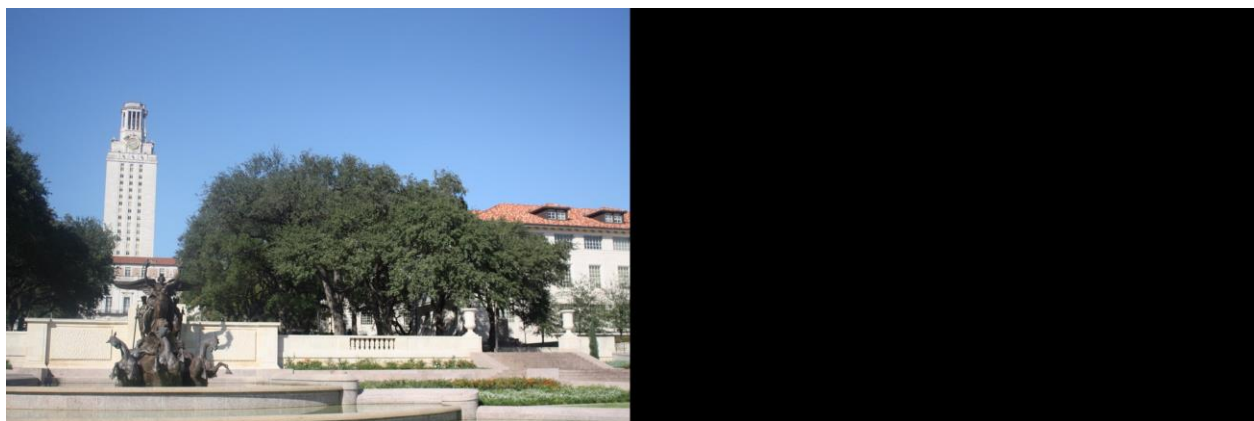
### Image registration

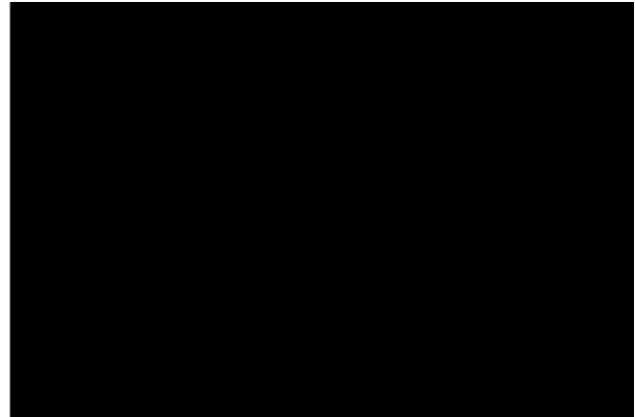
- Take the good matchings between the input images. Use **estimateAffine2D** function to estimate affine geometric transform from the coordinates of matching pairs of interest points.
- Using transformation matrix returned by **estimateAffine2D** function, transform the second image by calling **warpAffine** function. Choose **flags** parameter as **cv2.WARP\_INVERSE\_MAP** and **dsize** parameter as   
`(rgb1.shape[1]+rgb2.shape[1], max(rgb1.shape[0], rgb2.shape[0]))`  
where **rgb1** and **rgb2** represent the first and the second image, respectively.
- Create a mask image as a matrix of ones whose number of rows and columns are the same as the second image. Transform this mask image as in the previous step.
- Visualize the second image and its mask after the transformation.



### Combining Registered Images

- Now extend the first image so that its number of rows and columns becomes the same as the transformed form of the second image.
- Also create a mask whose number of rows and columns are the same as the transformed form of the second image. Mask is 1 on the pixels on which the first image takes value and 0 elsewhere.
- Visualize the extended first image and its corresponding mask.





- Now combine the extended first image and the transformed form of the second image by taking their average value on the pixels where they overlap. **You will implement this part yourself without using any available functions.**
- Visualize the combination result.



**Note: All classes, methods, functions mentioned in this assignment text are included in OpenCV library.**

**What to hand in:**

- Codes  
hw4\_input1.ipynb  
hw4\_input2.ipynb  
These ipynb files should include all the codes and the results for each input image.
- Report  
In your report, you are expected to include the following information:
  - Brief explanation of what you have done
  - The results that you have obtained together with the corresponding parameters
  - Discussion of the results

It is important that you include all your results and discussion in the report.