UNIVERSITY OF AMSTERDAM

ASSIGNMENT 4

Image Alignment & Stitching

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Course:
Computer Vision 1

1 Introduction

In this assignment, we are intending to find keypoints between given two images that have a region of overlap between them using Feature detectors such as SIFT [1] and compute the Homography matrix and perform affine transformation between the two images using algorithms. In the last section, we stitch the input images by observing the feautres, orientation, matchings, inliers, homography matrix between the two images.

2 Image Alignment

Question 1.1 and **Question 1.2** In this section, we make use of feature descriptors, like SIFT[1], to detect the keypoints matches between two images. We see the two given boat images 'boat1.pgm' and 'boat2.pgm' in Fig. 1a and Fig. 1b respectively. We observe they have considerable overlapping, as well as slightly different orientation and scaling. Initially, we are required to find keypoints in both images using SIFT and match the corresponding points using matchers like OpenCV's BF Matcher that match them using a distance metric. In Fig. 1c we plot the random matches that we observe between the input images. We observe that SIFT is able to find keypoints between the images although there is change in scale, orientation, position of objects etc. Similarly, in Fig. 2 we observe the keypoint matches between the two given bus images and plot the random matches between two images.

(a) Input Image - Boat 1

(b) Input Image - Boat 2

(c) Key point matching between the images

Figure 1: Input images of Boat and the matches between the images using SIFT.

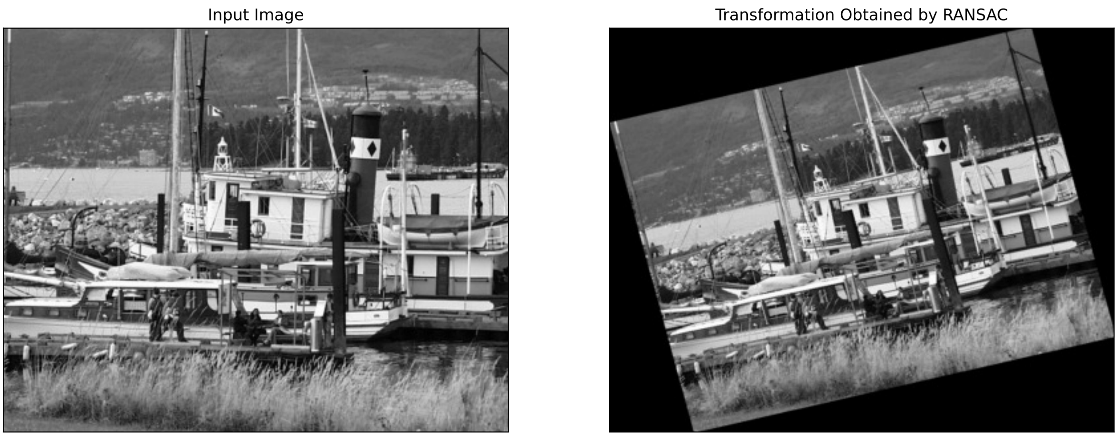
(a) Input Image - Bus 1

(b) Input Image - Bus 2

(c) Key point matching between the images

Figure 2: Input images of Bus and the matches between the images using SIFT

Question 1.3 We observe from Fig. 1a and Fig. 1b that the input images of the boats have some amount of overlap between them as well as common features. Therefore, we make use of SIFT[1] to extract the features from both the images. Further, we match them using a matcher such as BF.Matcher or Flann based matcher and filter the relevant matches using a distance metric. Finally, we make use of RANSAC algorithm to detect the inliers, which we use to compute the homography matrix between the two images. We then warp the images using the Input Image of Fig. 1a and the homography matrix and transform it and obtain the image result as shown in Fig. 3a. We observe that the image has aligned itself to the scene and correspondence that is similar to the right input image of the boat. Similarly we also obtain Fig. 3b by taking the inverse of the homography matrix that we obtained previously and warping the image to the new inverse of homography matrix.



(a) Boat Image 'Left' transformed using the homography matrix

(b) Boat Image 'Right' transformed using the homography matrix

Figure 3: Transformations obtained

Question 2.1 We need at least 3 matched pairs of keypoints. That is because we want to find an affine transformation between the two images, which has 6 degrees of freedom, and hence is modeled with 6 unknowns. Each keypoint gives us 2 equations, and therefore we need at least 3 of those for the system of equations to have a unique solution.

Question 2.2 We can't exactly quantify the number of iterations the algorithm would take since it depends a lot on the specific dataset we are using, the key points between the images etc. However, we observed that it depends a lot on two variables: the *number of matching pairs* and the *threshold*; if we choose smaller number of matching pairs for the iteration we can find a good transformation. We can also increase the value of threshold variable such that only the best points are returned that gives us the inliers quickly.

Figure 4: Image obtained using cv2 warp function

3 Image Stitching

In this part, we explore how to stitch an image using the aforementioned topics such as use of SIFT [1] to find the keypoint in the images, matching them using a matcher like OpenCV's BF Matcher, KNN Matcher and filter the matches to obtain the good matches only using a distance metric and compute the homography matrix M that helps us in plotting the canvas of the resultant stitched image, warp the images in a perspective manner using the key points generated.

(a) Input Image - Bus 1

(b) Input Image - Bus 2

Figure 5: Input images of Bus for the image stitching

Fig. 6 shows the obtained the stitched image. We can further improvise the stitched image by making use of image pre-processing filters like Histogram Equalizer, Image normalisation, using a good criterion to filter the matches between the images that are obtained by SIFT[1], warping the images using a cylindrical perspective if the image scene demands etc. We can also make use of techniques like image blending so as to fix the color difference between the images especially at the area of overlap between the two images that usually occurs due to camera hardware and capture.

Figure 6: Obtained Image for Image Stitching

4 Conclusion

In this assignment, we observed how we can find features that are common between two input images, and make use of these features to do meaningful things like estimating and visualising the common features between the two images, filter these matches using algorithms like RANSAC to obtain the inliers only and use them to calculate the homography matrix that helps us in transforming one image to mimic the other image's orientation, scene etc. Comparing to the built-in functions of OpenCV we get comparable results for the transformation of images. In the last section, we observe how two images that have an overlap region between them can be combined such that a panorama or a stitched image can be obtained. We observed how to estimate the coordinates of the new stitched images since it is not just the addition of image 1 and image 2 but we should also make use of overlap region to calculate the new coordinates of the stitched image and superimpose one image onto another.

References

[1] David G Lowe. Distinctive image features from scale-invariant keypoints. *International journal of computer vision*, 60(2):91–110, 2004.