BBM 418 - Computer Vision Laboratory
2022 Spring
Assignment 2

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1 Introduction

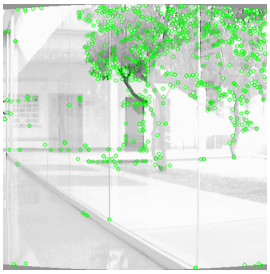
In this assignment, it is tried to obtain a panorama picture by combining more than one photograph with certain techniques. Different keypoint description methods will be used in this technique. The results will be compared with the original images, and information and comments about the assignment will be given in the conclusion section.

2 Main Steps

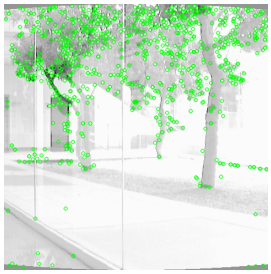
The technique used will be explained in the following steps by referring to the algorithms respectively. A separate file is opened in the code file for each step.

2.1 Feature Extraction

Two images were read with the help of OpenCV library. Keypoints are discovered for these two images. Keypoints are algorithms that detect the locations of important areas in images. Two keypoint description methods are used in this assignment. These are Scale-Invariant Feature Transform (SIFT) and Oriented FAST and Rotated BRIEF (ORB). In 2004, D.Lowe, University of British Columbia, came up with a new algorithm, Scale Invariant Feature Transform (SIFT) in his paper, Distinctive Image Features from Scale-Invariant Keypoints, which extract keypoints and compute its descriptors. ORB algorithm was brought up by Ethan Rublee, Vincent Rabaud, Kurt Konolige and Gary R. Bradski in their paper ORB: An efficient alternative to SIFT or SURF in 2011.



(a) Keypoints of the first image



(b) Keypoints of the second image

Figure 1: A keypoint analysis obtained with the SIFT algorithm.

2.2 Feature Matching

In this step, the BFMatcher function of the OpenCV library was used. With the help of this function, points that are likely to match are determined. These points are inspected, and pass the distance test. If the distance is above a certain rate, it stays, if it is below it, it is discarded.

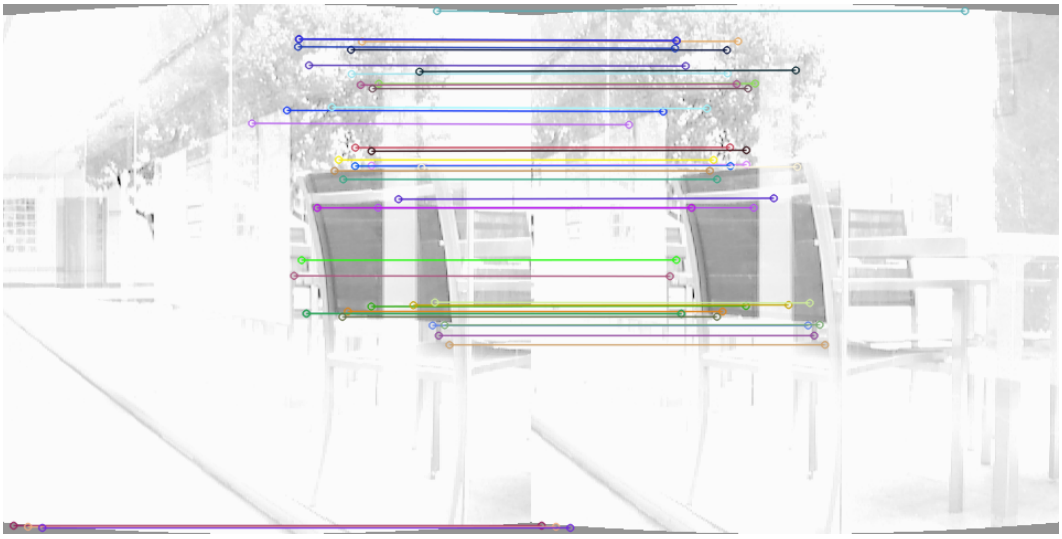


Figure 2: An example match images.

2.3 Finding Homography

Homography checks the match between 2 different planes with the same projection points. The formula below is the basic formula. The calculation has been made efficient with the efficient method at the address [1] shown in the bibliography.

$$\begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} h_1 & h_2 & h_3 \\ h_4 & h_5 & h_6 \\ h_7 & h_8 & h_9 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

2.4 Merging by Transformation

After the calculations, the two images are combined by cropping them in certain proportions.

Figure 3: An example match images.

3 Experimental Results

3.1 Important Points

Some deficiencies were observed during the experimentation process. One of them was that images without keypoints, such as a blank wall between subimages, prevented the creation of panoramas. Another reason was that the brightness of the pictures negatively affected the algorithm. It was determined that the higher the number of keypoints in the images, the more positive the results. Creating some panoramas with too few images shows unsuccessful results.

3.2 Comparision SIFT and ORB

3.2.1 Time Complexity

The times of keypoint calculations were averaged for each image in each data folder. It is observed that the ORB algorithm is much faster than the SIFT algorithm.

Method	Time
ORB	14.96 s
SIFT	29.32 s

3.2.2 Accuracy

Below are 21 images each created with SIFT and ORB algorithms under the appendix. When we look at 21 different panorama pictures, it has been observed that the ORB algorithm is better than the SIFT algorithm. It can be said that this result is expected with the ORB algorithm being a more efficient alternative to the SIFT algorithm.

4 Conclusion

In this assignment, an algorithm for creating a panorama image with subimages was examined. This is called Image Stitching with Keypoint Descriptors. By examining the projections of images processed at different angles, it was discovered that they could be combined. It can be said that the results are positive.

5 References

[1] https://math.stackexchange.com/questions/494238/how-to-compute-homography-matrix-h-from-corresponding-po

[2] https://docs.opencv.org/4.x/da/df5/tutorial_py_sift_intro.html

[3]https://docs.opencv.org/3.4/d1/d89/tutorial_py_orb.html

6 Appendix

6.1 SIFT and ORB Results

Figure 4: cvc01passadis-cyl-pano01 folder with SIFT 1

Figure 5: cvc01passadis-cyl-pano02 folder with SIFT 2

Figure 6: cvc01passadis-cyl-pano03 folder with SIFT 3

Figure 7: cvc01passadis-cyl-pano04 folder with SIFT 4

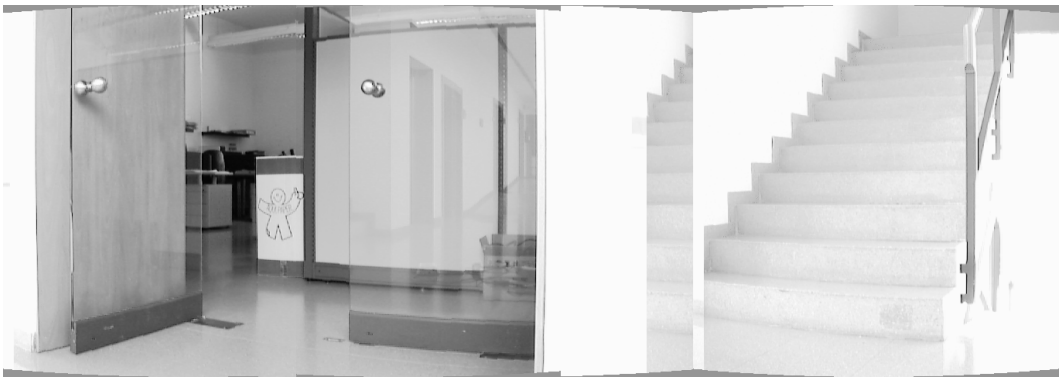


Figure 8: cvc01passadis-cyl-pano05 folder with SIFT 5

Figure 9: cvc01passadis-cyl-pano06 folder with SIFT 6

Figure 10: cvc01passadis-cyl-pano07 folder with SIFT 7

Figure 11: cvc01passadis-cyl-pano08 folder with SIFT 8

Figure 12: cvc01passadis-cyl-pano09 folder with SIFT 9

Figure 13: cvc01passadis-cyl-pano10 folder with SIFT 10

Figure 14: cvc01passadis-cyl-pano11 folder with SIFT 11

Figure 15: cvc01passadis-cyl-pano12 folder with SIFT 12

Figure 16: cvc01passadis-cyl-pano13 folder with SIFT 13

Figure 17: cvc01passadis-cyl-pano14 folder with SIFT 14

Figure 18: cvc01passadis-cyl-pano15 folder with SIFT 15

Figure 19: cvc01passadis-cyl-pano16 folder with SIFT 16

Figure 20: cvc01passadis-cyl-pano17 folder with SIFT 17

Figure 21: cvc01passadis-cyl-pano18 folder with SIFT 18

Figure 22: cvc01passadis-cyl-pano19 folder with SIFT 19

Figure 23: cvc01passadis-cyl-pano20 folder with SIFT 20

Figure 24: cvc01passadis-cyl-pano21 folder with SIFT 21

Figure 25: cvc01passadis-cyl-pano01 folder with ORB 1

Figure 26: cvc01passadis-cyl-pano02 folder with ORB 2

Figure 27: cvc01passadis-cyl-pano03 folder with ORB 3

Figure 28: cvc01passadis-cyl-pano04 folder with ORB 4

Figure 29: cvc01passadis-cyl-pano05 folder with ORB 5

Figure 30: cvc01passadis-cyl-pano06 folder with ORB 6

Figure 31: cvc01passadis-cyl-pano07 folder with ORB 7

Figure 32: cvc01passadis-cyl-pano08 folder with ORB 8

Figure 33: cvc01passadis-cyl-pano09 folder with ORB 9

Figure 34: cvc01passadis-cyl-pano10 folder with ORB 10

Figure 35: cvc01passadis-cyl-pano11 folder with ORB 11

Figure 36: cvc01passadis-cyl-pano12 folder with ORB 12

Figure 37: cvc01passadis-cyl-pano13 folder with ORB 13

Figure 38: cvc01passadis-cyl-pano14 folder with ORB 14

Figure 39: cvc01passadis-cyl-pano15 folder with ORB 15

Figure 40: cvc01passadis-cyl-pano16 folder with ORB 16

Figure 41: cvc01passadis-cyl-pano17 folder with ORB 17

Figure 42: cvc01passadis-cyl-pano18 folder with ORB 18

Figure 43: cvc01passadis-cyl-pano19 folder with ORB 19

Figure 44: cvc01passadis-cyl-pano20 folder with ORB 20

Figure 45: cvc01passadis-cyl-pano21 folder with ORB 21