CV 2021 HW2 Report

Group 24

0610122 李思賢, 309553049 陳怡安

Introduction

In this assignment, we implemented the automatic panoramic image stitching. Given two images that have some region overlapped, we try to connect them together to build a panoramic photo as naturally as impossible.

Implementation

1. Interest points detection & feature description by SIFT
   First, we find out the keypoints and their corresponding feature descriptions in each image by utilizing the OpenCV function.

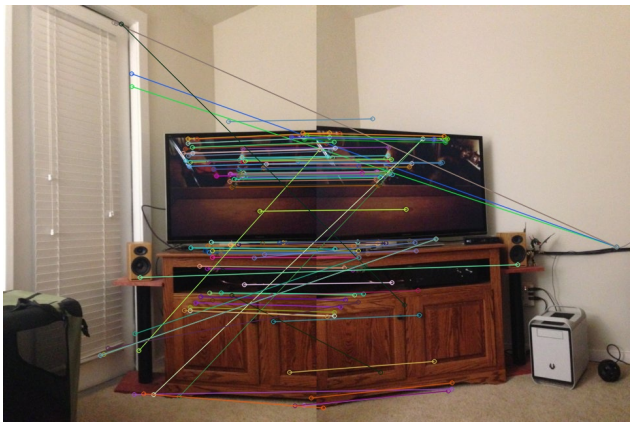
2. Feature matching by SIFT features
   Next, we want to find good matching pairs between those two images. For every key point in the first image, we calculate the L2-norm between its feature descriptions and that of every key point in the second image. We pick out two points with the smallest L2 distance to apply the ratio test. Divide their L2 distance and the result should be smaller than a threshold.
   $$\frac{||f_1 - f_2||}{||f_1 - f_2'||} < threshold$$
   This is in order to avoid the ambiguous matching. We want to ensure the first match is significantly better than the second one.

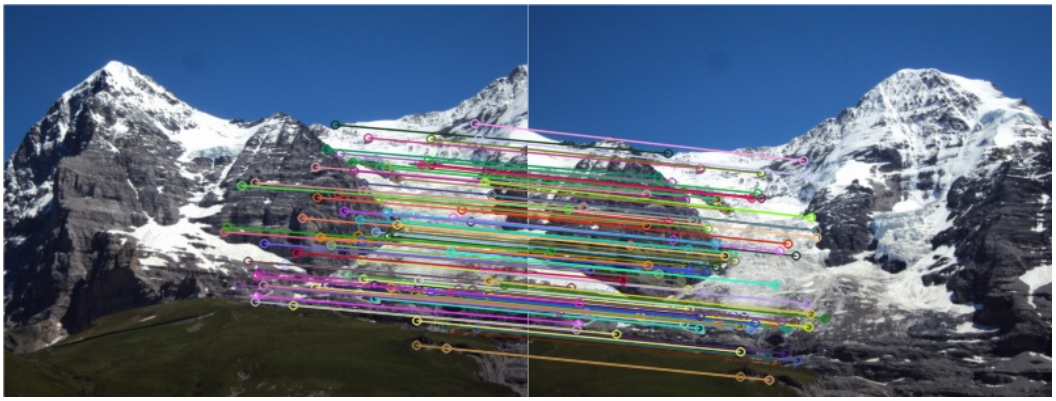
3. RANSAC to find homography matrix H
   We randomly sample 4 correspondences from matching pairs and use them to find the homography matrix for 200 times. After that, transform the key points of the first image by the homography matrix, and compute the error between transformed points and the corresponding points in the second image. If the error of a point pair is less than 10, take this pair as an inlier. We get the best homography matrix with the greatest number of inliers.

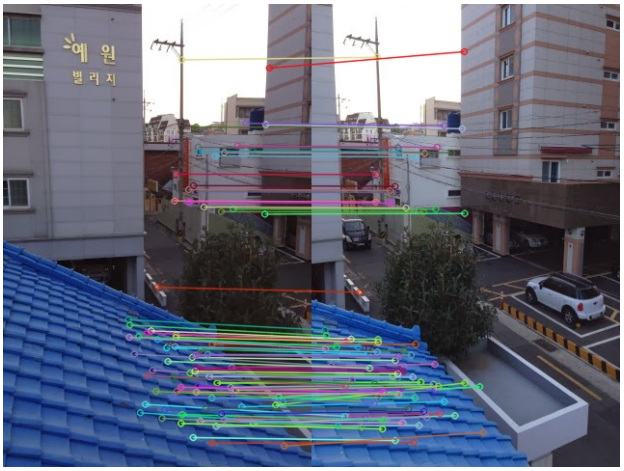
4. Warp image to create panoramic image
   In this step, we implement the backward warping function. First, we find the boundary of the transformed image. Then, use the inverse homography matrix to transform the first image onto the second image. Finally, we use bilinear interpolation to smooth the boundaries of two images.

Experimental results

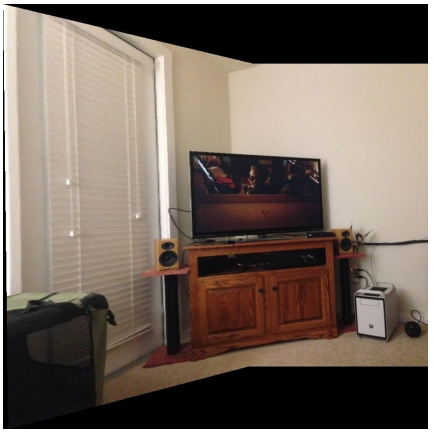
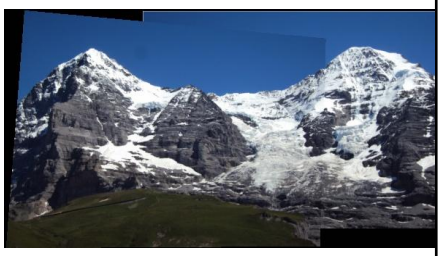
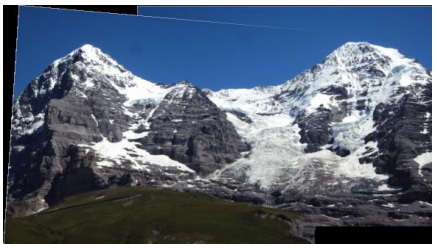
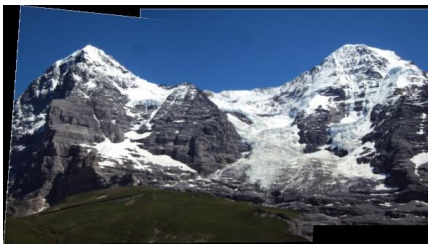
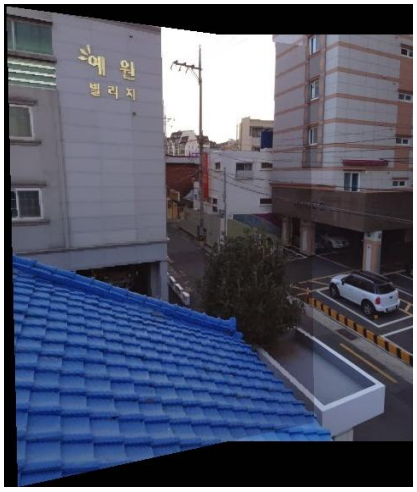
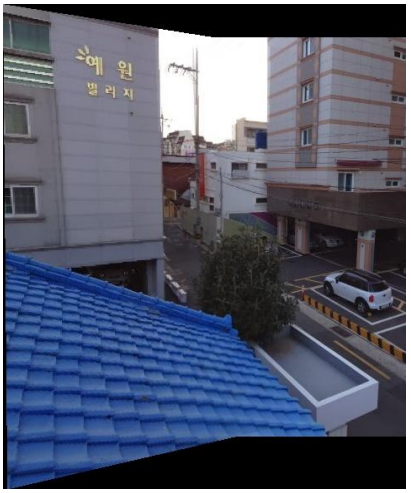
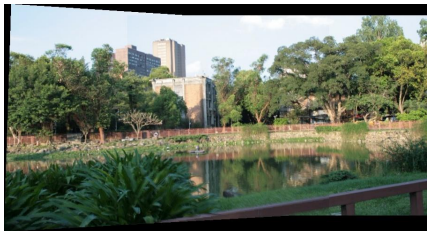
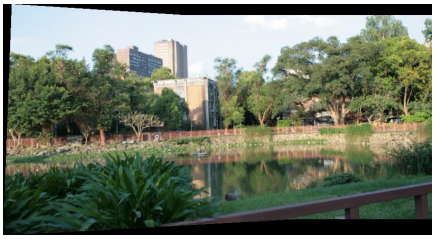
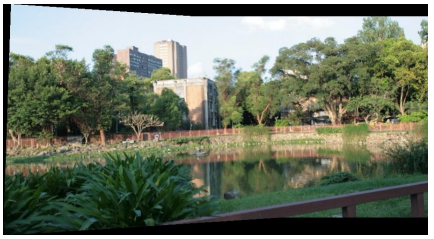
1. Key point matching





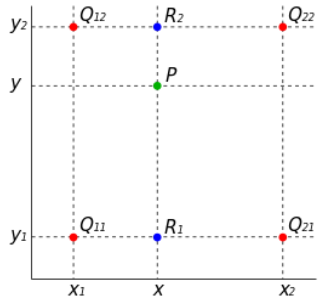


2. Image stiching

no blending	linear blending	bilinear blending
		
		
		
		

Discussion

At first, when a point coordinate transformed by the inverse homography matrix becomes non-integer, we just round it down to an integer value. Later, we tried to use the interpolation method. As shown below, P is the transformed point. We take the nearest four points, and estimate P's value by its distance to each point.



$$f(x, y_1) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{11}) + \frac{x - x_1}{x_2 - x_1} f(Q_{21}),$$
$$f(x, y_2) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{12}) + \frac{x - x_1}{x_2 - x_1} f(Q_{22}).$$
$$f(x, y) \approx \frac{y_2 - y}{y_2 - y_1} f(x, y_1) + \frac{y - y_1}{y_2 - y_1} f(x, y_2)$$

However, it seems that there's not much difference from the resulting image using these two methods. Hence, we go back to the first one, since it is a simpler way.

For blending the overlapping region of two images, in the beginning, we only do linear interpolation on the x axis. But there are still clear boundaries in the results, especially the second set of images. Therefore, we use bilinear interpolation and get better results.

Conclusion

With the aid of OpenCV function, we detect key points and obtain their feature descriptions from input images. Then, we use the ratio test to find out the good matching key point pairs across two images. Next, we calculate the homography matrix using the RANSAC algorithm. Finally, we write our warping function to transform one of the input images to the right prespection and connect the photos together. We also tried several blending methods which greatly improved the stitching quality.

Work assignment plan

code: 李思賢 & 陳怡安
report: 李思賢 & 陳怡安