Panorama Stitching

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1 Member Contributions

Sungbin Oh: Implemented initial implementations of feature detection, feature description, and feature Matching

Rohan Ahuja: Implemented initial implementations of RANSAC and panorama creation

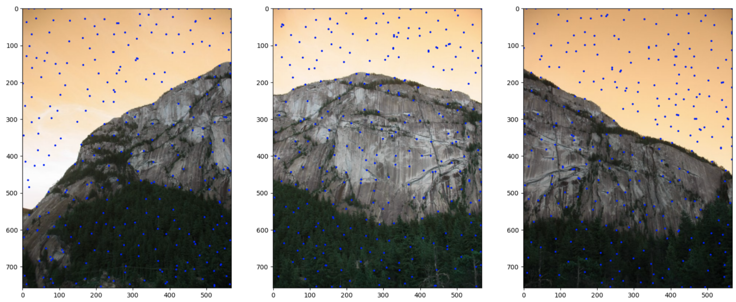
2 Introduction

This project aims to implement a panorama stitching algorithm using feature detection, description, and matching. The project uses the Harris Corner Detector to detect feature points in the images, and then uses a feature descriptor to describe the features. The features are then matched between images using a nearest neighbor approach. RANSAC is used to estimate the homography between the images, and the homographies are used to stitch the images together to create a panorama.

3 ANMS

We used the Adaptive Non-Maximal Suppression (ANMS) algorithm to select the best feature points from the Harris Corner Detector. The ANMS algorithm selects feature points that are maximally separated from each other, ensuring that the selected points are well-distributed across the image. The algorithm selects the best N feature points based on the corner response values. This was the most computationally expensive part of the project, as it required calculating the distance between all pairs of feature points to determine the suppression radius. Together, the ANMS algorithm and the Harris Corner Detector were effective in selecting the best feature points for further processing.

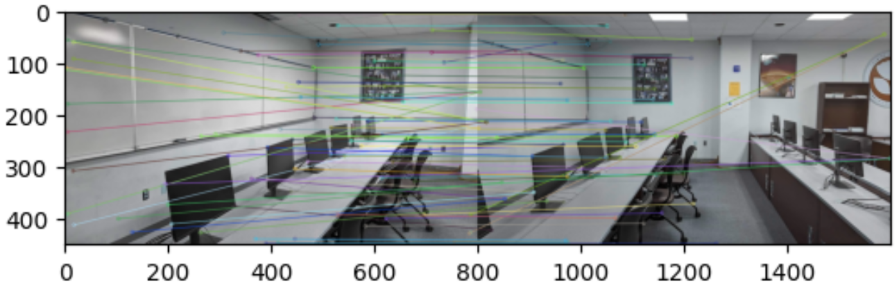
An example of ANMS output:



4 Feature Matching

We used a nearest neighbor approach to match feature points between images. For each feature point in the first image, we calculated the Euclidean distance to all feature points in the second image and selected the closest match. We then calculated the ratio of the distance to the best match and the distance to the second-best match. If the ratio was below a certain threshold (0.5 in our case), we considered the match to be valid. This approach was effective in matching feature points between images and forming pairs of matching points.

An example of feature matching:



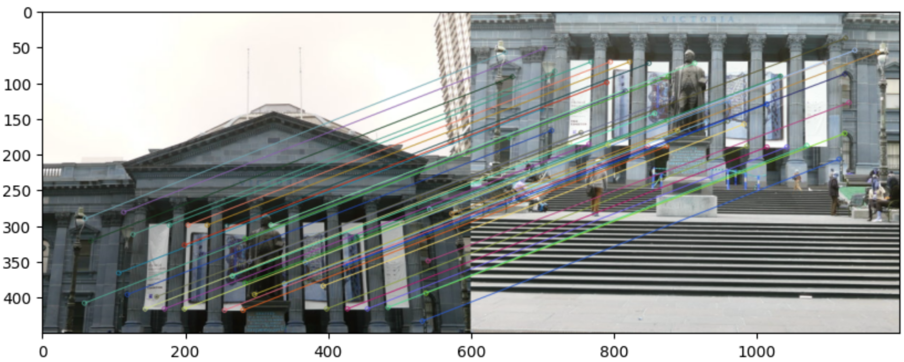
5 Feature Descriptors

We used a 40x40 window around each feature point to create a feature descriptor. We then applied Gaussian blur to the window and downsampled it to an 8x8 grid with a spacing of 5. This resulted in a 64x1 feature vector for each feature point. We then standardized the feature vector to ensure that the features were comparable between images. The feature descriptors were effective in describing the local image content around each feature point and were used for matching feature points between images.

6 RANSAC and Homography Estimation

We used RANSAC to estimate the homography between images. RANSAC is a robust estimation technique that is used to estimate a model from a set of noisy data. In our case, we used RANSAC to estimate the homography between images based on the matching feature points. The homography was then used to warp the images to a common coordinate system for stitching. The homography estimation process was effective in aligning the images and creating a well-aligned panorama. Upon visualizing the matching pairs, we observed that the RANSAC algorithm successfully removed outliers and estimated the homography accurately.

Here is an example of the output after RANSAC application. Notice most of the lines are parallel:



7 Image Warping (and Blending)

We used the homography estimated by RANSAC to warp the images to a common coordinate system. We then blended the images together to create a seamless panorama. The blending process involved averaging the pixel values of overlapping regions to create a smooth transition between images. This did leave some artifacts in the final panorama (such as double images of objects that were moving or imperfectly aligned). For example, note the doubling around the doorway on the right and the ceiling fan in the following:

Despite this shortcoming, the overall blending process was effective in creating a visually appealing panorama.

8 Results

The project was successful in creating panoramas from sets of images. Although our implementation did not convert the panoramas into rectangled shapes, the panoramas were visually appealing and accurately stitched together the images. The project demonstrated the effectiveness of feature detection, description, and matching, as well as the robustness of RANSAC in estimating the homography between images.