PS #5 Report

Problem #1: Mosaicing with Bilinear Transformation

Introduction

Image mosaicing is a useful technique for composing a scene out of multiple images of the same landscape or area. However, due to differences in angle and perspective between the images, splicing the images to reconstruct the actual landscape is not as simple as stitching them together. Images must be transformed using projective transformations and merged using blending techniques to accurately recreate the scene that the images capture.

Methods

The first step in mosaicing is keypoint identification. This is the process of choosing the points on each image that align to inform the projective transformation. Some more complicated methods may use feature detection to select keypoints automatically, but in this implementation, keypoints on each image are selected by hand. A total of 16 keypoints are selected: 4 on the left image, 4 on the right image, and 8 corresponding points on the center image.

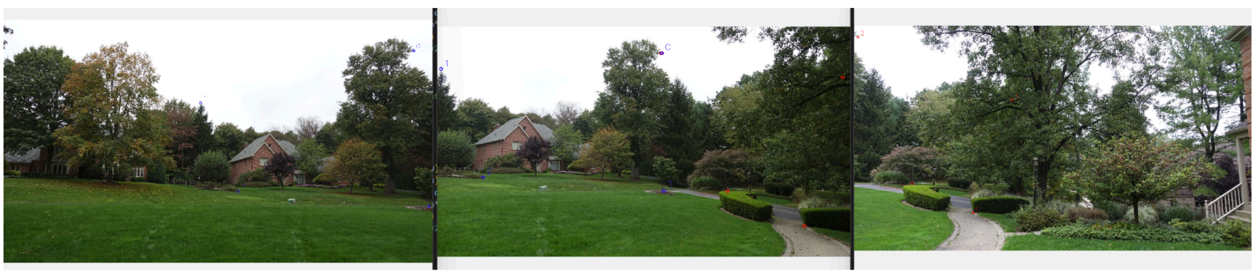

Fig 1: Manual keypoint selection.

After keypoint selection, the projective transformation is found. This is done by solving the following matrix equation

$$p' = hp$$

for h, where p and p' are the original and transformed pixel locations. h can be found by solving 8 simultaneous equations given that there are four *(p, p')* pairs.

Once the projective transformation is found for each of the left and right images and applied, the overlapping portions of all the images are combined using alpha blending.

Results

Each of the 4 sets of images presented different challenges and limitations of the mosaicing method implemented for this report. The most basic limitation is well demonstrated by the door.png image set.

Fig 2: Stitched result of the door.png image set.

The door image set mostly mosaiced easily, but the most basic limitations of the manual keypoint selection method are visible in the slight blurring on the right side of the door. This blurring occurs from errors in the alignment of the keypoints between images - that is, when the selected corresponding keypoints don't actually lie on corresponding features/pixels. Effects of these errors are less visible when there are larger areas of overlap, which is why they are minimal in this example.

In the house image set, the effects of manual keypoint selection are emphasized. There is some prevalent ghosting and blurring, especially in busier areas of the image such as the trees.

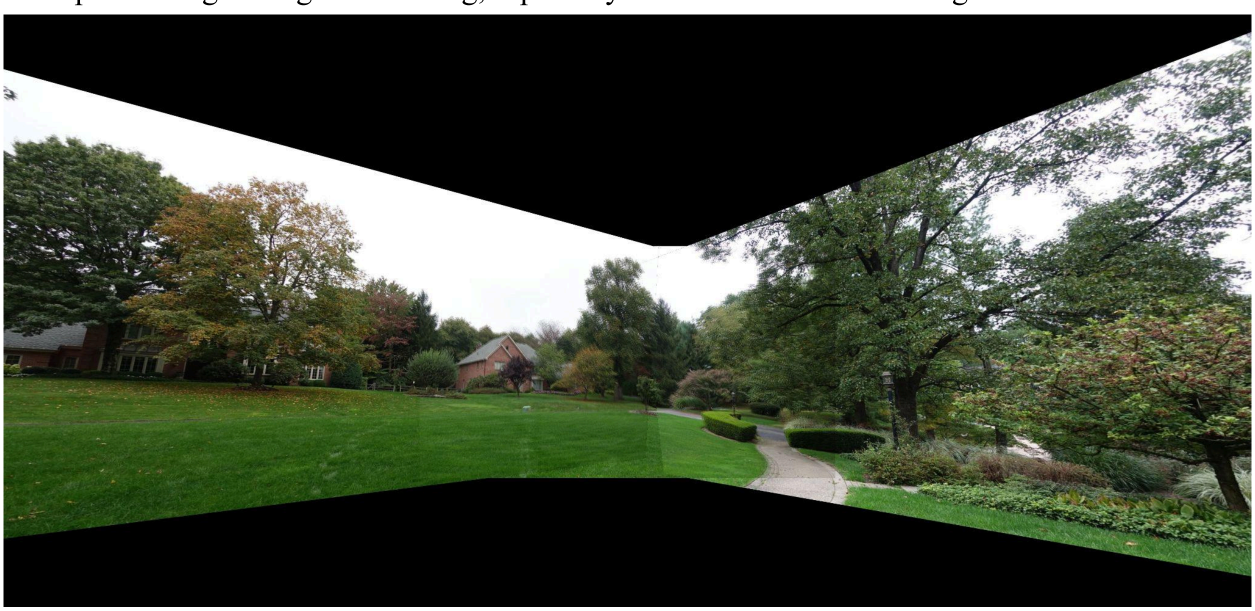

Fig 3: Stitched result of the house.png image set.

In an image with less well defined features and boundaries, manual keypoint selection of corresponding points is more difficult, leading to higher errors. This leads to the blurring seen in the overlapping regions, especially around the trees.

The Pittsburgh image set also suffers from significant blurring due to errors in keypoint selection. The image features are smaller than the accuracy with which points can be manually selected, which means that even small amounts of error/blur become very noticeable after blending.

Fig 4: Stitched result of the pittsburgh.png image set.

Lastly, the wall image set demonstrates the importance of having a large overlap area to produce quality mosaicing. On the right side, the center and right images have a large overlap, and the resulting keypoints can trace out a larger area, which reduces blurring. On the left, the images have very little overlap, and the effect of the keypoint placement errors is much larger, as is evidenced by the much more significant blurring.

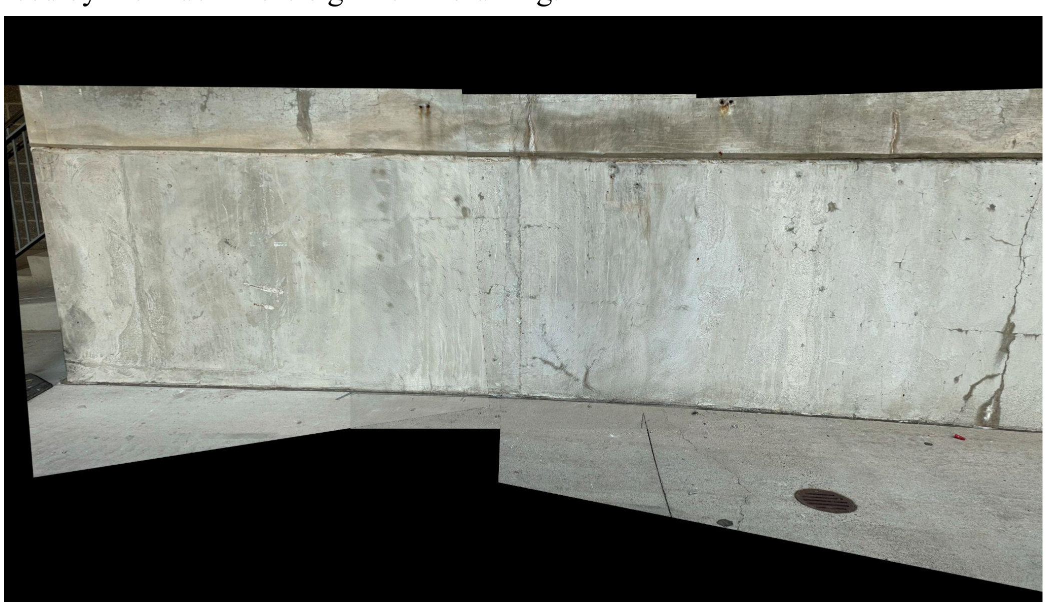

Fig 5: Stitched result of the wall.png image set.