

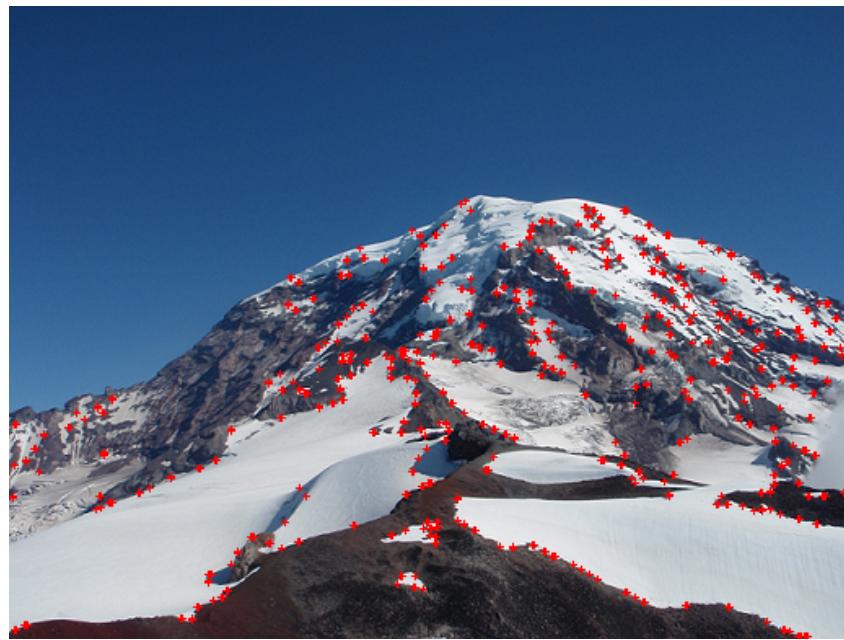
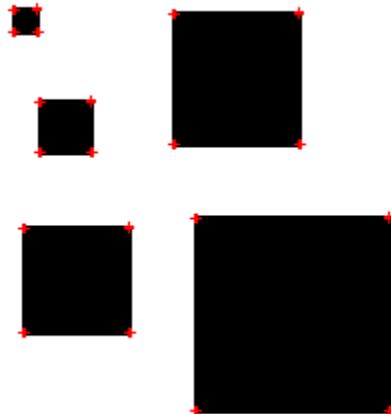
ECE/CSE 576, Spring 2019 Homework 2: Creating Panoramas

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1 Harris Corner Detector

Gaussian blurring was applied with $\sigma = 2$. The Harris response threshold was 50, and non-maximal suppression was done with a 5×5 window. Detected corners are denoted with a red cross. As a sanity check, we apply the algorithm to `Boxes.png`.



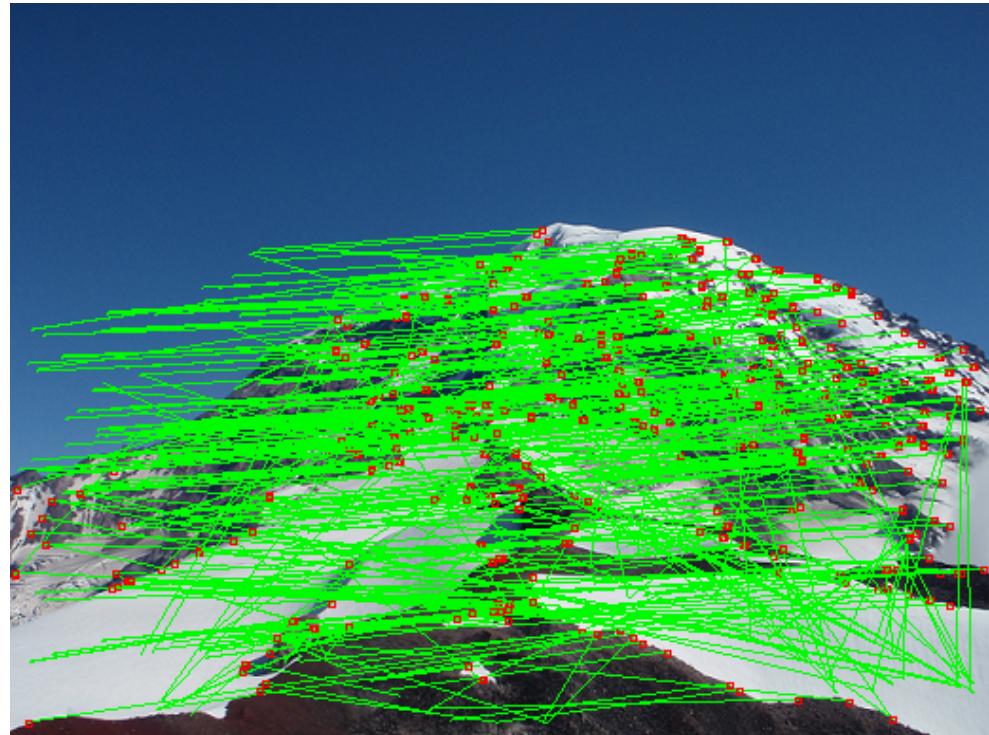
Applied to `Rainier1.png`.



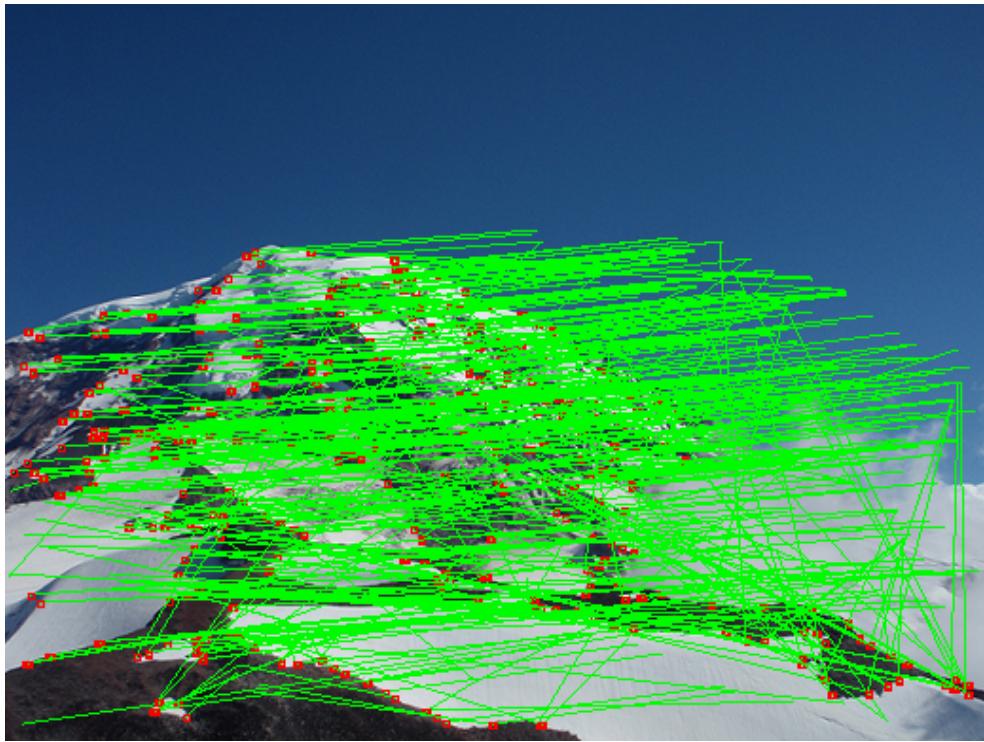
Applied to Rainier2.png.

2 Match Corner Points

The l_1 norm applied to the feature descriptor was used to find matching corner points in the other image.



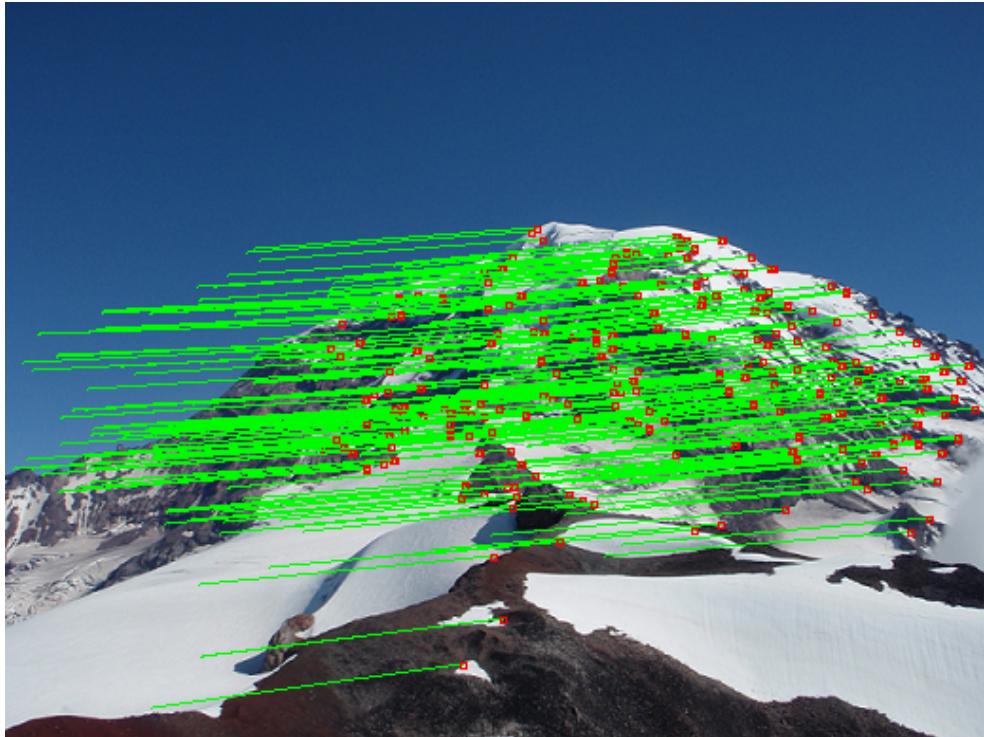
All matching corner points in Rainier1.png.



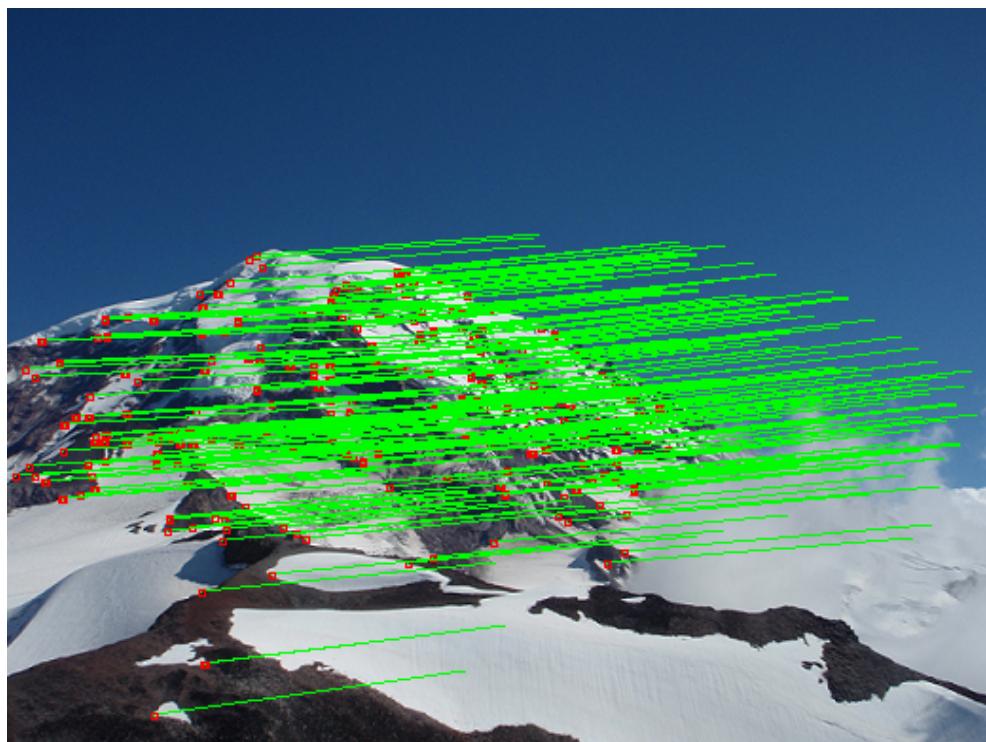
All matching corner points in Rainier2.png.

3 RANSAC

Homographies were sampled by choosing 4 matches. The homography with the largest number of inliers was chosen.



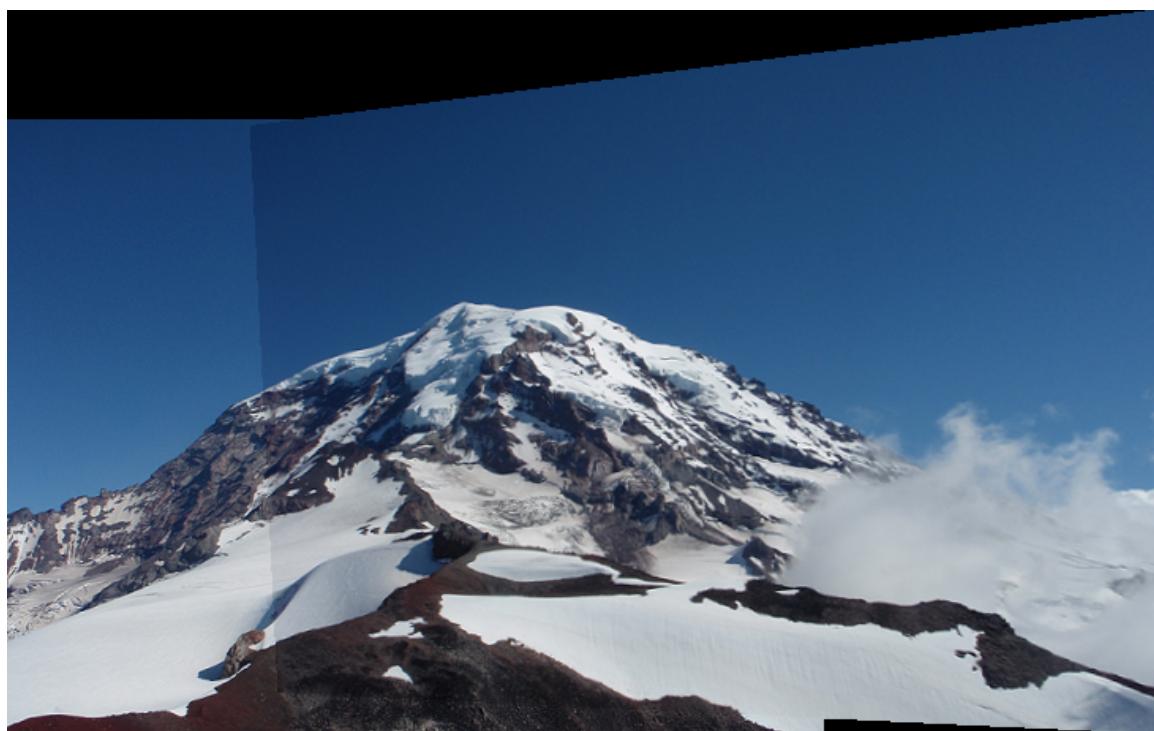
Matches from the homography with the largest number of inliers in Rainier1.png.



Matches from the homography with the largest number of inliers in Rainier2.png.

4 Stitch

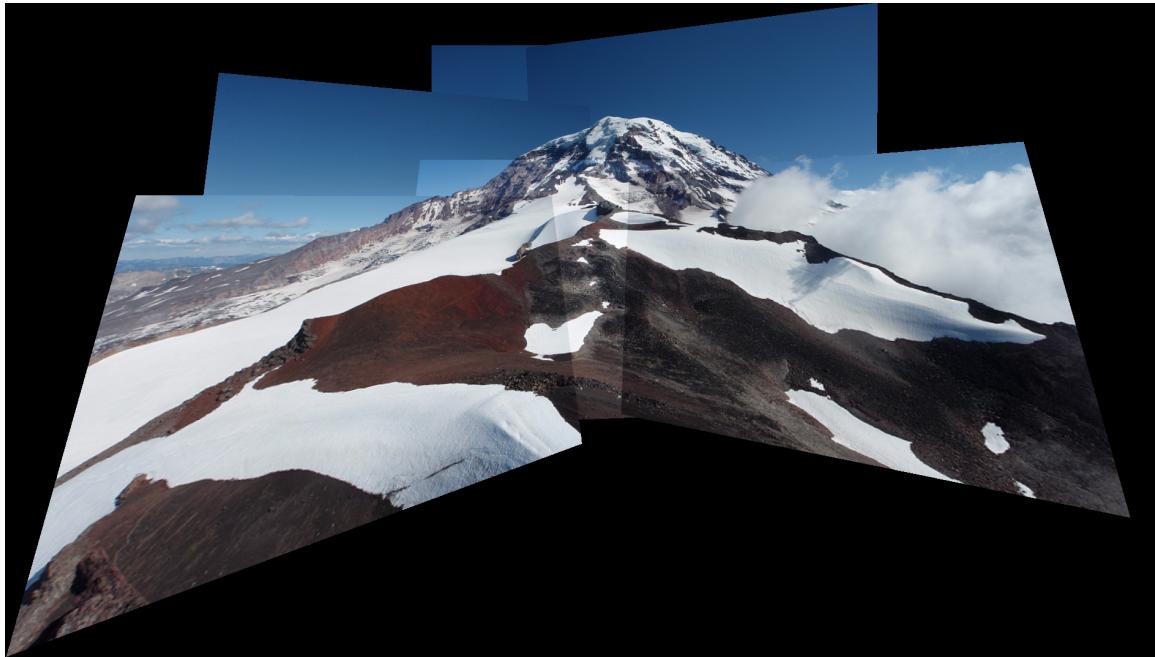
A flat panorama was made by using the first image as the reference coordinate system.



The result of stitching Ranier1.png and Ranier2.png.

Bell: Complete Mt. Ranier Panorama

The same technique in Section 4 can be applied repeatedly to get a complete panorama.



The result of stitching Ranier1.png, Ranier2.png, Ranier3.png, Ranier4.png, Ranier5.png, and Ranier6.png.

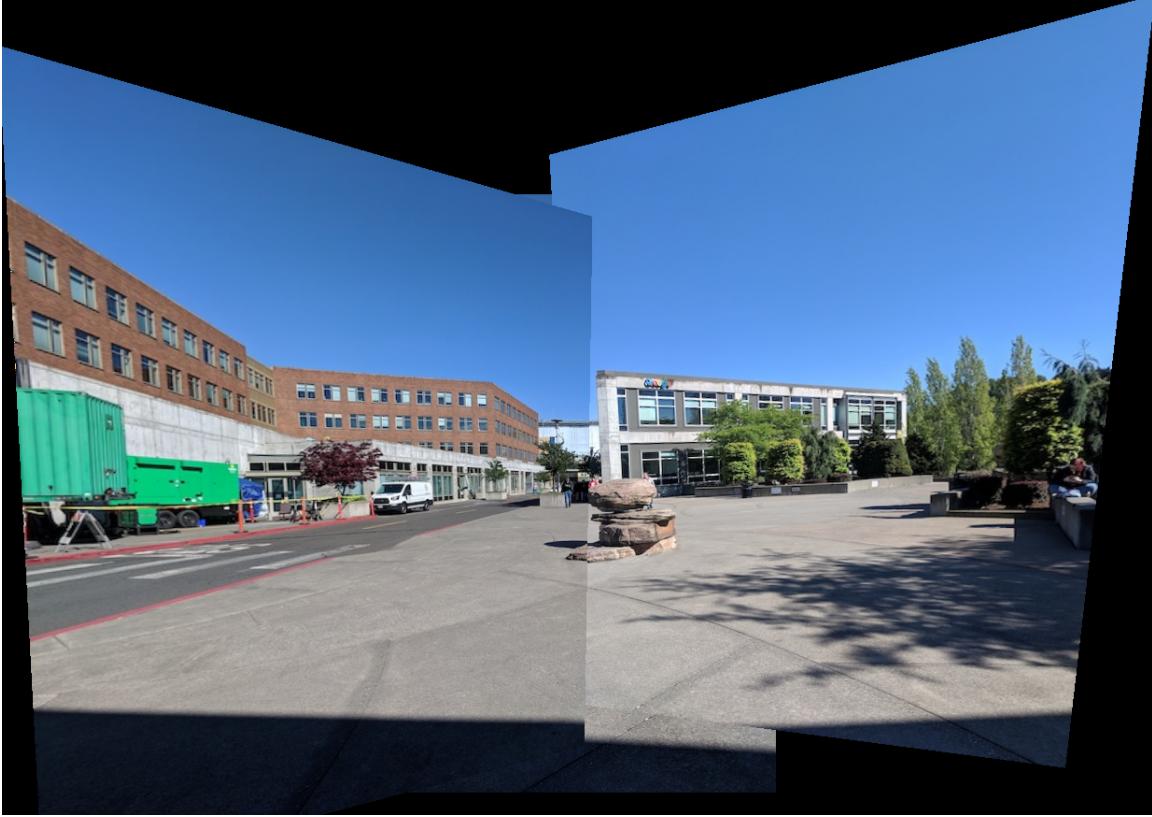
Whistle: My Own Panorama

I took pictures of my office building with my cell phone camera and stiched them together. Images were resized to 480×640 , but otherwise, untouched.



3 pictures of my office.

The center image was used as the reference coordinate system.



Whistle: Hanging

To deal with the rotated image, I created a new 16-dimensional feature descriptor. Consider a 9×9 window. Each dimension is the difference of the green channel of a pixel on the border with that of center pixel after applying a Gaussian blurring with $\sigma = 2.0$. The 0-indexed dimensions correspond to the following pixels.

0		1		2		3		4
15								5
14				P				6
13								7
12		11		10		9		8

Then, to make the distance metric rotation-invariant the distance between two feature descriptors for pixels P_1 and P_2 is

$$d(P_1, P_2) = \min_k \left(\sum_{j=0}^{15} |P_1[j] - P_2[(j + 2k) \bmod 16]| \right), \quad (1)$$

which computes the minimum l_1 distance over all $k\pi/4$ rotations.

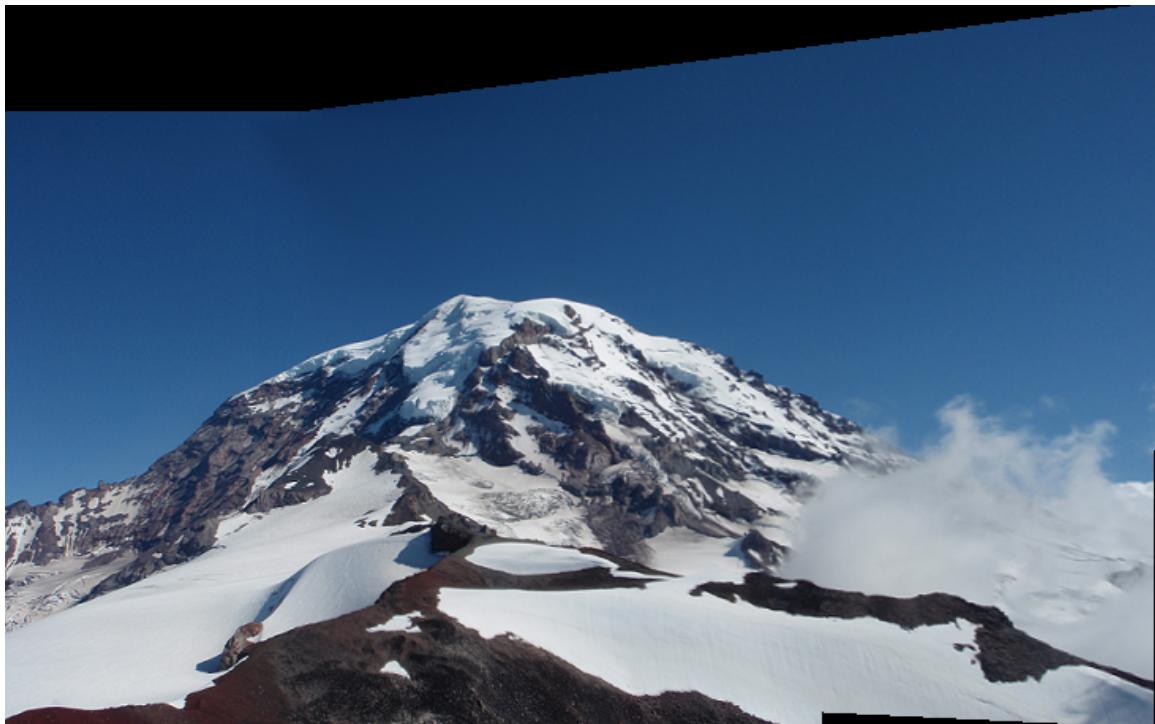
DESC_SIZE in `mainwindow.h` was changed to 16.



Hanging1.png and Hanging2.png by applying a 16-dimensional feature descriptor and Equation 1.

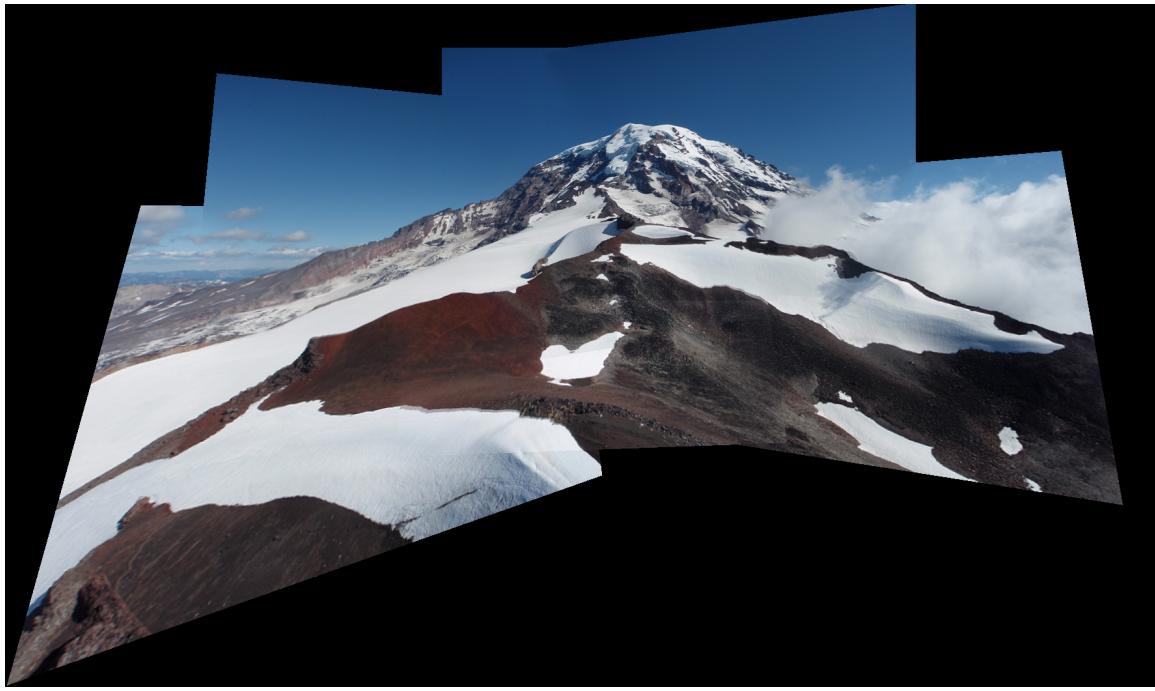
Whistle: Center-weighting

In Section 4 the seam between the two stitched images is apparent. Center-weighting can be used to make seam invisible.



The result of stitching Ranier1.png and Ranier2.png with center-weighting.

The same can be done with the complete panorama.



The result of stitching Ranier1.png, Ranier2.png, Ranier3.png, Ranier4.png, Ranier5.png, and Ranier6.png with center-weighting.



The Google campus with centering-weighting.



Hanging1.png and Hanging2.png stictched and center-weighted.

Appendix

All code used to generate these images can be found at `ppham27/cse576/hw2`. The embedded JPEG, PNG files, and the L^AT_EX can be found in `ppham27/cse576/hw2/report`.