ECE 661: Homework 5

October 4, 2012

Due: October 18, 2012 (Thursday) before the class

Problem:

This homework is an exercise in image mosaicking. To do this homework well, you must know: (i) the linear least-squares method for computing a homography from a set of inlier correspondences; (ii) the RANSAC method for discarding the outliers; and (iii) at least one nonlinear least-squares method for refining a homography.

The first thing you need to do is to use your camera to take a set of N images while you are basically standing at one location but turning through an angle for each successive shot. The value of N can be whatever you wish it to be. Start with $N = 5$. **You must make sure that you have a reasonable amount of overlap between the successive images since the homographies between the successive images will depend on the degree of overlap between the images.** Since you will be taking the pictures manually, you cannot be precise about the degree of overlap between the images (and it is not necessary to be precise).

For every pair of successive images, your homework must involve the following steps:

- Interest point extraction with either SIFT, or SURF, or Harris.
- Establishing putative correspondences between the interest points in every pair of successive shots using the same criteria that you used in Homework 4.
- Discarding outlier correspondences using RANSAC. The RANSAC algorithm requires you to set three parameters, δ, N, and M, where δ is a decision threshold to construct the inlier set, N the number of iterations,

and M the minimum size for the inlier set for it to be acceptable. If you wish, you can try the 10% rule described in Lecture 11 for setting δ. Try to set N and M as described in the same lecture.

- After you have selected the best inlier set of correspondences though RANSAC, use all the inliers to calculate the homography between a pair of images using the linear least-squares method.

- Finally, use either the Levenberg-Marquardt method or the DogLeg method to refine the homography.

You should already have the code for the first two step from Homework 4. The third step requires you to code up the RANSAC logic, on the one hand, and the linear least-squares method for homography computation on the other. Both are fairly trivial. Recall, for the linear least-squares method, all you have to do is to find the eigenvector that corresponds to the smallest singular value in the SVD decomposition of a matrix. For the final refinement of the computed homography with nonlinear least-squares, you can simply call the Levenberg-Marquardt function in OpenCV or use its Matlab implementation.

With regard to constructing a mosaic, after you have computed the homographies between every pair of successive images, you would need to chain the homographies in order to project all the images into the coordinate frame that corresponds to, say, the central image.

You are encouraged to use the OpenCV library or Matlab to do your homework but you must NOT use the built-in function for the RANSAC algorithm. However, you may use the built-in function for Levenberg-Marquardt.

Submission of Your Work:

You should turn in a report in pdf format for your homework solution using the blackboard. The report should include

1. A brief outline of how you computed the homography for a given pair of images with the RANSAC algorithm and how you refined it with the Levenberg-Marquardt or DogLeg function.

2. A brief outline of how you carried out image mosaicking with the computed homographies to the central image.

3. The matching results and all parameter values used in your algorithm.

Figure 1: A sample of image mosaicking with the central image boxed in the upper row

4. You should show the inliers and outliers for at least two pairs of successive images in a distinguishable way.
5. The mosaic you create from all the images in a set shown as in Figure 1.
6. Your source code along with comments.

You are permitted to look at sample solutions from previous semesters. However, the work you turn in must be your own.

Notes.

- Clearly identify the steps you have taken to solve the problem and describe these steps in your own words.
- Your grade depends on the completeness and clarity of your work as well as the results.