CS217, Homework 2
Due Date: Tuesday, May 12th

Submitting Homework

Please upload all your homework solutions to the appropriate folder on the EEE website. Please upload a liberally illustrated writeup either as a pdf file (e.g., ”writeup.pdf”) as well as your code in a seperate subdirectory (e.g. ”code/ransac.m”). For mathematical exercises, please document clearly the intermediate steps of how you arrived at your answer. For code, please include comments and images/discussion in your writeup as appropriate so I know what you have done. There are some test images to get you started on the website here:

`http://www.ics.uci.edu/~fowlkes/class/cs217/hwk2/data/`

There are MATLAB implementations of most of this assignment available from various sources on the web. It should go without saying that you will get much more out of this assignment if you do your own work from scratch rather than just copying them.

Problem 1: Feature Matching

Download an implementation of SIFT feature matching. I suggest VLFeat:

`http://www.vlfeat.org/`

You will need to compile it for your platform. Follow the tutorial here:

`http://www.vlfeat.org/overview/sift.html`

for extracting and matching SIFT features. Don't forget to run the vl setup function to add the VLFeat toolbox to your MATLAB path.

Test the SIFT matching code on a stereo pair of your choice (i.e. two images of a rigid scene) and visualize the matching results. Include examples in your writeup.

Problem 2: RANSAC

As you can see from the matching results, SIFT finds matches which are not consistent with a single overall camera motion. In order to find a consistent set of matches, implement RANSAC to estimate the fundamental matrix F. For each random sample you should estimate F using the normalized 8 point algorithm (as described in Hartley's paper “In defense of ...” linked from the class website and discussed in section 4.4 of Hartley and Zisserman). You will need to experiment with the appropriate error threshold for determining inliers and outliers.

1. Using the same image pairs as in Problem 1, show the best set of correspondences chosen by RANSAC as inliers. If things are working correctly, the correspondences should be more consistent than in Problem 1 since they all now satisfy the same epipolar constraint.
2. Visualize the epipolar geometry for a subset of 20 feature points in one of your image pairs. For each image you should plot the 20 feature points along with the epipolar lines on which they should lie given F and their corresponding point in the other image. What can you say about the relative pose of the two camera views based on the arrangement of epipolar lines?

3. How stable is your estimate of F? If you rerun RANSAC multiple times with random samplings, does it always return the same F matrix? How could you get a more robust estimate?

Problem 3: Calibrated Structure from Motion

Download the calibration images provided in the data directory (`sfm.zip`). Use the camera calibration toolbox from the previous assignment to estimate the intrinsic parameter matrix K. For the pair of test images, use the SIFT matching routine to return a set of matching points. Normalize these point coordinates using K^{-1} and then modify your code from Problem 2 to recover the essential matrix E. Remember that you can still use the 8 point algorithm but now you will need to set the two singular values to be equal instead of just zeroing out the smallest singular value. Using the SVD technique we described in class, recover the two possible rotation matrices R and translation vectors t associated with E. Discuss your results. Is the recovered translation reasonable based on what you see in the images?