ECE4580 Homework #7
Due: Feb. 27, 2014

Problem 1. (25 pts)   Using the left and right camera views from the stereo problem Homework 4, Problem 2, and the known homogeneous matrix description of the right camera frame with respect to the left camera frame, identify the epipolar lines for the right image given the three (homogeneous form) left image points

$$\vec{r}_{L,1} = \left\{ \begin{matrix} 175.000 \\ 13.000 \\ 1.000 \end{matrix} \right\}, \quad \vec{r}_{L,2} = \left\{ \begin{matrix} 168.000 \\ 156.000 \\ 1.000 \end{matrix} \right\}, \quad \vec{r}_{L,3} = \left\{ \begin{matrix} 475.000 \\ 40.000 \\ 1.000 \end{matrix} \right\}.$$

The camera projection matrix is

$$\Psi = \begin{bmatrix} 400 & 0 & 320 \\ 0 & -400 & 240 \\ 0 & 0 & 1 \end{bmatrix},$$

and the camera resolution is 640×480, for both cameras. To make life easier, the old stereo extrinsic parameters, the camera projection matrix, and the image coordinates for the left camera are located in the file `epipolar.mat`.

(1) What is the essential matrix E associated to this stereo camera system?

(b) What is the fundamental matrix F associated to this stereo camera system?

(b) What are the equations for the epipolar lines in the right camera of the points viewed in the left camera? You can either return in the form of
$$ax + by + c = 0,$$
or in the form
$$y = mx + b.$$

Note: Since these lines should be in image coords, the fundamental matrix should be used to generate the epipolar equations.

(c) Plot the epipolar lines for the right image plane (limit the axis to the image resolution limits) and indicate which ones actually cross the right camera image plane.

(d) Suppose that the projections of the given three points onto the right camera are

$$\text{(a)} \left\{ \begin{matrix} 196.000 \\ 300.000 \end{matrix} \right\} \quad \text{(b)} \left\{ \begin{matrix} 559.000 \\ 119.000 \end{matrix} \right\} \quad \text{(c)} \left\{ \begin{matrix} 280.000 \\ 289.000 \end{matrix} \right\}.$$

Identify which are the corresponding points on the left image by seeing where they plot relative to the epipolar lines. (The points are also provided in the given Matlab file).

Problem 2. (15 pts)   Use imfilter to perform a Gaussian blur on an image. An nrows x ncols Gaussian template can be obtained in the following method:

h = fspecial('gaussian', [nrows ncols], sd);

where `sd` is the standard deviation of the Gaussian (type 'help fspecial' for more info), and where `nrows` and `ncols` are be the number of rows and columns, respectively, of the image. Call the function smooth.m. Amongst the homework files there is a Matlab file called blurme that contains a simple image of a square. blur it with different standard deviations and explain what happens. In the homework document, include both your code and the square image smoothed with a standard deviation of 2.

Apply the code to another image of choice (can be from the homework, from the web, or wherever). Turn in a before and after, along with the standard deviation selected.

Note: the options `nrows` *and* `ncols` *indicate the size of the convolution kernel window to use. It is not the size of the image to filter. Using the image size will give a huge convolution kernel; way bigger than is needed. In general the window should be as big, or bigger, than twice the standard deviation.*

1

Problem 3. (30 pts)   Using Matlab's cross-correlation function, find the occurences of a template patch `tI` in the image `I` found when loading the `template.mat` Matlab file. Where in the image is the template found? What would you like to have seen returned?

Note: Matlab actually has two ways to perform the cross-correlation. Through the function `xcorr2`*, or through* `imfilter` *with the added option* `'corr'` *passed as an argument. Peaks in the cross-correlation indicate strong matches against the template.*

Problem 4. (25 pts)   By Saturday (at the latest), each group should receive a baby step to perform for the following Thursday. Your homework is to complete that baby step and communicate the results to the graduate contact student assigned to your group by Thursday night preferably (Friday morning at the latest).