ECE 661 Homework 9

Due: 12/04/2008 Thursday (before the class)

This homework requires you to carry out projective reconstruction of the scene structure from a pair of stereo image. Do the following:

1. Take a pair of stereo images with a hand-held camera. Exact positioning of the camera is not important. Make sure that there is sufficient overlap between the scene structure recorded in the two images. For an indoor scene consisting of an object placed on top of a table at a distance of roughly 5ft from the camera, you may wish to use a separation of roughly 6 and 12 in between the camera positions. For a general outdoor scene, a baseline length of a couple of feet might be more appropriate.

2. Manually mark a set of corresponding points (at least 8 points) between these two images. Use these correspondences to estimate the fundamental matrix using the 8-point algorithm described on page 282 (Algorithm 11.1). Make sure that you enforce the constraint on the rank of the estimated fundamental matrix. For extra credit, use RANSAC to automate this step.

3. Apply the Canny edge detector to the two images. Assume that all edge pixels output by the Canny operator are the interest-points that you will use for stereo matching. For each interest-point thus found in the left image, choose its corresponding right-image interest-point by enforcing the epipolar constraint. If there exist multiple candidates for matching, use the one that yields the largest value for normalized cross correlation (NCC). Also make sure that the ordering constraint is satisfied on each epipolar line. What that means is that the left-to-right order of interest points on an epipolar line in the left image must be the same as the left-to-right order of the corresponding interest points in the right image.

4. Now construct a canonical configuration for the cameras and then compute a projective reconstruction of the scene structure (See Section 10.3 for projective reconstruction and Section 12.2 for actually computing the coordinates of the world 3D points).

5. Finally, demonstrate the result by visualizing the 3D reconstructed points. One simple way to do this is by using the MATLAB function 'plot3'.

   - Save the 3D coordinates of the reconstructed points into a text file in the following format

$$\begin{matrix} X1 & Y1 & Z1 \\ X2 & Y2 & Z2 \\ \vdots & \vdots & \vdots \\ Xn & Yn & Zn \end{matrix}$$

   (i.e. one point per line)

   - Assume that the above file is named as 'result.dat'. Now run the following MATLAB script.

```
pts3d = load('result.dat');
figure;
plot3(pts3d(:,1), pts3d(:,2), pts3d(:,3), '.r');
axis equal;
```

   Then, on the figure window, you can click on the menu "tool | rotate 3d" (and/or pan, zoom in, zoom out, etc.) to adjust the visualization viewpoint.

6. If you did a good job of estimating the intrinsic parameter matrix K in Homework 8, you have the option of transforming your projective reconstruction into a metric reconstruction for extra credit.

Notes.

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