CMSC 317: The Computational Image
Assignment 5: Feature Detection
Due October 5th, 2011

Given a projection of a white screen imaged by a camera, find the four corners. These detected corners will be used later to calibrate a projector camera system. Four correspondences are necessary to estimate the homography between the projected image and the camera image. Implement one of the following approaches:

Harris Corners

Implement the Harris Corner Detector. First, use the Sobel horizontal and vertical filters to find the horizontal and vertical gradient images ($\mathbf{I_x}$ and $\mathbf{I_y}$):

$$\mathbf{S_y} = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} \quad \mathbf{S_x} = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

These can be used to find the matrix $\mathbf{H}$ for each pixel (a window size (w) of 3, 5, or 7 is recommended):

$$\mathbf{H} = \begin{bmatrix} \sum_w I_x^2 & \sum_w I_x I_y \\ \sum_w I_x I_y & \sum_w I_y^2 \end{bmatrix}$$

Then given this matrix, you should decide if this pixel is a corner using one of the methods discussed in class, for example:

$$f = \lambda_1 \lambda_2 - \alpha(\lambda_1 + \lambda_2)^2 = \det(\mathbf{H}) - \alpha \mathrm{trace}(\mathbf{H})^2 = h_{1,1} h_{2,2} - h_{1,2} h_{2,1} - \alpha(h_{1,1} + h_{2,2})^2$$

where $\alpha = 0.05$

Nonmaximal Suppresion: Given a pixel p, if any of the neighbors of p (where the neighborhood size is configurable) have a greater f value, then the pixel is supressed, i.e. $f(p) = 0$.

Edge Detection

Use the Sobel detectors or the Laplacian edge detector to find potential edge pixels:

$$\mathbf{L} = \begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

Next, use the Hough Transform to estimate the four primary lines in the image. Once you have the equations for the four most likely lines, find the four corners of the projected image by finding the intersection points between the lines. (reminder: $l_1 \times l_2$ gives the intersection point.)