Part I: Written Problem

1. Do problem 7.6 from the textbook.

2. The Gradient Second Moment Matrix is defined as:

\[
A = \begin{bmatrix}
\frac{\sum J_x^2}{\sum J_x J_y} & \frac{\sum J_x J_y}{\sum J_y^2}
\end{bmatrix}
\]

where the \([J_x, J_y]^T\) is the spatial gradient of the image, and the sum is taken over a neighborhood \(N\).

(a) For each image above, calculate \(A\) for the center 5x5 window (each block is a single pixel, black is 0 and white is 1).

(b) Find the Eigenvalues of \(A\) for each case. What relationship can you tell between the Eigenvalues and the image type?
(c) Describe how this information can be used to improve optical flow estimation.

Part II: Optical flow
Your assignment is to implement the optical flow method in section 8.4.1. Run your program on the test images fg005.bmp - fg009.bmp. Your output should be a depiction of the optical flow. There are two ways to the display the flow, with the first being preferred. (1) For every 10 pixel in the first image, draw a small arrow or line segment to indicate the direction and magnitude of the flow at that pixel. (2) For simplicity, you can instead create two gray level images denoting the x and y components of the flow. For example, consider the x-component. A gray shade might indicate no flow whereas a lighter shade would indicate flow to the left while a darker shade would indicate flow to the right.

Show the effect for different window sizes (N), and different filter widths $\sigma_s$.

Part III: Improvement Improve your program by employing the weight matrix described in page 197. Repeat all steps above.

Hand in

1. Print out result for programming part and turn in together with your written problems in class. NO EXCEPTION.

2. Send the code to TA any time during the day (code only, no picture).