Edge Detection (LEC 11)

Edge detection operators are based on the idea that edge information in an image is found by looking at the relationship a pixel has with its neighborhood. If a pixel's gray level value is similar to those around it, there is probably not an edge at that point. However if a pixel has a neighbors with widely varying gray levels, it may represent an edge point. In other words, an edge is defined by a **discontinuity** in gray-level. Ideally an edge separates two distinct objects.

Definitions: Edge can be defined loosely as location in an image where there is a sudden variation in the gray level or color of pixels. An edge is a collection of pixel values whose brightness value changes abruptly. Edges represent boarders between regions on an object or in a scene.

The contours of potentially interesting scene element (solid object, surface marking, shadows, etc.) all generate intensity or color edges, so edge enhancement and detection are obvious steps to take when attempting to locate and recognize those scene elements.

Location and recognition are far from trivial because noise and other uninteresting image features can also generate edges . Given a noisy image, edge detection techniques aim to locate the edge pixels most likely to have been generated by scene elements, rather than by noise .

Typically, there are three *main steps* to perform for good result:-

1 – Noise reduction: where we try to suppress as much noise as possible, without smoothing a way the meaningful edges .

2 – Edge enhancement: where we apply some kind of filter that respond strongly at edges and weakly elsewhere, so that edges may be identified as local maxima in the filter's output.

3 – Edge localization: where we decide which of the local maxima output by the filter are meaningful edges and which are caused by noise (for example using threshold) .

Note that, some edge detection operators return orientation information (information about the direction of the edge), whereas others only return information about the existence of an edge at each point .

With many of edge detection operators, noise in the image can create problem. that is why it is best to preprocess the image to eliminate, or at least minimize, noise effect .To deal with noise effect, we must make a tradeoffs between the sensitivity and the accuracy of an edge detector .

For example, if the parameters are set so that the edge detector is very sensitive, it will tend to find many potential edge points that are attributable to noise . If we make it less sensitive, it may miss valid edges.

The *parameters* that we can set include:

1 – The size of the edge detection mask.

2 – The value of the gray – level threshold

A large mask is less sensitive to noise; a lower gray – level threshold will tend to reduce noise effect

1-Soble operator:

The Sobel edge detection masks look for edges in both the horizontal and vertical directions and then combine this information into a single metric. The masks are as follows:

Row Mask	Column Mask
$\begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix}$	$\begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix}$

These masks are each convolved with the image. At each pixel location we now have two numbers: S1, corresponding to the result form the row mask and S2, from the column mask. We use this numbers to compute two matrices, the edge magnitude and the edge direction, which are defined as follows:

Edge Magnitude= $\sqrt{{s_1}^2 + {s_2}^2}$

2-Prewitt operator:

The Prewitt is similar to the Sobel but with different mask coefficients. The masks are defined as follows:

Row Mask	Column Mask
$\begin{pmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{pmatrix}$	$\begin{pmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{pmatrix}$

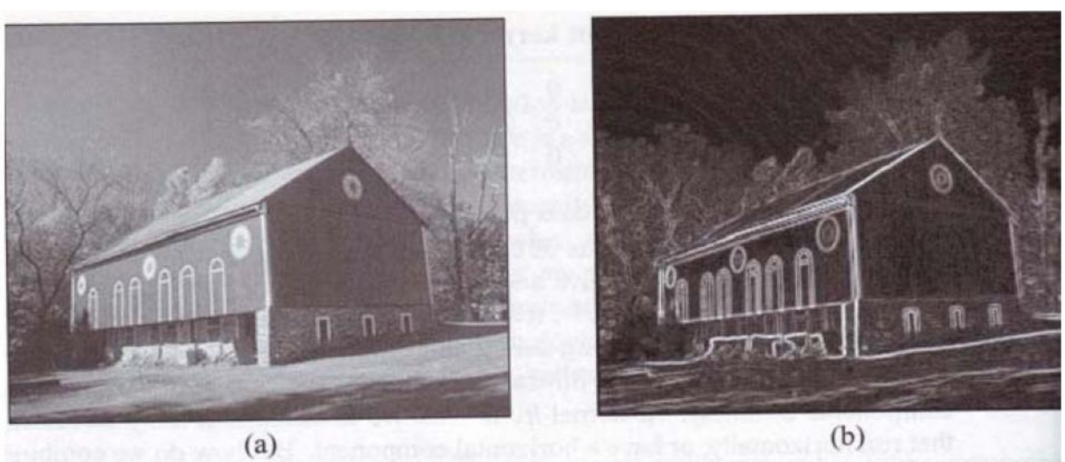

Figure (9-2): (a) the barn image (b) Gradient magnitudes for barn image, scaled to a 0-255 and displayed as an image

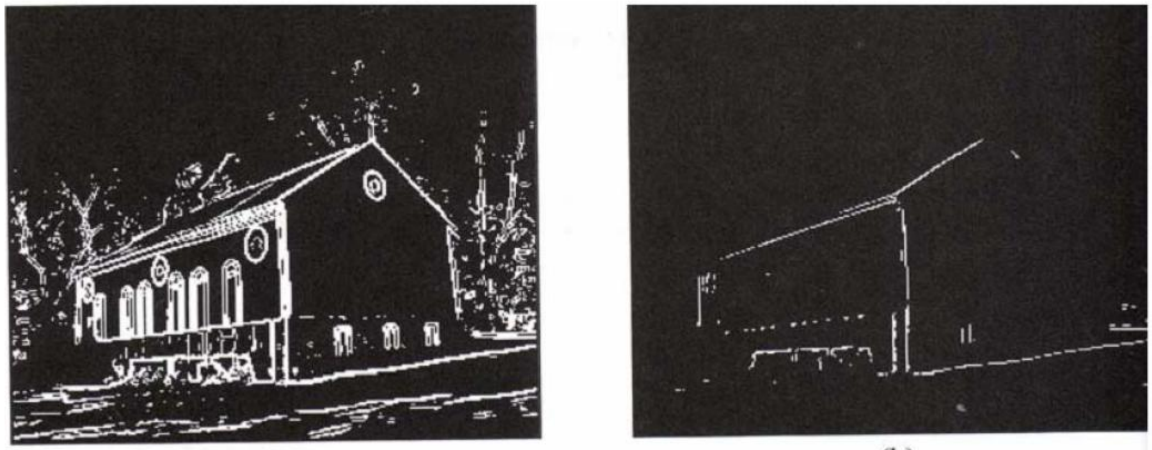
(a) (b)

Figure (9-3): (a) Edge maps created by thresholding the gradient magnitude in figure 11.7 threshold of 50 (b) threshold of 150