Image Segmentation

EDGE DETECTOR

A number of edge detectors based on a single derivative have been developed by various researchers. Amongst them most important operators are the Robert operator, Sobel operator, Prewitt operator, Canny operator, Krisch operator, etc. In each of these operator-based edge detection strategies, we compute the gradient magnitude in accordance with the formula given below. If the magnitude of the gradient is higher than a threshold, then we detect the presence of an edge. Below we discuss some of these operators.

1. Robert Operator-Based Edge Detector

The Robert Cross operator is a simple gradient operator based on a 2 x ***2*** gradient operator. This operator provides the simplest approximation of the gradient magnitude given as:

$$G[f(i,j)] = [f(i,j) - f(i+1,j+1)] + [f(i+1,j) - f(i,j+1)]$$

The convolution mask for the Robert's operator is shown below. Since the Robert kernel is only a **2** x ***2*** mask, it is quite sensitive to noise.

1	1
−1	−1

2. Sobel Operator-Based Edge Detector

Sobel operator is a **3** x **3** neighborhood based gradient operator. The convolution masks for the Sobel operator are defined by the two kernels shown in following figure the two masks are separately applied on the input image:

1	2	1
0	0	0
−1	−2	−1

(a)

1	0	−1
2	0	−2
1	0	−1

(b)

figure: Sobel masks to compute (a) gradient G_x, and (b) gradient G_y,

*T*o yield two gradient components G_x and G_y in the horizontal and vertical orientations respectively.

$$G_x = [f(i-1, j-1) + 2f(i-1, j) + f(i-1, j+1)] - [f(i+1, j-1) + 2f(i+1, j) + f(i+1, j+1)]$$

and

$$G_y = [f(i-1, j-1) + 2f(i, j-1) + f(i+1, j-1)] - [f(i-1, j+1) + 2f(i, j+1) + f(i+1, j+1)]$$

The gradient magnitude is usually computed as:

$$G[f(x, y)] = \sqrt{G_x^2 + G_y^2}$$

However, the other two formulae in Eq. 1 can also be used to compute the gradient magnitude. The direction of gradient is computed as in Eq. 2.

The result of an edge image generated by the Sobel operator is shown in following figure. The edge images have been computed using threshold values 110, 90 and 70. It may be observed from the images that as the treshold value is decreased, more and more number of non edge points become edge points

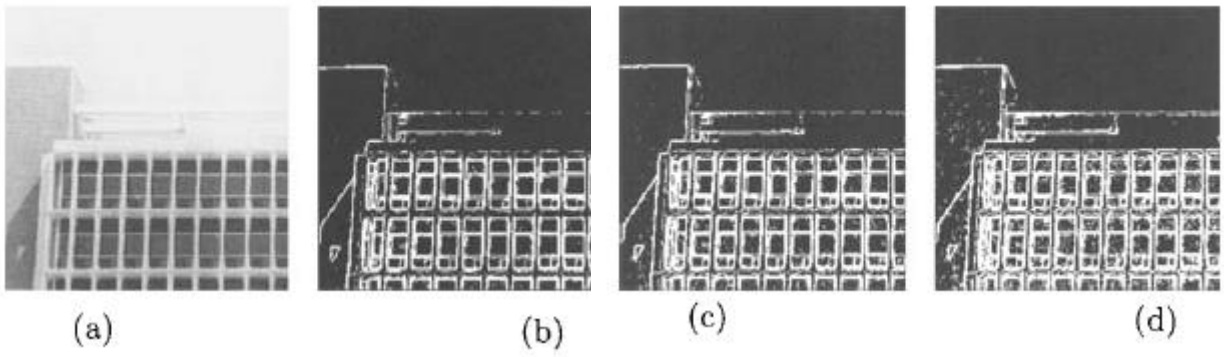

figure: Edge Image using Sobel operator (a) Original image, edge detection using threshold value (b) 110, (c) 90, (d) 70.

3. Prewitt Operator-Based Edge Detector

The Prewitt operator is defined by a set of eight masks, four of which are shown in following figure. Others can be generated by rotation of 90^0 successively. The mask that produces maximal response yields the direction of the gradient. The magnitude and direction of the edge gradients can be computed in a similar fashion as in the Sobel operator. The result of an edge image generated by the Prewitt operator is shown in following figure.

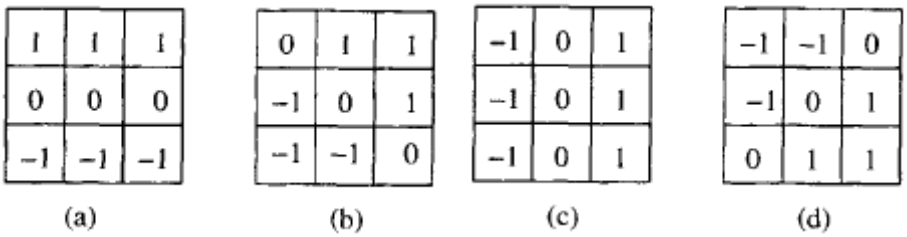

figure: Prewitt masks in 90^0 successive rotations

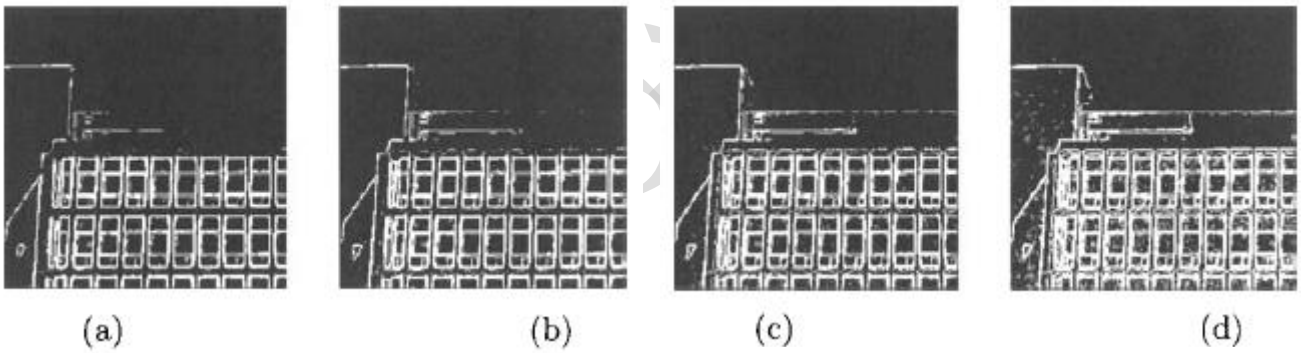

figure: Prewitt results with thresholds (a) 110, (b) 90, (c) 70 (d) 50

4. Kirsch Operator

Similar to the Prewitt operators, Kirsch masks can be defined in eight directions, which yields the estimated gradients in these directions. In following figure, we show the Kirsch masks which detect gradients in four directions only.

3	3	3
3	0	3
−5	−5	−5

(a)

−5	3	3
−5	0	3
−5	3	3

(b)

5	−3	−3
5	0	−3
5	−3	−3

(c)

−3	−3	−3
−3	0	−3
5	5	5

(d)

figure: Kirsch masks to compute gradients in four directions