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Comparison of Edge Detection using Video Aquisition

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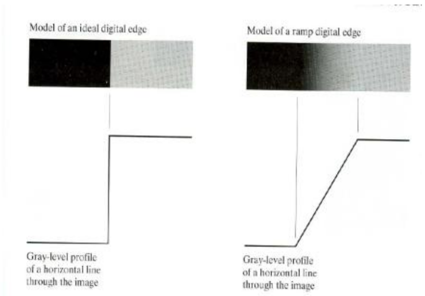
Abstract: Edges detection Characterize boundaries and are therefore considered for prime importance in image processing. Edge detection is the foundation of object recognition and computer vision. The various Edge detection methods are applied to find the edges of objects in the input video stream. Comparative analysis of these above techniques based on certain parameters like type of edge, edge localization, nature, cost ,role …etc are discussed in this paper.

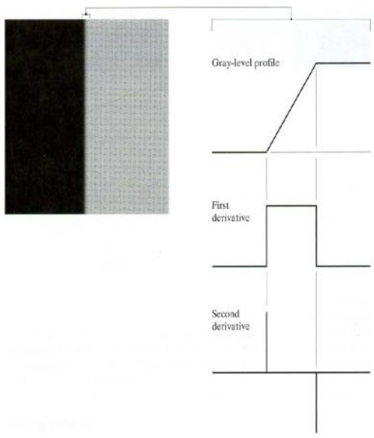
Keywords: Robets, Prewitt, Sobel, canny

Introduction:

Ideal edge has the properties of the model shown in below figure. An ideal edge according to this model is a set of connected pixels(in the vertical direction here) each of which is located at orthogonal step transition in gray level (as shown by the horizontal profile in the figure).In practice, Optics, Sampling and other image acquisition imperfections yield edges that are blurred, With the degree of blurring being determined by factors such as the quality of the image acquisition system, the sampling rate and illumination conditions under which the image is acquired. As a result, edges are more closely modeled as having a "ramplike" profile, such as the one shown in below figure.



The first derivative is positive at the points of transition into and out of the ramp as we move from left to right along the profile : it is constant for points in the ramp; and is zero in areas of constant gray level. The second derivatives is positive at the transition associated with the dark side of the edge, negative at the transition associated with the light side of the edge, and zero along the ramp and in areas of constant gray level. The signs of the derivatives in below figure would be reversed for an edge that transition from light to dark.



The magnitude of the first derivative can be used to detect the presence of an edge in an image. And the sign of the second derivative can be used to determine whether an edge pixel lies on the dark or light side of an edge. The first derivative at any point in an image is obtained by using the magnitude of the gradient at that point. The second derivative is similarly obtained by using the Laplacian.

Gradient Operators:

First order derivatives of a digital image are based on various approximations of 2-D gradient. The gradient of an image *f*(x,y) at location (x,y) is defined as the vector.

$$\nabla \mathbf{f} = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix}.$$

An important quantity in edge detection is the magnitude of this vector denoted ∇f . Where

$$\nabla f = \text{mag}(\nabla \mathbf{f}) = [G_x^2 + G_y^2]^{1/2}.$$

The direction of the gradient vector also is an important quantity . Let $\alpha(x,y)$ represent the direction angle of the vector at (x,y). Then

$$\alpha(x, y) = \tan^{-1}\left(\frac{G_y}{G_x}\right)$$

Where angle measured with respect to the x-axis. The direction of an edge at (x,y) is perpendicular to the direction of the gradient vector at that point.
The different types of gradient operators are:

Roberts cross gradient operator:

It is based on the principle that difference on any pair of mutually perpendicular direction can be used to calculate the gradient. Difference between diagonally adjacent pixels is used to process the image.

Prewitt operator:

It is performed using 3x3 mask. In this mask, the derivative in x-direction is calculated by difference between first and third row of 3x3 mask.

$$G_x = (z_7 + z_8 + z_9) - (z_1 + z_2 + z_3)$$

Similarly, the derivative in y- direction is calculated by the difference between first and third columns of mask.

$$G_y = (z_3 + z_6 + z_9) - (z_1 + z_4 + z_7).$$

−1	−1	−1
0	0	0
1	1	1

−1	0	1
−1	0	1
−1	0	1

Sobel operator

It uses two 3x3 kernels which are convolved with the original image to calculate approximations of the derivatives - one for horizontal changes and the other for vertical

$$G_x = (z_7 + 2z_8 + z_9) - (z_1 + 2z_2 + z_3)$$

$$G_y = (z_3 + 2z_6 + z_9) - (z_1 + 2z_4 + z_7).$$

−1	−2	−1
0	0	0
1	2	1

−1	0	1
−2	0	2
−1	0	1

Canny edge detector:

The edge detection method proposed by Canny is based on the image gradient computation but in addition tries to:

- Maximize the signal to noise ratio for a proper detection.
- Find a good localization of the edge point.
- Minimize the number of positive responses around a single edge.

The Steps of the Canny edge detection method are given below:

- Noise filtering through a Gaussian kernel.
- Computing the gradient's module and direction.
- Non-maxima suppression of the gradient module
- Edge linking through adaptive hyteresis threshold

Experimental Analysis

Edges are detected using the Sobel, Prewitt, and Roberts methods, by thresholding the gradient function. For the Canny method , a threshold is applied to the gradient using the derivative of a Gaussian filter.

Figure1: Video input

Detection using Sobel Filter

The Sobel method finds edges using the Sobel approximation to the derivative. It returns edges at those points where the gradient of the video input frame is maximum. Figure2 displays the results of applying the sobel method to the video input of Figure1.

Figure2:Sobel edge map of Figure3

Detection using Prewittl Filter

The Prewitt method finds edges using the Prewitt approximation to the derivative. It returns edges at those points where the gradient of the video input frame is maximum. Figure3 displays the results of applying the Prewittl method to the video input of Figure1.

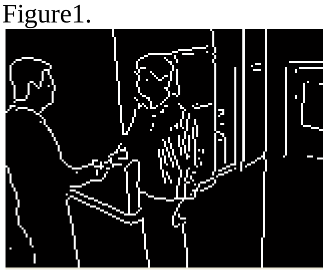


Figure3: Prewitt edge map of Figure1

Detection using Roberts Filter

The Roberts method finds edges using the So Roberts approximation to the derivative. It returns edges at those points where the gradient of the video input frame is maximum. Figure4 displays the results of applying the Roberts method to the video input of Figure1.

Figure4: Roberts edge map of Figure1

Detection using canny

The canny edge method finds edges by looking for local maxima of the gradient of the video input frame. The gradient is calculated using the derivative of the Gaussian filter. Figure5 displays the results of applying the Roberts method to the video input of Figure1.

Figure5:Roberts edge map of Figure1

Conclusion

In this paper, different edge detection methods have been studied for video input. Sobel, Prewitt, Roberts, Canny edge detectors have been experimented to identify the edges by using the MATLAB software. The results are analysed and compared. Sobel edge detector method is some what tough than
Prewitt edge detector. But Prewitt produces slightly noisy results. Robert edge detector gives minor details about video input frame. Canny edge detector gives the most prominent results than other detectors.

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