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A Review on Edge Detection Technique

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***Abstract*— Edge is defined as the outside limit of an object, area, or surface. Edge detection is the process of identifying the edge or border of any object. Edge detection is first and important step in image processing. Steps of any Edge detection technique comprises of Smoothing, Finding gradients, Non-maximum suppression, Double thresholding. In Edge detection technique detecting the edge and ignoring unwanted data. In this paper discussed about some edge detection technique**.

Keywords— Face recognition , Edge detection, Biometric.

I. INTRODUCTION

Human Face detection is the process of identifying the features of faces to detect the faces on the basis of the discriminate features. Features of faces are eyes, ears, eyebrows, nose, lips, hairs, chicks, forehead etc. Face detection can be carried out using these features of faces. Face is important part to identify the person. It can be used as the computer visual application. Face is the important part of our body by which it is easy to identify and recognize the person. [1] Face recognition is also defined as the process of automatically identifying and verifying a person from a digital image. Computer based face recognition systems for security applications is a widely researched topic as facial features provide unique biometric identity for users. Face recognition systems are based on object recognition and tracking technologies. One of the important steps in object recognition is successful edge identification and extraction [2]. Edge detection is a very important area in the field of Computer Vision. Edges define the boundaries between regions in an image, which helps with segmentation and object recognition. They can show where shadows fall in an image or any other distinct change in the intensity of an image. Edge detection is a fundamental of low-level image processing and good edges are necessary for higher level processing. [3].

Edge detection is a well developed field on its own within image processing. Edge detection is basically image segmentation technique, divides spatial domain, on which the image is defined, into meaningful parts or regions. Edges characterize boundaries and are therefore a problem of fundamental importance in image processing. Edges typically occur on the boundary between two different regions in an image. Edge detection allows user to observe those features of an image where there is a more or less abrupt change in gray level or texture indicating the end of one region in the image and the beginning of another. It finds practical applications in medical imaging, computer guided surgery diagnosis, locate object in satellite images, face recognition, and finger print recognition ,automatic traffic controlling systems, study of anatomical structure etc[4].

Edge is a part of an image that contains significant variation. The edges provide important visual information since they correspond to major physical, photometrical or geometrical variations in scene object. Physical edges are produced by variation in the reflectance, illumination, orientation, and depth of scene surfaces. Since image intensity is often proportional to scene radiance, physical edges are represented by changes in the intensity function of an image [5].

Depending upon variation of intensity / grey level various types of edges are shown in Figure 1[6].

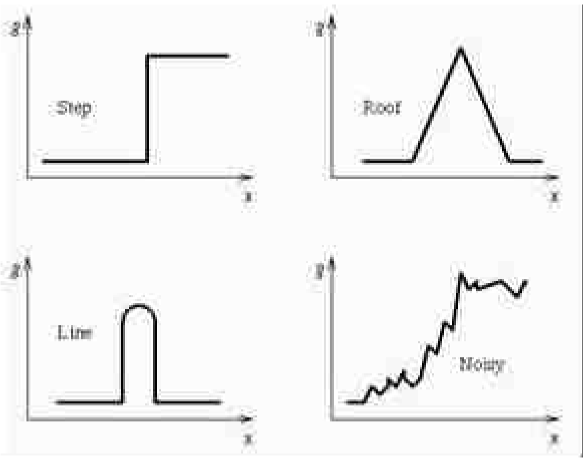


Fig.1 Typical edge profiles

Generally, Edge detection contains three steps namely Filtering, Enhancement and Detection.

1. Filtering:

Some major classical edge detectors work fine with high quality images, but often are not good enough for noisy pictures because they cannot distinguish edges of different significance. Noise is unpredictable contamination on the original image. There are various types of noise, but the most broadly studied two kinds are white noise and ―salt and pepper‖ noise. During salt and pepper noise, pixels in the image are very different in color or intensity from their surrounding pixels; the defining characteristic is that the value of a noisy pixel bears no relation to the color of surrounding pixels. In general this type of noise will only affect a small number of image pixels. When analyzed, the image contains dark and white dots, hence the word salt and pepper noise.

2. Enhancement:

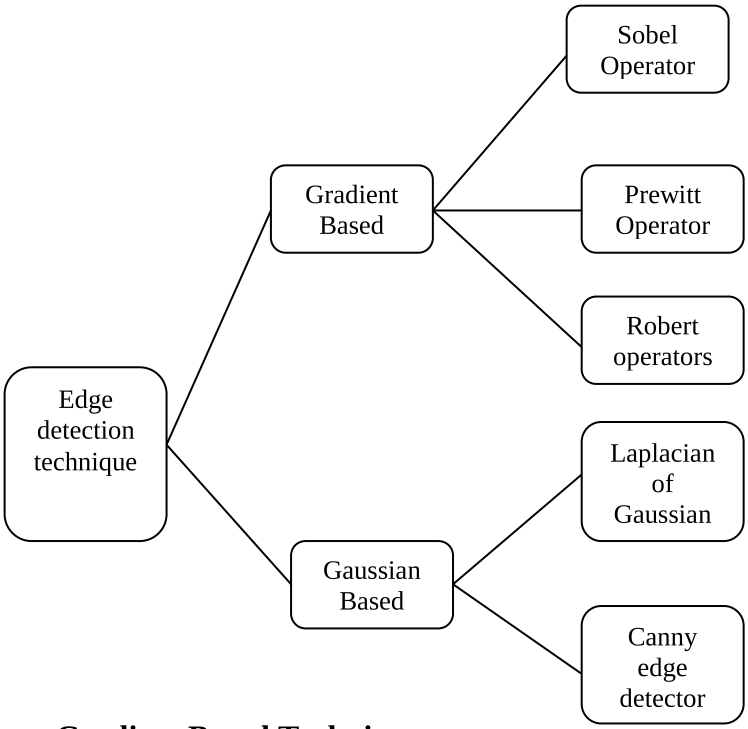
Digital image enhancement techniques are concerned with improving the quality of the digital image. The principal objective of enhancement techniques is to produce an image which is better and more suitable than the original image for a specific application. Linear filters have been used to solve many image enhancement problems. Not all image sharpening problems can be satisfactorily addressed through the use of linear filters.

3. Detection:

Many points in an image have a nonzero value for the gradient, and all of these points are not considered as edges for a particular application. Some methods should be used to determine which points are edge points or not [2].

II DIFFERENT EDGE DETECTION TECHNOLOGIES

Edge detection makes use of differential operators to detect changes in the gradients of the grey levels. It is divided into two main categories:



A. Gradient Based Technique

1. Robert operator

It is gradient based operator. It firstly computes the sum of the squares of the difference between diagonally adjacent pixels through discrete differentiation and then calculate approximate gradient of the image. The input image is convolved with the default kernels of operator and gradient magnitude and directions are computed. It uses following 2 x2 two kernels:

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G_x =

1	0
0	-1

G_y =

0	1
-1	0

The plus factor of this operator is its simplicity but having small kernel it is highly sensitive to noise not and not much compatible with today's technology. These kernels are designed to respond maximally to edges running at 45° to the pixel grid, one kernel for each of the two perpendicular orientations. The kernels can be applied separately to the input image, to produce separate measurements of the gradient component in each orientation (call these *Gx* and *Gy*). These can then be combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient. The gradient magnitude is given by:

$|G| = \sqrt{Gx + Gy}$

although typically, an approximate magnitude is computed using:

$|G| = |Gx| + |Gy|$

which is much faster to compute.

The angle of orientation of the edge giving rise to the spatial gradient (relative to the pixel grid orientation) is given by:

$q = \arctan(Gy/Gx) - 3\pi/4$

2. Sobel operator

Sobel operator is a discrete differentiation operator used to compute an approximation of the gradient of image intensity function for edge detection. At each pixel of an image, sobel operator gives either the corresponding gradient vector or normal to the vector. It convolves the input image with kernel and computes the gradient magnitude and direction. It uses following 3x3 two kernels:

G_x =

-1	0	1
-2	0	2
-1	0	+1

G_y =

1	2	1
0	0	0
-1	-2	-1

These kernels are designed to respond maximally to edges running vertically and horizontally relative to the pixel grid, one kernel for each of the two perpendicular orientations. The kernels can be applied separately to the input image, to produce separate measurements of the gradient component in each orientation (call these *Gx* and *Gy*). These can then be combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient [3]. The gradient magnitude is given by:

$|G| = \sqrt{Gx^2 + Gy^2}$

Typically, an approximate magnitude is computed using:

$|G| = |Gx| + |Gy|$

which is much faster to compute.

The angle of orientation of the edge (relative to the pixel grid) giving rise to the spatial gradient is given by:

$q = \arctan(Gy/Gx)$

As compared to Robert operator have slow computation ability but as it has large kernel so it is less sensitive to noise as compared to Robert operator. As having larger mask, errors due to effects of noise are reduced by local averaging within the neighborhood of the mask [8].

3 Prewitt operator

The function of Prewitt edge detector is almost same as of sobel detector but have different

Kernels:

G_x

-1	0	1
-1	0	1
-1	0	+1

G_y

-1	0	1
-2	0	2
-1	0	+1

B. **Guassian Based**

1. Laplacian of Gaussian

Laplacian of gaussian is also known as Marr-Hildreth Edge Detector. Laplacian of Gaussian function is referred to as LoG. In this approach, firstly noise is reduced by convoluting the image with a Gaussian filter. After that isolated noise points and small structures are filtered out with smoothing. Those pixels, that have locally maximum gradient, are contemplated as edges by the edge detector in which zero crossings of the second derivative are used. Only the zero crossings, whose corresponding first derivative is above some threshold, are selected as edge point in order to avoid detection of insignificant edges. By using the direction in which zero crossing occurs we can obtain the edge direction.

The LoG of an image f(x,y) is a second derivative defined as

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

It first smoothes the image and then computes the Laplacian. This yields in double edge image; hence for finding the edge the zero crossing between the double edges is taken.

The Laplacian of an image with the pixel intensity value L(x,y) is given by:

$$L(x,y) = \frac{\partial^2 I}{\partial x^2} + \frac{\partial^2 I}{\partial y^2}$$

The commonly used discrete approximations to Laplacian filter are:

1	1	1
1	-8	1
1	1	1

L_x

-1	2	-1
2	-4	2
-1	2	-1

L_y

The Gaussian filtering is combined with Laplacian to break down the image where the intensity varies to detect the edges effectively [7].

2. Canny Edge Detection

Canny edge detector is one of the most commonly used image processing tools. It detects edges in a very robust manner.

Unlike Roberts Cross and Sobel, the canny operation is not very susceptible to noise. It takes less time than Roberts cross. It is one of the most important methods to find the edges by separating noise from input image. The algorithm is adaptable to various environments. It is a better method because it extracts the features in an image without disturbing its features. There are certain criteria to improve current methods of edge detection. The first and most obvious is low error rate. It is important that edges occurring in images should not be missed. The second criterion is that the edge points be well localized i.e. the distance between the edge pixels as found by the detector and the actual edge should be minimum. A third criterion is to have only one response to a single edge.

2.1 Importance of Canny

Despite of number of edge detection techniques available canny algorithm is considered because it contains a number of adjustable parameters which can affect the computation time and effectiveness of the algorithm.

a) The size of the Gaussian filters: The smoothing filter used in the first stage directly affects the results of the detection of small, sharp lines. A larger filter causes more blurring, smearing out the value of an given pixel over a larger area of image.

b) The use of two thresholds with hysteresis allows more flexibility than in a single-threshold. A threshold set too high can miss important information. On the other hand, a threshold set too low will falsely identify irrelevant information (such as noise) as important.

The edge detection in this technique is optimized with regard to the following criteria.

a) Maximizing the signal-to-noise ratio of the gradient.

b) Edge localization for ensuring the accuracy of edge.

c) Minimizing multiple responses to a single edge [7].

III. CONCLUSION

Edge detection is the initial and first step in any image processing. The Edge of the image is extracted and ignoring unwanted data. Detecting the edge reduce the amount of data. In this paper we discuss about some edge detection technique. We discuss about Gradient based and Gaussian based edge detection technique. Gradient based edge detection techniques are Sobel, Prewitt and Robert Operator. Gaussian based edge detection techniques are Laplacian of Gaussian and canny edge detector.

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