A Performance Comparison on Different Edge Detection Techniques for Iris Images

Dr.R.Shanmugasundaram
Associate Professor, Department of Computer Science,
Erode Arts and Science College (Autonomous),
Erode, Tamil Nadu, India.
Email: rshanmuga.lec@gmail.com
Dr.S.Prasath
Assistant Professor, Department of Computer Science,
Nandha Arts and Science College
Erode, Tamil Nadu, India.
Email: softprasaths@gmail.com

Abstract – Image Segmentation plays an important role in image processing and computer vision. Segmentation subdivides an image into its constituent regions or object. Image segmentation can be obtained by using various methods, some which are easier to achieve than others due to the need of high programming. Edge detection techniques are mostly used to find object based on local changes in intensity field of image processing applications. In this paper attempt to study the most commonly used edge detection techniques such as canny, Sobel, Prewitt, Roberts, LoG. From the experiments and results observed the canny edge detection gives better results.

Keywords- PCA, ICA, LDA, DCT, LFA, LoG.

1. INTRODUCTION

Since last decades, researchers are involved on iris recognition in image processing and they achieved so many mile stone because iris recognition is the critical stage to identify the iris in images due to pose, presence or absence of structural components, iris expression, occlusion, image orientation. Several methods have been evolved to increase recognition rate.

Many biometric recognition methods have been proposed. Basically, they techniques can be classified into three categories [1]: Holistic or Global-Appearance-based methods [2], Local-feature-based methods or local appearance-based methods, and hybrid methods [3]. In Global-Appearance-based methods, the whole image is used as a raw input to the learning process. Examples of these techniques are Principal Component Analysis (PCA), Discrete Cosine Transforms (DCT), and Linear Discriminate Analysis (LDA). The local appearance-based methods can be divided into two groups: The ones that require the use of specific regions located on a iris such as eyes, nose and mouth, as well as their relationships with each other [4] and the ones that simply partition the input iris image into blocks without considering any specific regions [5]. In hybrid methods, associate feature of the holistic and local techniques. Modular Eigen iriss [6] Hybrid Local Feature Analysis (LFA) [7] and Component-based 3D Models [8] are examples of these methods. The most successful and well-studied techniques to iris recognition are the appearance-based methods.

While capturing the image, due to motion or interference some disturbance, blur etc is added automatically in the image. This is called noise. The features cannot be extracted correctly from such images. To improve the quality of image, enhancement techniques such as edge sharpening, noise removal etc are used. [9]. The output of image processing can be either an image or a set of characteristics or parameters related to image. The image processing techniques like image restoration, image enhancement, image segmentation. Also, segmentation refers to the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). Image segmentation is typically used to locate objects and boundaries (lines, curves, edges etc.) in images. The segmentation process may include edge detection. Sometimes edge detection is used for feature extraction.

2. EDGE DETECTION TECHNIQUES

2.1 Edge Models

Edge models are classified according to their intensity profiles. A step edge involves a transition between two intensity level levels occurring ideally over the distant of 1 pixel. Edges that are blurred and noisy, determined by limitations in the focusing mechanism and noise level determined by the electronic components of imaging system. In such situations, edges are more closely modeled as having an intensity ramp profile. The slope of the ramp is inversely proportional to the degree of blurring in the edge. It can be seen that in this model, there is no thin (1 pixel thick) path. Instead, an edge point which is now any point contained in the ramp, and an edge segment would then be a set of such points that are connected. A third model of an edge is called roof edge. Roof edges are models of lines through a region, with the base of a roof edge being determined by the thickness and sharpness of the line [12].

2.2 Sobel Operator

Sobel edge detection method was introduced by Irwin Sobel in 1970 (Rafael C. Gonzalez (2004)). The Sobel technique of edge detection for image segmentation finds edges using Sobel approximation derivative. Typically it is used to find the approximate absolute gradient magnitude at each point in an input grayscale image. The operator consist of a pair of 3x3 convolution mask, which is the x and y direction on the image. It is discovered at first derivative level. The horizontal and vertical pixel masks for Sobel Operator are shown in figure 1. This is very similar to Robert Cross operator.

Gx

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

Gy

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

Fig. 1 Sobel operator

The mask will be moved until all the images and each value, R, will be kept into an output array, which is located at the mask centre. The formula to find the gradient magnitude is Equation (1).

$$|R| = |R_x||R_y| \quad \text{...... (equ.1)}$$

Where R_x and R_y are given by using (equ.2) and (equ.3)

$$R_x = (a2+ca3+a4) - (a0+ca7+a6) \quad \text{...... (equ.2)}$$

$$R_y = (a0+ca1+a2) - (a6+ca5+a4) \quad \text{...... (equ.3)}$$

Where c is a constant with a value 2.

2.3 Prewitt Edge Detection

Prewitt Operator is pioneered by Judy Prewitt and is based on the central difference concept and is given by,

$$\frac{\partial p}{\partial x} \approx \frac{p(x+1,y) - p(x-1,y)}{2} \quad \text{...... (equ.4)}$$

The convolution masks of prewitt operator are shown in figure 2. Prewitt operator is similar to the Sobel operator and is used for detecting vertical and horizontal edges in images.

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

Fig. 2 Prewitt operator

2.4 Robert Cross Edge Detection

The Robert Cross operator performs a simple, quick to compute 2-D spatial gradient measurement on an image. Pixel values at each point in the output represent the estimated absolute magnitude of the spatial gradient of the input image at that point. The operator consists of a pair 2x2 convolution masks as shown in figure 3. This is very similar to the Sobel operator. It uses {+1,–1} operator that will calculate the value

$$p(\bar{x}_i) - p(\bar{x}_j) \quad \text{...... (equ.5)}$$

For (i,j) pixel at neighborhood pixel. Mathematically, this equation is known as forward differences.

$$\frac{\partial p}{\partial x} \approx p(x+1,y) - p(x,y) \quad \text{...... (equ.6)}$$

Calculation for gradient magnitude is,

$$G = \sqrt{(g_x \cdot f)^2 + g_y \cdot f)^2} \text{...... (equ.7)}$$

Convolution mask of Robert Cross Operator is shown in Figure 3.

+1	0
0	-1

gx

0	+1
-1	0

gy

Fig.3 Robert Operator

2.5 Laplacian of Gaussian (LoG)

This edge detector was invented by Marr and Hildreth (1980) who combined Gaussian filtering with the Laplacian. Those who continued his way were Berzins (1984), Shah, Sood and Jain (1986), Huertas and Medioni (1986). The Laplacian is often applied to an image that has first been smoothed with something approximating a Gaussian Smoothing filter in order to reduce its sensitivity to noise. The operator normally takes a single gray level image as input and produces another gray level image as output.

2.6 Canny Edge Detection

The current standard edge detection scheme widely used around the world is the canny edge detector. John Canny did for his Masters degree in MIT in 1983. The canny edge detector first smoothes the image, to eliminate noise and then finds the image gradient to highlight regions with high spatial derivatives. The algorithm then tracks along these regions and suppresses any pixel that is not at the maximum.

3. EXPERIMENTATION & RESULTS

In this paper, the edge detection technique is used as a preprocessing technique where localization of iris is more important. With edge detection techniques, other algorithms can also be used such as Hough Transform, Integro-differential operator etc to localize the iris. For our experiments, the sample iris print images from the standard iris image database are used. From the below Table.3.1 it is shows that pixels values of the original image and output of Sobel edge, Roberts edge, Prewitt edge, LoG edge and Canny edge. By considering all the pixels values and the results shows canny edge detected images high compared with other edges.

Images	Original Image	Sobel	Prewitt	Robert	LoG	Canny
1	3164444	678	578	688	1394	1854
2	2685513	725	735	768	1485	1997
3	2761159	557	598	654	1229	1785
4	2438330	468	415	575	1045	1859
5	2209490	486	489	532	1245	1563

Table.3.1 Pixels Values of Edge Detected Image

4. CONCLUSION

The edge detection is the initial step for recognition technique, it is important to show the differences between various edge detection techniques. In this paper we studied the most commonly used edge detection techniques such as Canny, Prewitt, Sobel and Roberts. The Prewitt operator has a major drawback that it is very sensitive to noise and it does not consider the high frequency variation. The Roberts operator works well only when the acquired image has very less noise and well defined edges. The Sobel operator is having smoothing capability, which smoothen all the edges. So it is difficult to find the edges correctly. Canny operator finds all the strong and weak edges those are connected to strong edges only. Therefore, edge features can be extracted easily and correctly with canny operator. Computationally Prewitt, Sobel and Roberts operators are simple whereas Canny is more expensive, even though it provides better results.

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