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PERFORMANCE MEASURE OF LOCAL OPERATORS IN FINGERPRINT DETECTION

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ABSTRACT

Digital image processing encompasses processes whose inputs and outputs are images that extract attributes from images. This paper, 'Performance measure of local operators in fingerprint detection' aims at detecting the edges of fingerprint images. This method uses five local operators namely Sobel, Roberts, Prewitt, Canny and LoG. The edge detected image is further segmented to extract individual segments from the image. Performance measure of the local operators is obtained by calculating the peak signal to noise ratio by adding various external noise. The performances of the local operators for different types of noise are compared and the best operator suited for those noises is obtained. This can be used as a pre-processing for pattern recognition (Fingerprint Recognition) where the edge segmented fingerprint images are required for a comprehensive database for storing the identities of citizens, employees, medical applications etc.

Key words: local operators, noise, pattern recognition

1.Introduction

Among all the biometric techniques, fingerprint-based identification is the traditional method which has been successfully used in numerous applications. Everyone is known to have unique, immutable fingerprints. A fingerprint is made of a series of ridges and furrows on the surface of the finger [1]. The uniqueness of a fingerprint can be determined by the pattern of ridges and furrows as well as the minutiae points. Minutiae points are local ridge characteristics that occur at either a ridge bifurcation or a ridge ending. Fingerprints are today the most widely used biometric features for personal identification. Most automatic systems for fingerprint comparison are based on minutiae matching [2, 3]. A ridge termination is defined as the point where a ridge ends abruptly. Reliable automatic extracting of minutiae is a critical step in fingerprint classification. The performance measure of fingerprints is very important in various fields. Most of the detection methods which have been proposed in the literature are based on image binarization, while some others extract the minutiae directly from gray scale images [4, 5]. Concerning these two approaches, this work proposes the selection of the best local operator for different fingerprints in different situations. The best local operator is selected by calculating the PSNR'S of fingerprint images. Segmentation is employed for separating each component which is mainly used for person identification.

2. Edge Detection

Edge detection is by far, the most common approach for detecting meaningful discontinuities in intensity values. Such discontinuities are detected by using first and second order derivatives. Edge detection of an image reduces significantly the amount of data and filters out information that is not very important, preserving the important structural properties of an image. The methods for edge detection can be grouped in two categories, namely gradient and Laplacian. The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image. The Laplacian method searches for zero crossings in the second derivative of the image in order to find edges. The local operator used for detecting the edge includes Sobel, Prewitt, Roberts, Canny and Log.

3. Noises

Fingerprint images may contain some dust particles etc., which reduces the identification accuracy. In this, certain types of noise are added to the input image to get a blurred image. The external noise added may be Salt and pepper, Speckle, Gaussian or Poisson. Each type of noise has its own variation on the image. This input image along with noise added is edge detected using a local operator to get an edge detected image. The edge detected images of the input image and the input image with noise are compared to find out the amount of error introduced in the fingerprint image due to the addition of external noise.

4. Segmentation

For segmentation process the input image should be devoid of noise. Therefore the edge detected images are passed through median filters to eliminate noise[6,7]. The edge detected image without noise is given as input for the segmentation process. In the edge detected image, an edge is one which has continuity in its intensity level. Each such edge is labeled using a function, as a result of which each edge or line segment of the edge detected image is allocated with a particular number. The maximum number of line segments found in the edge detected image is also determined using the function. With the maximum number of line segments known, a particular line segment can be segmented from the edge detected image by specifying the number assigned to the line segment. This is done by comparing the number assigned to each line segment with the input number to find out which matches with it, then all the other segments are masked as 0 while the required line segment is given as 1 and can be viewed. The specified line segment in the edge detected image is segmented and the required line segment is alone displayed as output.

5. Peak Signal to Noise ratio

The PSNR is the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. The PSNR is most commonly used as a measure of quality of reconstruction in image compression etc. It is most easily defined via the mean squared error (MSE) which for two m×n monochrome images I and K considering one of images as a noisy approximation of the other.It is defined as:

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}||I(i,j) - K(i,j)||^2$$

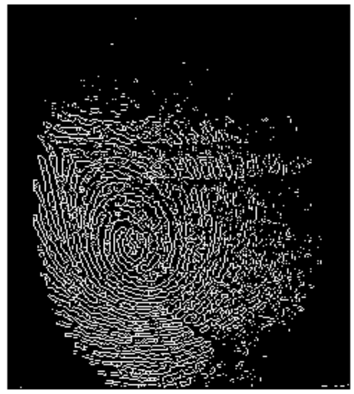
The PSNR is defined as:

$$PSNR = 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right) = 20 \cdot \log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right)$$

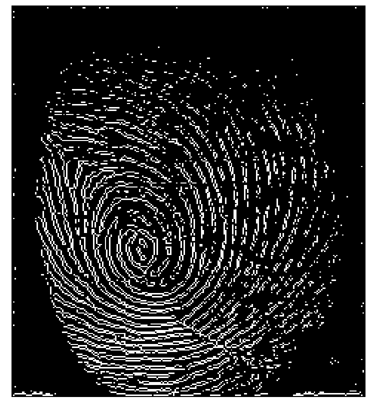
Here, MAX_I is the maximum pixel value of the image. When the pixels are represented using 8 bits per sample, this is 255. The peak signal to noise ratio is calculated from the error using the above formula. This value is used to estimate the performance of each local operator for each type of external noise added. The higher the value of the PSNR, the better is the performance of that particular local operator for the noise added. The result of the operators and comparison chart in Fig (1) and PSNR table (Table 1) are shown.

RESULTS

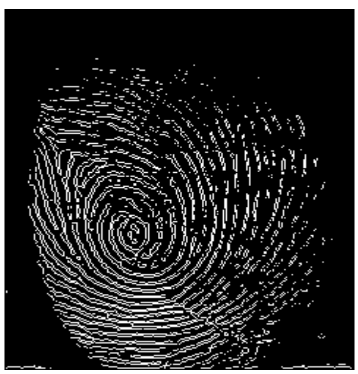
(a) Input image



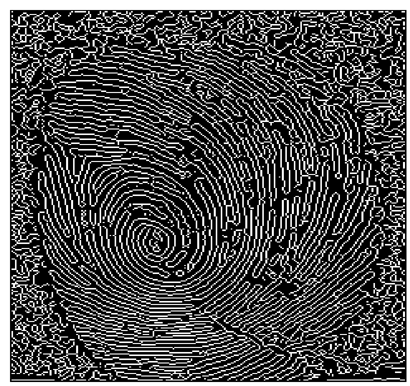
(b) Gaussian noise (Prewitt)



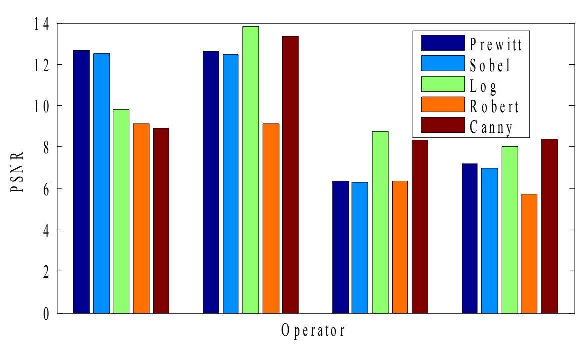
(c) Poisson noise (LoG)



(d) Salt & Pepper (LoG)



(e)Speckle(Canny)



(f)Comparison chart

Fig (1) Performance measure of local operators for different types of noise

6. TABLE 1: PSNR VALUES

	PREWITT	SOBEL	LOG	ROBERTS	CANNY
MSE(Gaussian)	3505.28	3643.34	6783.32	7992.34	8372.01
PSNR(Gaussian)	**12.6836**	12.5153	9.81638	9.10407	8.90251
MSE(Poisson)	3546.5	3694.15	2684.57	7949.19	3016.3
PSNR(Poisson)	12.6325	12.4557	**13.8421**	9.12757	13.3361
MSE(salt &pepper)	12669.2	12165.9	8674.02	15122.7	9535.96
PSNR(salt&pepper)	6.3345	7.2739	**8.7486**	6.3345	8.33
MSE(speckle)	12390.2	13127.5	10313.5	17441	9378.72
PSNR(speckle)	7.20001	6.94897	7.99673	5.71508	**8.40937**

CONCLUSION

The best operator for each noise is obtained by comparing the PSNR values of all local operators. This can serve as a pre processing for pattern recognition. It benefits on saving the time taken for fingerprint matching by providing the best operator for fingerprint images for various noise models. Segmentation of the edge detected image gives the location of each edge. This is used to indicate a particular region inorder to match the finger prints in forensic studies. The result obtained is based on a trial basis by using standard types of noise models. In future, this can be extended by using compound noise which benefits more in person identification applicable to various fields.

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