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FINGER PRINT RECOGNITION BY BACKGROUND SUBTRACTION AND IMAGE ENHANCEMENT WITH GAMMA CORRECTION

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Abstract: The fingerprint identification based on Image enhancement technique is essential for crime scene investigation, authentication of a person. The most challenging fields of computer aided design is to identify a person by his or her fingerprint. In this paper, the quality of each image in the input sequence is assessed and a clear fingerprint is selected from such a sequence for subsequent recognition. After preprocessing, an effective fingerprint image is extracted from the original image. Thereafter, features are extracted from image and those features are analyzed to match with a reference image feature. For this, an algorithm is developed and coded in MATLAB (R2015a).

Keywords: finger print; image analysis; gamma correction; image enhancement.

1. INTRODUCTION

1.1 Image subtraction

Image subtraction algorithm is used to recognize a moving object. This is simple and can be implemented by the limited realtime processing capabilities of the image processing board. Image subtraction is used for recognizing pinball and flippers. The subtracted result compares previous frame image with the current one. The image subtraction is performs between two image by pixel wise. In this method, one image matrix is subtracted from the other image and the output matrix will also be an image matrix.

Let, $I_1(x, y)$ and $I_2(x, y)$ are two images whose sizes are also same. After performing subtraction, the output image, $Q(x, y)$ will be as in Eqn. 1.

$$Q(x, y) = I_1(x, y) - I_2(x, y) \tag{1}$$

If subtraction operator performs only absolute differences between two images then resulting output matrix will be as in Eqn. 2.

$$Q = | I_1(x, y) - I_2(x, y) | \tag{2}$$

For colored or RGB image, the subtraction will be performed between all three components, RGB (i.e., red, green, and blue) of each pixel values of two input images. As result, the resultant output image will contain the subtracted pixel components of two input image matrices.

1.2 Image Enhancement

The interpretability or perception of information present in an image can be improved by performing image enhancement technique. It is done for processing an image to get more suitable values than original image for some specific application. This is divided into two domains: 1. Spatial domain,and 2. Frequency domain. In first method's operation is performed directly on pixels. But in other method, operation is performed on Fourier transform of image. Goodness of enhanced image depends on betterment of an image. If this technique is used as preprocessing tools then quantitative measures determines the most appropriate technique. The method to improve quality of digital image isdone by image enhancement [1-4] techniques in computer graphics. The image editors are some specialized programs to enhance an image quality.

1.3 Gamma Correction

Gamma correction is a method which can be expressed by power law expression.This ia a non-linear method. It can be used for coding and decoding of luminance or tristimulus values present in different still video images. The Gamma correction method can also be mentioned as gamma encoding, gamma nonlinearity, or simply gamma (g). It is expressed in Eqn. 3.

$$V_{out} = V_{in}^{g} \qquad (3)$$

In Eqn. 3, both the input and output values lie in the range, 0 to 1. These values are real and non-negative. When value of Gamma (g) is less than 1, it is encoding gamma which means encoding with compressive power-law nonlinearity (i.e., gamma compression). When g>1, it is called decoding gamma which is an application of expansive power-law nonlinearity (i.e., gamma expansion).

2. FINGERPRINT RECOGNITION

The fingerprint matching defines an automatic method which verifies the similarity between two human fingerprints. In many biometric systems, these are used in various forms to identify and verify the identity of human beings. Fingerprints are unique in nature for each individual. These are also the feature pattern for every person and it is permanent for all. So, for identification of a human being/ person, fingerprints are used in forensic investigation. In a fingerprint, many ridges and furrows are present. These may result good similarities in every small local window, such as parallelism and average width. So, fingerprints can be identified by Minutia not by ridges and furrows. Minutia is the abnormal point detected on the ridges. From a lot of research, it is reported that termination and bifurcation are the two most significant minutia. Termination is immediate ending of ridge and bifurcation is a point on a ridge from which two branches generate.The another process used in image processing which is a method used for expanding pixel value distribution in image for increasing perceptional information [5-8].

3. MATERIALS AND PROPOSED METHOD

To recognize a particular fingerprint, the entire method is divided into two sub-domains: (1) Verification of Fingerprint; (2) Identification of Fingerprint.

3.1 Overview of the Proposed Method

Quality of input fingerprint images determine matching performance of algorithm used for matching. Practically, quality of input acquired fingerprint images are poor. So structures of ridge present in the fingerprint images may not be prominent and or not be correctly detected [9-11]. It may create problems. The main problem is that, distinct number of spurious minutiae can be developed so that large amount of real minutiae may be ignored. As a result, minutiae localization (position and orientation) may become erroneous[12-14].

To ensure robustness of performance of minutiae extraction algorithm with regard to fingerprint image quality, the image enhancement algorithm for improving clarity of structures of ridge is essential.So algorithm is developed and the proposed algorithm is divided into two parts: Part I and Part II. The Part I of the algorithm is stated as follows:

Part I

i. Read two images:1. fingerprint with background and 2. only background.
ii. Convert both images into corresponding gray scale.
iii. Subtract background image from fingerprint with background.
iv. Do the Image enhancement by gamma correction (With gamma (g) value = 2).

Part II

The image which obtained after gamma correction is further processed and match with database for personal identification.

i. Load the image - Load input gray level fingerprint image.Ridges in fingerprint have large gray level intensity compared to valleys and background.

ii. Histogram equalization of the image - The input image is enhanced by histogram equalization.

Let, ‘x’ is a discrete grayscale image. Number of occurrences of gray level ‘*i*’ *is* ‘n_i’.So, probability of occurrence of a pixel of gray level ‘*i*’ in image can be expressed by Eqn. 4.

$$p(x_i) = \frac{n_i}{n}, \qquad i \in 0,.....,L-1 \tag{4}$$

Where,’L’denotes number of gray levels and ’n’denotes number of pixels present in image, ‘x’. ‘p’is histogram of ‘x’, normalized with mean and standard deviation values, ‘0’ and ‘1’ respectively.

Let, ‘C’is CDF (i.e., Cumulative Distribution Function) corresponding to ‘p’. It can be expressed by Eqn. 5.

$$C(i) = \sum_{j=1}^{i} p(x_j) \tag{5}$$

This is accumulated normalized histogram of an image.

iii. Fast Fourier Transform (FFT): It is performed by the value of k.Experimentally optimal value of k is 0.45. The value of k may be other to get better performance. For this, image is segmented into 32 * 32 pixels blocks to perform Fourier Transform using Eqn. 6:

$$F(u,v) = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y) \exp\left\{-j2\pi\left(\frac{ux}{M} - \frac{vy}{N}\right)\right\} \tag{6}$$

where, ‘u’ and’ v’ are pixels blocks consist of values from 0 to 31.For enhancing a specific block by its dominant frequencies. Fast Fourier Transform (FFT) of that particular block is multiplied by its magnitude in a set of times. Magnitude of actual FFT is equal to ‘abs(F(u,v))’, which means ‘|F(u,v)|’.

iii. Binarization- Binarization technique transforms 8-bit gray image into 1-bit image, in which ‘0’-value denotes ridges and 1-value denotes furrows. As a result, ridges becomes highlighted by the color’black’and furrows by color ‘white’.

iv. Direction - It estimates direction of each block of fingerprint imagewith W*W, in size (W is always of 16 pixels by default).

v. ROI Area - ROI means the Region Of Interests and it is extracted by doing two morphological operations: ‘OPENING’and’CLOSING’.

vi. Thinning - Thinning is a process based on filtering. It is done for eliminating redundant pixels present in ridges until to obtain ridges of ‘1’ pixel wide.

vii. Removing H break, Spikes - After thinning, H breaks are removed, isolated peaks are removed and spike are removed by algorithm described in False Minutiae Removal.

viii. Save and Minutia Match - Finally, fingerprint image is saved and matching process is performed with database by minutia match algorithm (alignment stage or match stage)[15-18].

3.2 Algorithm Level Design

In the first part of proposed method, the object is to obtain digital images of background image without fingerprint and background image with fingerprint to perform image subtraction process. The contrast stretching operation and gamma correction are performed on images.

The three stages are performed to obtain minutia in fingerprint image. Those are: (1) Preprocessing; (2) Minutia extraction; (3) Post-processing.

In Preprocessing stage, Histogram Equalization and FFT are performed on fingerprint image for enhancing it.Binarization process is done by locally adaptive threshold method. Then segmentation method is done by using block direction estimation and direction intensity

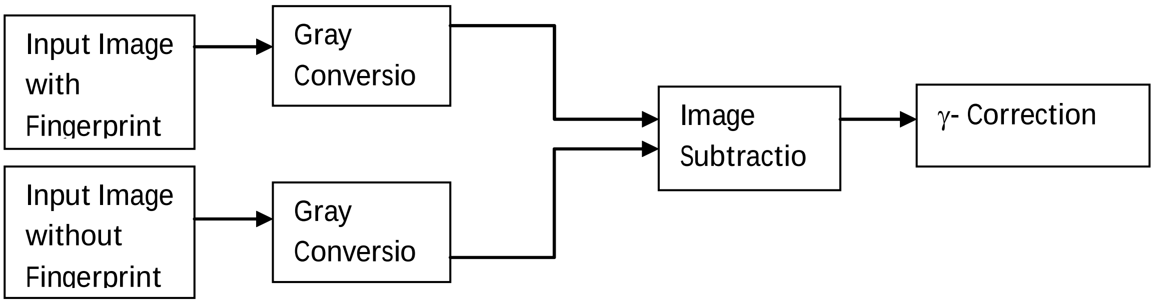


Fig 1: The concept diagram of Part I of proposed method

followed by doing 'OPENING ' and 'CLOSING' Morphological operations to extract ROI.

Thinning algorithms are tested in Minutia Extraction stage.

In the post-processing stage removal of false minutiais done. Bifurcation process is proposed to unify termination and bifurcation.

Fingerprint matching process involves scanning, then testing. An image is scanned and tested against a database of known fingerprints to find out its match. It is a process to obtain "correlation" between two images.

4. SIMULATION AND RESULTS

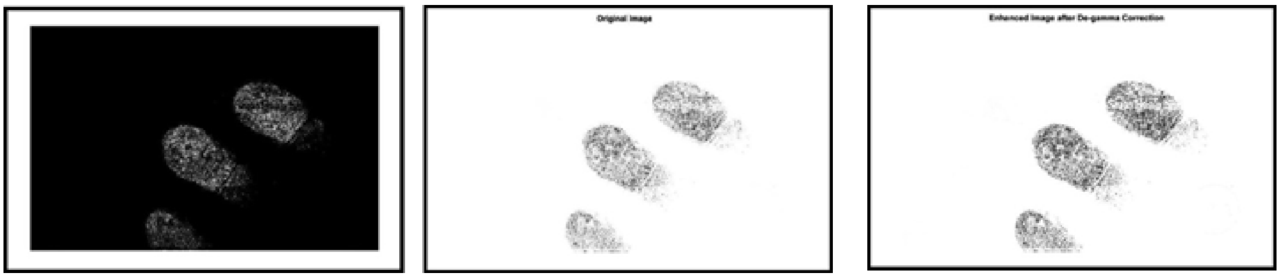
The entire task was programmed in MATLAB (R2015a). For performing this task Matlab functions are written for each steps and then all functions are assembled to obtain the results.

Outputs after simulating the Part I of Proposed Algorithm:

At first a scanned image of a SBI debit card without finger print is taken. After that, the same debit card with fingerprint scanned image is taken in consideration.

(a) (b)

Fig 2: (a)Grayscale conversion image of Scanned debit card without fingerprint RGB image; (b) Grayscale conversion image of Scanned debit card with fingerprint RGB image.



(a) (b) (c)

Fig.3: (a)Image after performing subtraction between Fig 2(b) and Fig 2(a) (i.e., Fig 2(b) - Fig 2(a)); (b) Inverted image of subtracted image, Fig 3(a); (c) : Image after gamma correction of inverted image, Fig 3(b).

Outputs after simulating the Part II of Proposed Algorithm:

In this stage, a set of ten different fingerprint images are taken and database of images is constructed using Matlab R2015a software. Image database is shown in Fig 4. A single fingerprint image is taken as reference image to match with database images. In Fig.5(a), reference image is shown.

All the steps of Part II stage of Algorithm stated in subsection 3.1 are performed. All outputs are shown in Fig.5 and Fig.6.

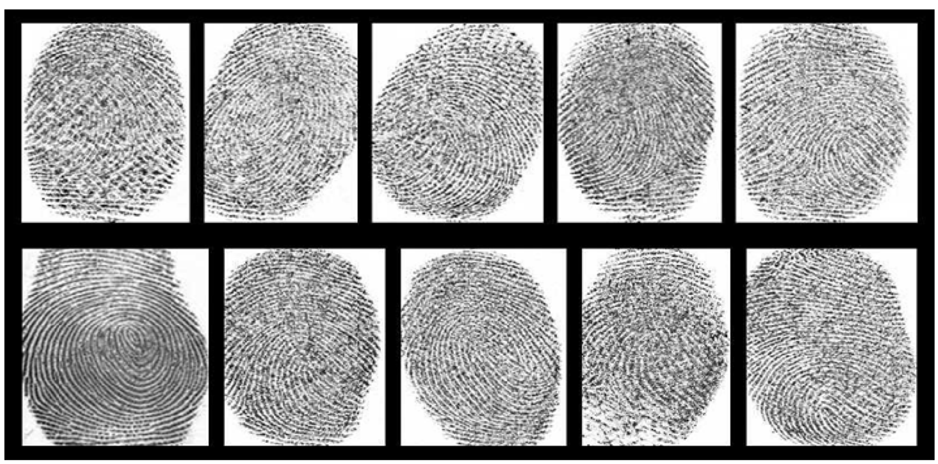


Fig.4: Database of Fingerprints

(a) (b) (c) (d)

Fig 5: (a) Reference image for matching; (b) Output after performing Histogramequalizationon reference image;(c) Enhanced image after doing FFT on image shown in Fig. 5(b); (d) Output after doingbinarization on enhanced image i.e., Fig.5(c)

(a) (b) (c) (d)

Fig. 6: (a) Block Direction Orientation of the image; (b) Obtained Region of Interest; (c) Image after thinning; (d) Image after removing spikes

At last, actual minutiae from images are found. The correlation between input fingerprint image and images present in database are calculated separately. The correlation is calculated by Eqn. (7). If correlation coefficient is greater than 0.80, it is considered as a match [10].

$$r_{xy} = \frac{\sum_i^n \left(x_i - \bar{x}\right)\left(y_i - \bar{y}\right)}{\sqrt{\sum_{i=1}^n \left(x_i - \bar{x}\right)^2 \sum_{i=1}^n \left(y_i - \bar{y}\right)^2}} \qquad (7)$$

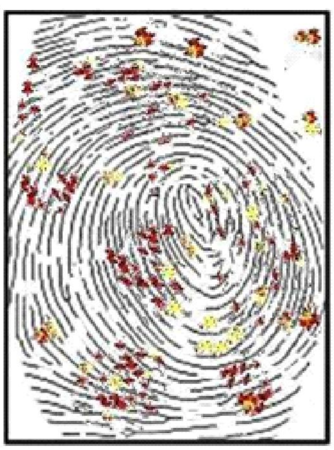


Fig.7: Actual minutiae of the input image

5. CONCLUSION

Image enhancement is an important for identifying evidence at a crime scene. To get rid of background, FFT or background subtraction is performed. In this paper, image enhancement, including gamma corrections is done to remove background and to obtain image for fingerprint matching. After finding minutiae of the images, correlation coefficient is calculated between each image of the database and the input image. When correlation coefficient value is obtained more than 0.80, it is taken as a matching.

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