Fingerprint Identification and Recognition Using Backpropagation Neural Network

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Abstract - Biometrics is a technology, which identifies a person based on his physiology or behavioral characteristics. Fingerprint Identification and Recognition is one of the biometrics methods available that has been widely used in various applications because of it is reliability and accuracy in the process of recognizing and verifying a person identity. The main purpose of this paper is to develop a fingerprint identification and recognition system. The system consists of three main parts; which are image acquisitions, image processing and "identification and recognition".

Fingerprint images are acquired and stored into the database in the image acquisition stage. These images are then enhanced in the image processing stage by performing gray level enhancement, spatial filtering, image sharpening, edge detection, segmentation and thinning processes.

After the image has been processed, it would then be fed into the back propagation neural network as input in order to train the network. After training, the neural network is ready to perform the identification and recognition operations (matching process). A neural network has been successfully developed to identify and recognize the core part of the fingerprint images.

1. INTRODUCTION

Biometrics is a technology, which identifies a person based on his physiological or behavioral characteristics. It relies on "something which you are" to make personal identification and therefore can inherently differentiate between an authorized person and a fraudulent imposter. Biometrics was claimed to be the ultimate technology for automatic personnel identification [1]. Theoretically a human physiological of behavioral characteristics can be used to make a personal identification only if it has the following properties:

i. Universality: Referring to the characteristic, which everybody should have.
ii. Uniqueness: Referring to the characteristics where no 2 persons have the same characteristics
iii. Permanence: Referring to the characteristic, which is unchangeable.
iv. Collectability: Referring to the characteristics, which can be measured quantitatively.

In general, biometrics system operations are available only in two modes: the identification mode and the recognition/verification mode.

1.1 Identification Mode

In this mode, the identity of a person is identified by searching the entire system database for a match. The identity of a person is established according to the retrieval result.

1.2 Recognition/ Verification Mode

In this mode, the authentication of a person identity is made by comparing the captured biometrics measures with his/her own templates stored in the database. Both modes are recognized as *one - to - one* comparison.

2. APPROACH AND METHODS

Generally fingerprint identification and recognition system consist of 3 main parts:

i) Fingerprint Image Acquisition (Collecting Fingerprint)
ii) Fingerprint Image Processing
iii) Fingerprint Identification And Recognition

2.1 Fingerprint Image Acquisition

In this stage, fingerprints samples are taken manually, as there is no fingerprint detector or scanner available. A small daub of ink is placed on the inking slab and thoroughly rolled until a thin and even film of pigment covers the entire surface of the inking slab. Then the bulb of the finger is placed at the right angle to the surface of the inking slab and rolled until the bulb of the finger is evenly inked. The inked finger is impressed on a piece of white paper until satisfactory fingerprint is obtained. Various fingerprint samples are taken from different individuals in order to create a collection of fingerprints patterns available. The fingerprint obtained is then scanned by a regular computer flatbed scanner as gray level images with 400 dpi. The scanned images are saved as Joint Photographic Experts Group (JPEG) format. Fingerprint image acquisition consists of two main parts:

2.1.1 Fingerprint image acquisition for database

In this section, only the useful area of the digitized fingerprint image (JPEG format) acquired in the earlier section would be selected and edited to the size of 256 x 256. The flowchart of this process and its implementation results are shown in Figure 1a.

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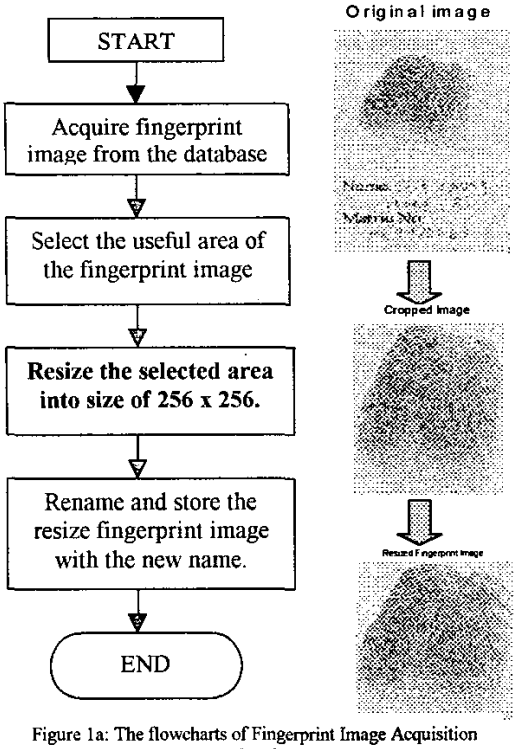


Figure 1a: The flowcharts of Fingerprint Image Acquisition (For Database)

2.1.2 Fingerprint image acquisition for neural network

In this section, only the **core** area of the digitized fingerprint image (JPEG format) acquired in section 2.1.1 would be selected, resized to the size of 64 x 64, renamed and saved into another database; ready to be fed into the neural network for training process. The whole process of this section and its implementation results is illustrated in Figure 1b.

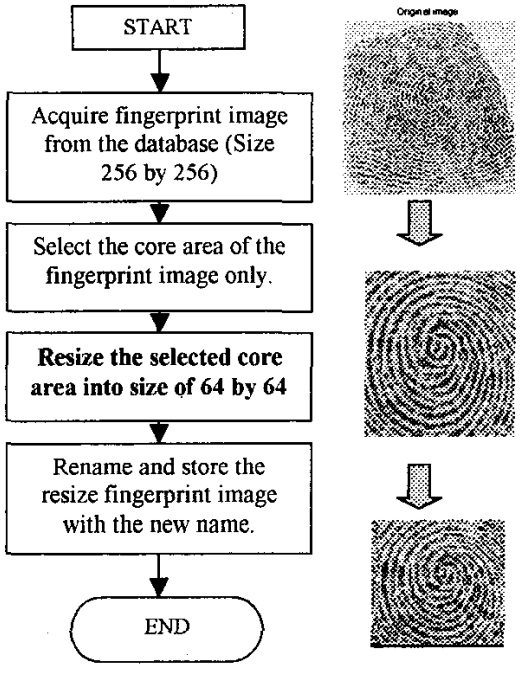


Figure 1b: The flowcharts of Fingerprint Image Acquisition (For Neural Network)

2.1.3 Fingerprint Image Processing

Image processing is best described as a process to improve visual appearance of images to a human viewer. This process is essential in order to prepare the images for further measurement [2]. The fingerprint images are processed by using 6 main image-processing steps. They are:

2.1.4 Gray Level Enhancement

The principle objective of gray level enhancement is to improve the contrast of the fingerprint image because the acquired fingerprint image in the earlier session might be too bright or too dark [3].

2.1.5 Median Filtering

In this stage the fingerprint image is filtered in order to reduce or suppress noise [3].

2.1.6 Image Sharpening

- The prime objective is to highlight the fine detail in the fingerprint image [2].

2.1.7 Edge Detection

In this stage, the edges existing inside the fingerprint images are detected by using Sobel edge detection method. Sobel mask is convoluted with the original image in order to detect the significant edges. The Sobel mask is given by equation 1.0 [4]:

$$A_1 = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \qquad (1.0)$$

2.1.8 Segmentation

The main objective of segmenting a fingerprint image is to separate the clear fingerprint area from the non-fingerprint area [4]. In this stage, the edge detected gray level fingerprint image is threshold to a binary image by using adaptive thresholding methods [7].

2.1.9 Thinning/ Skeletonization

In this stage, binarized (segmented) fingerprint image are skeletonized or thinned into one pixel wide. The flowchart for all the fingerprint image processing algorithms is clearly illustrated in Figure 2.

2.2 Fingerprint Identification and Recognition

Fingerprint identification and recognition stage is the most important stage of the system this paper. It is divided into two main processes, which are the back propagation neural network training process and the matching process.

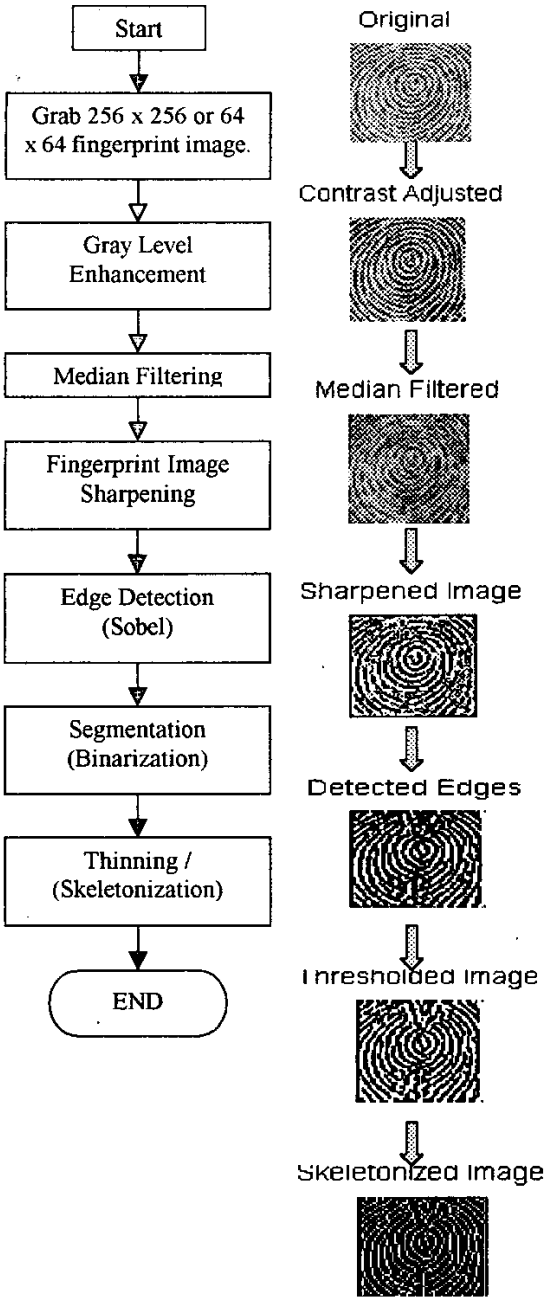


Figure 2: Flowchart of the Six Image Processing Steps and Its Respective Results.

2.2.1 BackPropagation Neural Network Training Process

In this stage, all the processed fingerprint images are used as an input to the back propagation neural network designed to perform the training process [6]. This designed BPN network has to be trained so that the network can recognize the fingerprint images. All necessary parameters are set before the network was trained. After the network is completely trained, recognition and identification process of fingerprint images can be done easily. The flowchart of the entire training process is illustrated clearly in Figure 3.

2.2.2 Matching Process

In this final stage, the earlier trained neural network is used to perform identification and recognition process. This process is also recognized as simulation process [5]. The flowchart and the results of the matching process using different types of fingerprint inputs are shown in figure 4 and figure 5 respectively. In order to perform simulation, Matlab command *sim* is used to simulate the parameters from network netn (network 2) and the data from test pattern. Then the Matlab command *dist* is used to compute the Euclidean distance between the two neurons in the network. Three types of fingerprint images are used to perform simulation. They are the ideal fingerprint input, noisy fingerprint input and new fingerprint input.

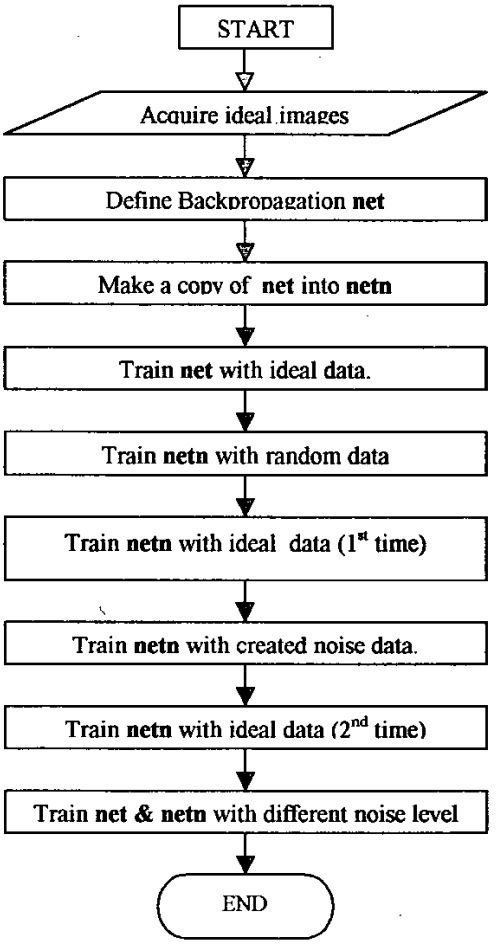


Figure 3: Flowchart of the Training Process

The types of noisy fingerprint images investigated here are Gaussian noised, Speckle noised and Salt and Pepper noised fingerprints images. Each of them is experimented in different occasion in order to confirm that the trained neural network works effectively.

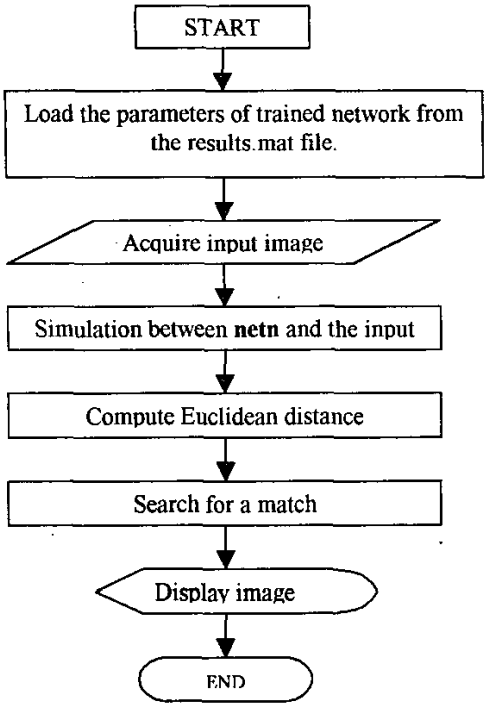
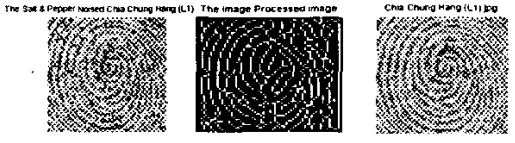


Figure 4. Flowchart of the Matching Process

a) Using Ideal Fingerprint Image Input

b) Using Gaussian Noise Fingerprint Image Input

c) Using Speckle Noise Fingerprint Image Input



d) Using 'Salt & Pepper' Noise Fingerprint Image Input

e) Using New Fingerprint Image, which has not been used to Train the Neural Network.

Figure 5: Results of the Matching Process.

3. SUMMARY

The fingerprint identification and recognition constructed is capable of identifying and recognizing the core area of fingerprint image only. In order to enhance the system constructed features extraction has to be implemented inside this system. This is simply because features extracted from the fingerprint image can be classified into local features and global features, thus increasing the accuracy of further fingerprint identification and recognition process. Not only that, the size of the input to the neural network also can be reduced as well in which it will also result in saving the processing time.

4.0 REFERENCES

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