FINGERPRINT VERIFICATION SYSTEM BASED ON NEURAL NETWORK ANALYSIS

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DECLARATION

"I hereby declared that this thesis entitled Fingerprint Verification Based On Neural Network Analysis is a result of my own work except for the works that have been cited clearly in the references."

Signature : ....

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Date : 15 MAY 2006

Special dedicated to my beloved parents, family and fellow friends, who had strongly encouraged and supported me in my entire journey of learning…

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ABSTRACT

The use of fingerprint for identification has been employed in law enforcement for about a century. A much broader application of fingerprint is for personal authentication, for instance to access a computer, a network, a bank-machine, a car, or a home. Fingerprint verification system based on neural network analysis is a process of verifying the fingerprint. This project highlights the development of fingerprint verification system using MATLAB. Verification is done by comparing the data of fingerprint with true owner fingerprint. The fingerprint images then will go through the processing data and comparison process to differentiate the data fingerprint. In this project, a backpropagation neural network algorithm in toolbox MATLAB was trained to learn and identify whether the fingerprint is genuine or forgery.

ABSTRAK

Penggunaan cap jari sebagai pengenalan identiti telah di gunakan dalam penguatkuasaan undang-undang untuk bertahun lamanya. Aplikasi penggunaan cap jari sebagai pengenalan peribadi di gunakan seperti untuk mengakses komputer, rangkaian, mesin ATM, kereta atau rumah. Sistem pengesahan cap jari berasaskan pada analisis rangkaian neural adalah proses untuk mengesahkan identiti sesuatu cap jari. Projek pengesahan cap jari ini di bangunkan menggunakan program MATLAB. Pengesahan di lakukan dengan membuat perbandingan untuk membuktikan pemilik sebenar cap jari. Cap jari tersebut akan melalui pemprosesan data dan proses perbandingan untuk mengenal pasti perbezaan setiap data cap jari. Dalam projek ini algoritma '*backpropagation neural network*' di dalam '*toolbox*' MATLAB digunakan untuk mengesahkan ketulinan cap jari tersebut.

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CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

There are many types of human biometrics features that are being explored and developed today. They are including face recognition, iris recognition, signature recognition, and voice recognition. There is also much type of algorithms to do the recognition or verification. A neural network is an interconnected group of biological neurons. The neural network will be trained to identify the fingerprint.

Fingerprint verification based on neural network analysis is a process of verifying the individual fingerprint. This project is using neural network to analyses the input of fingerprint.

1.2 OBJECTIVE

To achieve the goal of these project, an objective are defined as a guided. The objectives are:

a) To develop software to recognize fingerprints using MATLAB.
b) To study about interaction in MATLAB.
c) To study about Neural Network in MATLAB and application in process comparison.
d) To gain knowledge about fingerprint verification.

1.3 SCOPE OF PROJECT

The scope of this project is to developed software fingerprint verification system by using MATLAB. Fingerprint images were captured by fingerprint sensor or scanner. This system is using a simple multi layer neural network trained with the back propagation and learning vector quantization for comparing the fingerprint. Processing of the image fingerprint done by image processing toolbox in MATLAB. Histogram data is needed as an input to neural network toolbox in the case of fingerprint verification. The neural network was trained to learn and distinguish between a genuine and forgery fingerprint

1.4 PROBLEM STATEMENT

There are many applications for identification authentication use nowadays. The entire majority is used signature or password to identification authentication. But the problem is the password is easy to forget or lose password number and for signature is easy to duplicate. To overcome this problem the project is develop the fingerprint as personal password. Biometric personal characteristic such as fingerprint is different from the person to another person.

There are no person in this world have same fingerprint as so for twin. Fingerprint is easy to differentiate the people and for personal identity fingerprint is always used. This project will be recognized the fingerprint by using neural network system.

1.5 THESIS OUTLINE

This thesis represent by five chapters. The following is the outline of this fingerprint verification project in chapter by chapter. Chapter I discuss about the brief overview about the project such as introduction, objectives, problem statement and scope of the project.

Chapter II describes about the research and information about the project. Every facts and information, which found through journals or other references, will be compared and the better methods have been chosen for the project. The literature review and the software development of the project that is used a back propagation neural network MATLAB 7 with the aid of Paint Tool also available in this chapter.

Chapter III, discuss about the project methodology used in this project such as data capture, pre-processing and comparison process. All these methodology should be followed for a better performance. Chapter IV describes about the project findings such as result and analysis of the fingerprint verification. The result is presented by tables, graphs and figures. And finally chapter V tell about discussion and conclusion are achieved in this project

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

Fingerprints are the ridge and furrow patterns on the tip of the finger and have been used extensively for personal identification of people [8]. The biological properties of fingerprint formation are well understood and fingerprints have been used for identification purpose for centuries. Since the beginning of the 20^{th} century [9], fingerprint have been extensively used for identification of criminal by the various forensic department around the world. Due to its criminal connotations, some people feel uncomfortable in providing their fingerprints for identification in civilian applications [11].

Since fingerprint-based biometric systems offer positive identification with a very high degree of confidence, and compact solid state fingerprint sensors can be embedded in various system (e.g, cellular phones) [6], fingerprint-based authentication is becoming more and more popular in a number of civilian and commercial application such as welfare disbursement, cellular phone access and laptop computer log-in. The availability of cheap and compact solid state scanners as well as robust fingerprint matches are two important factors in the popularity of fingerprint-based identification systems [12].

Fingerprint also have a number of disadvantages as compared to other biometrics. For example approximately 4% of the population does not have good quality fingerprint, manual workers get regular scratches on their fingers which poses a difficulty to the matching system, finger skin peels off due weather [13], finger develop natural permanent creases, temporary creases are formed when the hands are immersed in water for a long time and dirty finger can not be properly imaged with the existing fingerprint sensors [22]. Further, since fingerprints cannot be captured without the user's knowledge, they are not suited for certain applications such as surveillance.

Fingerprint verification involves matching two fingerprint images, in order to verify a person's claimed identity [24]. The most popular approaches match local features, such as minutiae; using point-pattern matching, graph matching or structural matching [25]. These methods require extensive preprocessing to reliably extract the minutiae and are also very sensitive to noise due to image acquisition and feature extraction. Global recognition approaches, on the other hand, match features characterizing the entire image, typically extracted by filtering or transform operation. They require less preprocessing than the minutiae-based approached, but are effective when the representation is invariant to translation, rotation and scale [33]. The invariants are addressed by registering the images with respect to a references axis, which can be consistently detected in the different instances of the fingerprint. Singular points were used as references points but their detection is not precise enough for matching

The lines that flow in various patterns across fingerprints are called *ridges* and the spaces between ridges are valleys [3]. it is these ridges that are compared between one fingerprint and another when matching. Fingerprints are commonly matched by one (or both) of two approaches. The more microscopic of the approaches is called minutia matching [6]. The two minutia types that are shown in Figure 2.1 are a ridge ending and bifurcation. An ending is a feature where a ridge terminates. A bifurcation is a feature where a ridge splits from a single path to two paths at a Y-junction. For matching purpose, a minutia is attributed with features. These are type, location (x,y), and direction (and some approaches use additional features) [8]

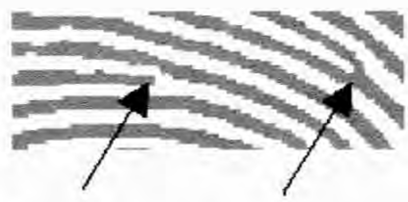

Figure 2.1: A ridge ending and bifurcation of fingerprint minutiae: [15]

The more macroscopic approach to matching is called global pattern matching or simply pattern matching. In this approach, the flow of ridges is compared at all locations between a pair of fingerprint images [9]. The ridge flow constitutes a global pattern of the fingerprint. Three fingerprint patterns are shown in Figure 2.2 (Different classification schemes can use up to ten or more pattern classes, but these three are the basic pattern).

Two other features are sometimes used for matching: core and delta (Figure 2.2). The core can be thought of as the center of the fingerprint pattern [10]. The delta is a singular point from which three patterns deviate [14]. The core and delta locations can be used as landmark locations by which to orient two fingerprints for subsequent matching- though these features are not present on all fingerprint [15].

There may be other feature of the fingerprint that is used in matching [2]. For instance, pores can be resolved by some fingerprint sensors and there is a body of work to use the position of the pores for matching in the same manner that the minutiae are used. Size of the fingerprint, and average ridge and valley widths can be used for matching, however these are changeable over time [5]. The positions of scars and crease can also be used, but are usually not used because they can be temporary or artificially introduced [6].

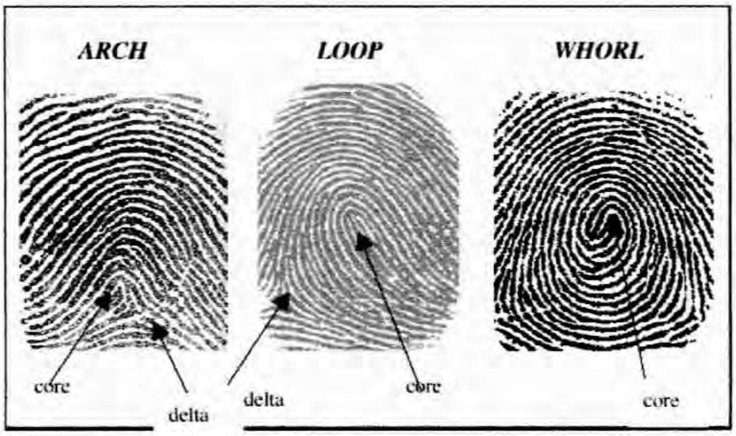

Figure 2.2 Fingerprint patterns: arch, loop and whorl [25]

A majority of the existing fingerprint verification systems are based on matching minutia features [3]. Therefore minutiae extraction forms a very critical step and largely determines the overall accuracy of the matching system. Poor ridge structure and processing artifact result in missing and spurious minutia that can degrade the matching performance. Sharat S. Chikkerur, Sharath Pankanti, Nalini K.Ratha, Ruud Bolle and Venu Govindaraja propose a novel approach based on steer able wedge filter to eliminate false positives resulting from feature extraction [7]. The proposed feature can also be used as a minutia detector that operates directly on the gray scale images.

Maio and Maltoni proposed a feature extraction algorithm that directly operates on grayscale images alleviating many of the sources of error that are caused by binarization and thinning [3]. The algorithm is based on tracking the ridge by following the location of the local maxima along the flow direction [4]. However, in poor contrast or poor quality images where the local maxima cannot be reliably located false positives are still introduced.

The paper Fingerprint Classification and Matching Using a Filterbank by Salil Prabhakar [4] developed a novel filter-based representation technique for fingerprint verification. The technique exploits both the local and global characteristics in a fingerprint image to make verification. Each fingerprint image is filtered in a number of directions and a fixed-length feature vector is extracted in the central region of the fingerprint. The feature vector is compact and requires only 640 or 896, depending on image size bytes [12]. The matching stage computes the Euclidean distance between the template finger code and the input finger code.

The Directional Image Partitioning of Fingerprint Classification by Raffaele Cappelli, Alessandra Lumini, Dario Maio and Davide Maltoni purpose a new approach to automatic fingerprint classification [2]. The directional image is partitioned into 'homogeneous' connected regions according to the fingerprint topology, thus giving a synthetic representation, which can be exploited as a basis for the classification. A set of dynamic masks, together with an optimization criterion [5], is used to guide the partitioning. The adaptation of the masks produces a numerical vector representing each fingerprint as a multidimensional point, which can be conceived as a continuous classification.

Sheng-De Wang and Chih-jen Lee proposed Fingerprint Verification Using Directional Micropattern Histograms and LVQ Networks [6]. The paper is about designing a fingerprint recognition system that makes use of the directional micro pattern histograms of fingerprint image for local ridge orientation calculation, core point detection, and feature extraction. An improved learning vector quantization network is also proposed to avoid the unfairness of the winning rate and to determine a proper number of hidden units [8]. Experimental results show that the recognition rate of the proposed method is 99.62% for a small-scale fingerprint database [10].

Meanwhile, Fingerprint Matching Using an Orientation-Based Minutia Descriptor by Marius Tico and Pauli Kuosmanen proposed a novel fingerprint representation scheme that relies on describing the orientation field of the fingerprint pattern with respect to each minutia detail [1]. This representation allows the derivation of a similarity function between minutiae that is used to identify corresponding features and evaluate the resemblance between two fingerprint impressions [2]. A fingerprint-matching algorithm, based on the proposed representation, is developed and tested with a series of experiments conducted on two public domain collections of fingerprint images. The results reveal that our method can achieve good performance on these data collections and that it outperforms other alternative approaches implemented for comparison.

Shenglin Yang and Ingrid Verbauwhede proposed about they construct an automatic secure fingerprint verification system based on the fuzzy vault scheme to address a major security hole currently existing in most biometric authentication systems. The construction of the fuzzy vault during the enrollment phase is automated by aligning the most reliable reference points between different templates, based on which the converted features are used to form the lock set. The size of the fuzzy vault, the degree of the underlying polynomial, as well as the number of templates needed for reaching the reliable reference point are investigated. This results in a high unlocking complexity for attackers with an acceptable unlocking.

Fingerprint Verification Using Correlation Filters by Krithika Venkataramani and B.V.K. Vijaya Kumar proposed about the design of the correlation filter. Correlation filter theory is quite advanced and a tutorial survey paper by Kumar [7] contains brief descriptions of many of these filter designs. Correlation filter theory has evolved from matched filters, which provide the maximum signal-to-noise-ratio in detecting a known reference image in the presence of additive noise. However, matched filters are unacceptably sensitive to even small changes in the reference image and thus one matched filter would be needed for every training image.

Secure Fingerprint Verification Based On Image Processing Segmentation Using Computational Geometry Algorithms by M .Poulos, E.Magkos, V. Chrissikopoulos and N.Alexandris present application of computational geometry algorithms in the fingerprint segmentation stage. In this paper, they showed that the extracted feature (characteristic polygon) might be used as a secure and accurate method for fingerprint-based verification over the Internet. On the other hand the proposed method promisingly allows very small false acceptance and false rejection rates, as it is based on specific segmentation.

Ke Huang and Selin Aviyente were proposed about the fingerprint verification based on wavelet subbands. They were used an algorithm for fingerprint verification by using the statistics of subbands from wavelet analysis. One important feature for each frequency subband is the distribution of the wavelet coefficients, which can be modeled with a Generalized Gaussian Density (GGD) function. A fingerprint verification algorithm that combines the GGD parameters from different subbands is proposed to match two fingerprints. The verification algorithm in this paper is tested on a set of