FINGERPRINT RECOGNITION USING FEATURE EXTRACTION

IZNI SYARINAZ BINTI ISMAYUDDIN

A thesis submitted in fulfillment
of the requirements for the award of the degree of
Bachelor of Computer Science (Software Engineering)

Faculty of Computer System & Software Engineering
University College of Engineering & Technology Malaysia

NOVEMBER, 2006

ABSTRACT

Lately, fingerprint recognition usage among users is to make sure the safety of security level or pin code user is very encourage. There are so many applications that using fingerprint recognition such as fingerprint recognition for password and it is also used in order to recognize individual identity card. However, the fingerprint among individual is so unfamiliar and not for common known. Throughout this project, 'Fingerprint Recognition using Feature Extraction' can recognize the types of fingerprint for every individual and the unique is, with every characteristics of the difference fingerprint among individual, it can be read in computer language by using the method that was shown in image processing. The reason why this system was developed is to analyze the method that always been used to recognize fingerprint. Besides that, fingerprint recognition from analog image into digital image can be carry out by using feature extraction method that is can recognize the characteristic in fingerprint image.

ABSTRAK

Kebelakangan ini, penggunaan cap jari adalah digalakkan bagi memastikan tahap keselamatan atau kod rahsia pengguna terpelihara. Pelbagai aplikasi yang menggunakan cap jari seperti penggunaan cap jari sebagai kata laluan dan selalu digunakan untuk mengenal pasti kad pengenalan setiap individu. Namun, jenis cap jari bagi setiap individu jarang di ketahui umum. Melalui project 'Fingerprint Recognition using Feature Extraction' dapat mengenal pasti jenis cap jari yang di miliki bagi setiap individu dan keunikannya adalah dengan ciri-ciri cap jari yang berbeza-beza bagi setiap individu berupaya diterjemahkan dalam bahasa komputer menggunakan kaedah-kaedah yg terdapat dalam pemprosesan imej. Tujuan system ini di bangunkan ialah untuk menganalisa kaedah-kaedah yang sering digunakan bagi pengecaman cap jari. Selain itu, pengecaman bentuk cap jari dari gambar analog ke gambar digital dilaksanakan mengunakan kaedah pengekstrakan ciri-ciri yang mana dapat mengenal pasti karakter dalam bentuk gambar cap jari.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ABBREVIATIONS

JPEG	-	Joint Photographic Experts Group
MATLAB	-	Matrix laboratory
SDLC	-	System Development Life Cycle
KUKTEM	-	Kolej Universiti Kejuruteraan & Teknologi Malaysia
TM	-	Template Matching
RGB	-	Red Green Blue
STFT	-	Short Time Fourier Transform

CHAPTER 1

INTRODUCTION

1.1 Introduction

Every human has their own fingerprints and from the research, there are several types of fingerprints, which are tended arch, arch, right loop, left loop and whorl. That is why fingerprints are unique because the texture for every human are different but it can be recognize or classified for each types.

Among all of the biometric techniques, fingerprint-based identification is the oldest method, which has been successfully used in numerous applications. Everybody was known to have unique and immutable fingerprints. So that, it can recognize and differentiate fingerprint one (1) to another. A fingerprint is made of a series of ridges and furrows on the surface of the finger. 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.

This project proposed for Undergraduate project that is "Fingerprint recognition system using Feature Extraction process". The function of this system is to detect or match the suitable image when the image of fingerprint is requested. Therefore, this system can recognize the type of fingerprint of the users when the image of the fingerprint is the same.

1.2 Problem Statement

Every human have the various types of fingerprint. However, each person has a unique type of fingerprint. Even though the types of fingerprint are the same but the minutiae of fingerprint is always different for each human being. What is the importance or advantages of knowing the types of fingerprint?

The importance of knowing the types of fingerprint is to identify the identity of individual. For example in finding and identify the fingerprint of criminal case, it is easier if the types of fingerprint being grouped into its own group of fingerprint which are basically in five (5) main group that consists of arch, tended arch, left loop, right loop and whorl. Therefore, it can reduce time for searching and identify the data of the criminal. Besides that, this is a new approach in image processing application.

By then, after analyze several factors that related to the current problem, the suitable solution is by using fingerprint recognition system using Feature Extraction. Therefore, it is easier, safety, and reliability compare to the system that being used for the time being.

1.3 Objectives of System

The objectives of this project are:

i) To analyze techniques used fingerprint recognition.

ii) To develop prototype of the fingerprint recognition system using feature extraction.

1.4 Scope of System

The scopes of this project consist of:

i) The format of image is using JPEG format.

ii) Size of image is using 240 x 240 pixels.

iii) The image output is in grayscale image (black and white color).

iv) The prototype system will be developing using MATLAB 7.0.

v) Twenty (20) pieces sample of image are used.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Fingerprint is one of the most widely used biometrics. The advent of several inkless fingerprint scanning technologies coupled with the exponential increase in processor performance. It has taken fingerprint recognition beyond criminal identification applications to several civilian applications such as access control, time and attendance, and computer user login.

Fingerprints are widely believed to be unique. Basically, fingerprints do not change significantly with age. If a finger is damage, it normally heals in such a way that the fingerprint restored. Because of these characteristics, a person's fingerprint can be used as a method to identify human individuals.

2.1.1 History of Fingerprints

Fingerprints have long been involved in recognition and signature. Humans have used fingerprints for personal identification for a very long time. Modern fingerprint matching techniques initiated in the late 16th century. Henry Fauld, in 1880, first scientifically suggested the individuality and uniqueness of fingerprints. At the same time, Herschel asserted that he had practiced fingerprint identification for about 20 years. This discovery established the foundation of modern fingerprint identification. In the late 19th century, Sir Francis Galton conducted an extensive

study of fingerprints. He introduced the minutiae features for single fingerprint classification in 1888. Edward Henry made an important advance in fingerprint identification in 1899 an elaborate method of indexing fingerprints very much tuned to facilitating the human experts performing (manual) fingerprint identification. In the early 20th century, fingerprint identification formally accepted as a valid personal identification method by law enforcement agencies and became a standard procedure in forensic. Fingerprint identification agencies were setup worldwide and criminal fingerprint databases were established. With the advent of lives can fingerprinting and availability of cheap fingerprint sensors, fingerprints are increasing used in government and commercial applications for positive person identification [1]. The conclusion of the history is show in Table 2.1 below.

Table 2.1: The History of Fingerprint [1]

Year	Description
1686	Marcello Malpighi, a professor of anatomy at the University of Bologna, noted in his; ridges, spirals and loops in fingerprints. He made no mention of their value as a tool for individual identification.
1823	John Evangelist Purkinji, a professor of anatomy at the University of Breslau, published his thesis discussing 9 fingerprint patters, but he too made no mention of the value of fingerprint for personal identification
1856	Sir William Herschel, first used fingerprints on native contracts in Jungipoor, India. Sir Herschel began to note that the inked impressions could, indeed, prove or disprove identity. While his experience with fingerprinting was admittedly limited, Sir Herschel's private conviction that all fingerprints were unique.
1880	Dr. Henry Faulds forwarded an explanation of his classification system and sample forms for recording inked impressions to Sir Charles Darwin. The same year Faulds also published an article in the scientific journal "Nature" where he discussed fingerprints as means of personal identification and the use of ink as a method for obtaining these.

1891	Juan Vucetich, an Argentine Police Official, began the first fingerprint files based on Galton pattern types. At first, Vucetich included the Bertillon System with the files.
1897	On 12 June 1987, the Council of the Governor General of India approved a committee report that fingerprints should be used for classification of criminal records. Haque and Bose are the two Indian fingerprint experts credited with primary development of the Henry System of fingerprint classification and it is still used in all English-speaking countries.
1946	The F.B.I. had processed 100 million fingerprint cards in manually maintained files; and by 1971, 200 million cards. With the introduction of AFIS technology, the files were split into computerized criminal files and manually maintained civil files. Many of the manual files were duplicates though, the records actually represented somewhere in the neighborhood of 25 to 30 million criminals, and an unknown number of individuals in the civil files.

2.1.2 Type of Fingerprints

Fingerprints can be dividing into the three (3) major pattern type arches, loops, and whorls. These major pattern types can be dividing further into different subgroup such as right, left or twin loops, plain or tended arches and spiral or concentric circles as whorls [2]. Figure 2.1 shows the type of fingerprint with their images.

In addition, a fingerprint pattern, when analyzed at different scales, exhibits different types of features. Actually, it can be looked in three levels, which are the global level, the local level, and the very-fine level. The descriptions of each level are:

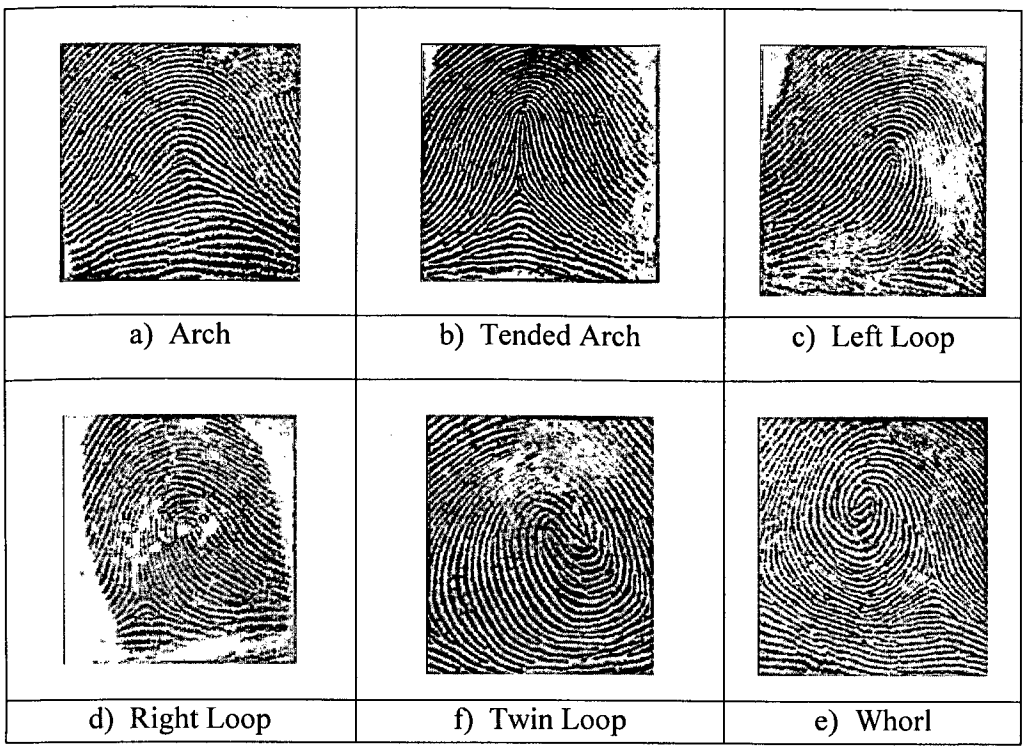

Figure 2.1 Type of Fingerprint [2]

i) Global Level

At global level, have singularity points called core and delta points. These singularity points are very important for fingerprint classification but not sufficient for accurate matching.

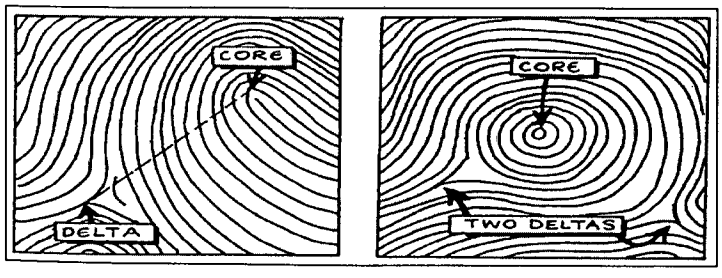

Figure 2.2 Global Levels [2]

According to Figure 2.2, core and delta marked on sketches of the two (2) fingerprint patterns loop and whorl. Loop has one delta, whorls have two deltas and the minutiae detail is not shown.

ii) Local Level

At local level have minutiae details or minutiae points. Minutiae details also known as ridge characteristics, ridge details or Galton's details. Based on figure 2.3, one way to classify the minutiae details are in terms of ridge termination, bifurcation, independent ridge, dot or island, lake, spur and crossover. The two most prominent minutiae details are ridge termination (ending) and ridge bifurcation.

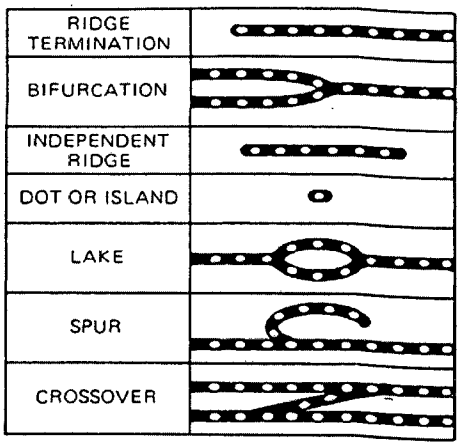

Figure 2.3 Local Levels [2]

iii) Very-fine Level

At very-fine level, have essentially the finger sweat pores. The position and shape of the pores can be use to help identify a person.

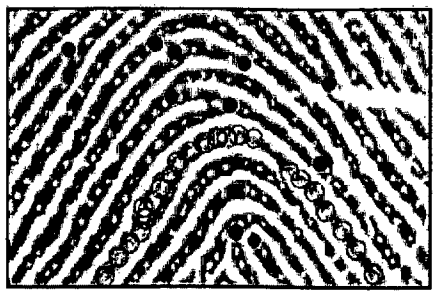

Figure 2.4 Very-fine Levels [2]

Based on Figure 2.4, part of a fingerprint image with sweat pores and minutiae details visible. The black lines in the image correspond to the ridges in the fingerprint, and the white lines in the image correspond to the valleys in the fingerprint. The white dots on the ridges correspond to the sweat pores in the fingerprint and are marked with empty circles on a single ridge line. Minutiae details are marked with black-filled circles.

2.2 Fingerprints Recognition

2.2.1 Image Acquisition

Image acquisition is the first process for capture image using a camera digital. CCD sensor or satellite that provide analog image to convert into digital image. Digital image can be considered a matrix whose row and column indices identify a point in the image and the corresponding matrix element value identifies the gray level at that point. Example image acquisition application is using fingerprint reader to capture or read an image for fingerprint or using satellite to capture image in location detecting of flooding area.

2.2.2 Pre-processing Image

Pre-processing image consists of filtering image where the first image is not clear and difficult to read. The purpose for filtering process is to improve the quality of image after capture image from analog to digital image. Actually, there are several technique in filtering technique such as order filter, median filter, average filter, maximum or minimum filter. The technique that use is depends on the input of image.

2.2.3 Image Threshold

Threshold is the part of image recognition. Fingerprint pixel in a grayscale image are recognize as 'object' pixels if their value is greater than some threshold value which assume an object to be brighter than the background and as 'background' pixels for otherwise. Basically, an object pixel is given a value of '1' while a background pixel is given a value of '0'. Threshold process is important because able to differentiate between image of fingerprint and the background of image. Besides, there are several techniques in threshold process such as median threshold, minimum threshold, maximum threshold and fixed value threshold. The technique that use is depends on the contrast between object pixels and background pixels or for the foreground and background image.

2.2.4 Image Segmentation

The objective of image segmentation is to find regions that represent fingerprint or meaningful parts fingerprint. They are several techniques using in image segmentation like region growing and shrinking technique where an operating by row and column based on image space. This method can be local that operate on small neighborhoods or can be global that operating on the entire image or a combination of local and global. Another technique is clustering technique where

segments the image by placing similar elements into groups or cluster based on the similarity measure for example by color space or histogram space.

2.2.5 Feature Extraction

Feature extraction is the operation to extract image features for identifying or interpreting meaningful physical objects from images. That means from the feature extraction, system recognized the feature or characteristic of the image and generates the data by the binary image. Two (2) techniques of clustering images in feature extraction are by row and column and divide the image into smaller window. The example of application for feature extraction is fingerprint recognition. Whereby it extract the fingerprint image features to recognize the type of images.

2.2.6 Template Matching

Template matching is the operation to match or compare the image based on the feature image from the feature extraction process. This process was compared the image from database and the input image. Using template matching, it can recognize the image appropriately because using the data after feature extraction.

2.3 Current System Using Feature Extraction for Fingerprints Recognition

2.3.1 Feature Extraction Using Chain Code Contours [3]

According to this thesis, the binarization approach is to convert the gray scale image into a binary image prior to minutiae detection. While algorithms differ in several implementation aspects, they have the following common stages.

According to the Figure 2.5, it shows the different stages in a typical feature extractor following the binarization approach.

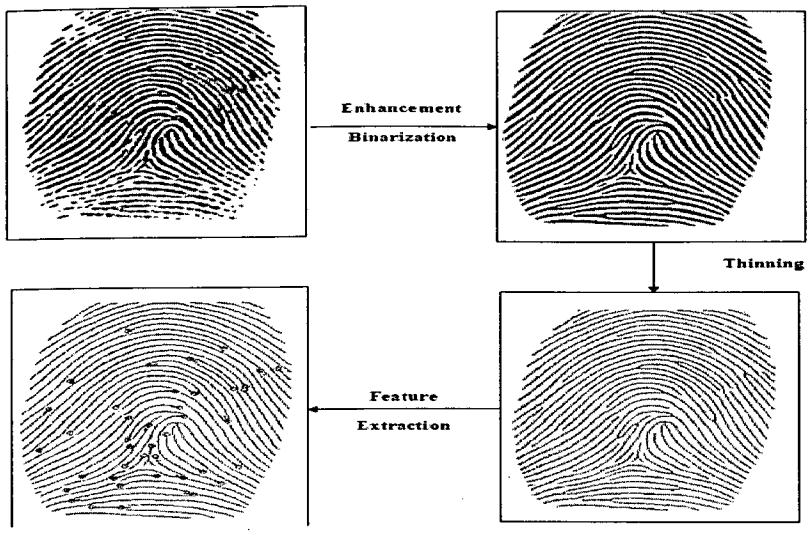

Figure 2.5 Binarization Approach [3]

The first step starts in segmentation or binarization stage. In this step, the gray scale image was converting to a binary image through the process of simple threshold or some form of adaptive binarization. The quality of the binarization output improved if the gray scale image was enhancing prior to this process. This step is also referring to as segmentation in literature. However, this should not be confused with segmentation of the fingerprint foreground from the background during region mask generation.

The second step is the thinning stage. The resulting binary image is thinning by an iterative morphological process resulting in a single pixel wide ride map. Some algorithms and our proposed approach do not require this stage.

The third step is the Minutiae Detection where the problem of minutiae detection is trivial. The resulting pixel wide map is scanned sequentially and minutiae points are identified based on its neighborhood. Ridge endings are characterized by single neighbor and bifurcations are identified by locating pixels with three or more neighbors.

The last step is the post-processing stage. The minutiae extraction process results in two forms of errors. The detection may introduce *spurious* minutiae where they do not exist in the original or may *miss* genuine minutiae. While nothing can be done about the missing minutiae, spurious minutiae can be eliminated by considering their spatial relationships. Several heuristic rules may then be applied to filter out these false positives.

2.3.2 Fingerprint Identification Based on The Minutiae Located in Fingerprint [4]

According to this thesis, the minutiae matching are the suitable method to use for fingerprint comparison. Basically, minutiae are local discontinuities in the fingerprint pattern. Only the ridge ending and ridge bifurcation minutiae type are used in fingerprint recognition. Example of minutiae is shows in Figure 2.6.

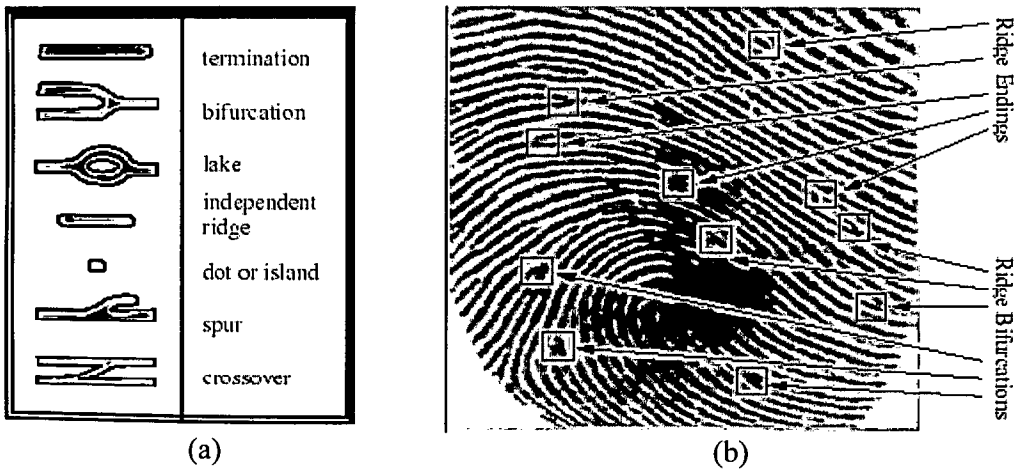

Figure 2.6 (a) Different Minutiae Types, (b) Ridge Ending & Bifurcation