Fingerprint Recognition Using Minutia Matching

Dr. Neeraj Bhargava[#1],Dr. Ritu Bhargava[*2],Prafull Narooka[#3],Minaxi Cotia[*4]

[1]*Department of Computer Science, School of Engineering & System Sciences, MDS University, Ajmer, Rajasthan, India*

[2]*Department of MCA, Govt. Women Engineering College, Ajmer, Rajasthan, India*

[3]*Research Scholar, MJRP University, Jaipur, Rajasthan, India*

[4]*Department of Computer Science, School of Engineering & System Sciences, MDS University, Ajmer, Rajasthan, India*

Abstract - **Fingerprints are the most widely used biometric feature for identification and verification in the field of biometrics. This paper presents the types of fingerprint, implementation of a minutiae based approach to fingerprint identification and verification. In this research paper we have discussed a minutiae based matching technique. This approach has been intensively studied; this technique is the backbone of the current available fingerprint recognition products.**

Keywords-- **Fingerprint, fingerprint recognition, fingerprint pattern type, fingerprint matching techniques.**

I. INTRODUCTION

Fingerprint recognition is one of the reliable, most important and useful biometric technique used for person identification and verification. Fingerprints are one of the maximum used biometric technologies for considered legal proofs of evidence in all over the world [1]. A fingerprint is an impression of the friction ridges found on the inner surface of a finger. A fingerprint is comprised of ridges and valleys, the ridges are the dark area of the fingerprint and valleys are the white area that exists between the ridges.
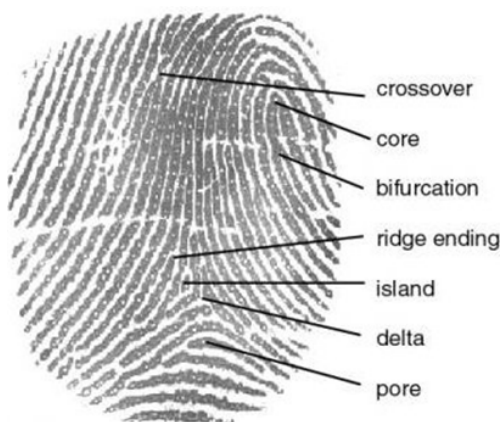

Fig.1 Minutiae Features In Fingerprint

Figure.1 shows the ridges create a point, which is known by different names. The point where a ridges break is called an ending point and the point where ridges divided into two is a bifurcation point. Two other special points are known as core and delta. The core is the point with the most variant changes in the direction of the line, and the delta is the point where the ridges spread into three directions. Crossover is a short ridge that runs between two parallel ridges. An island is a line type which stands alone, that is it does not touch another line-type and is totally contained in the pattern area of interest.

II. FINGERPRINT PATTERN TYPES

Fingerprint patterns are divided into three main groups consisting of Arches, Loops and Whorls. Approximately 5% of all fingerprints are Arches, 30% are Whorls and 65% are Loops.

A. Loop Patterns:

In a Loop pattern, the ridges will flow in one side, re-curve, (loop around) touch or pass through an imaginary line drawn from the delta to the core, and exit the pattern on the same side from which it entered. The loop pattern consists of one or more re-curving ridges and one delta.
There are two types of loop patterns:

1. Ulnar loop

2. Radial loop.

Difference between ulnar and radial loop are, if the ridges flow in from the little finger side, this would be an ulnar loop and if the ridges flow in from the thumb side this would be a radial loop.

Fig.2 Fingerprint Loop Pattern

B. Whorl Patterns:

Any fingerprint pattern which contains two or more deltas will be a whorl pattern. A whorl pattern consists of a series of almost concentric circles. There are four types of whorl patterns:

1. Plain whorl,

2. Central Pocket Loop whorl

3. Double Loop Whorl

4. Accidental Whorl

Plain whorls consist of one or more ridges which make a complete circuit with two deltas, between at least one re-curving ridges within the inner pattern area is cut or touched. Central pocket loop whorls consist of at least one re-curving ridge to the line of flow, with two deltas, between which when an imaginary line is drawn, no re-curving ridge within the pattern area is cut or touched.

Double loop whorls consist of two separate and distinct loop formations with two separate and distinct shoulders for each core, two deltas and one or more ridges which make, a complete circuit.

The accidental pattern will contain two points of delta. One delta will be related to a re-curve and the other will be related to an up thrust.

Fig.3 Fingerprint Whorl Pattern

C. Arch Pattern :

In an arch pattern, ridges flow in one side and flow out the opposite side. There are no deltas in an arch pattern. There are two types of arch patterns [2]:

1. Plain arch,

2. Tented arch.

Fig.4 Fingerprint Arch Pattern

Plain arches have a flow of ridges from one side to the other of the pattern, no "significant up thrusts" and the ridges enter on one side of the impression, and flow out the other with a rise or wave in the centre.

Tented arches have an angle, an up thrust, or two of the three basic characteristics of the loop.

Fingerprints have been widely used because of their high acceptability, immutability, individuality and acceptability. A good fingerprint contains 25 to 80 minutiae points. Minutiae based fingerprint recognition consists of Thinning, Minutiae extraction, Minutiae matching and Computing matching score. The major steps involved in automated fingerprint recognition include

a) Fingerprint Acquisition,

b) Fingerprint Segmentation,
c) Fingerprint Image Enhancement,
d) Feature Extraction,
e) Minutiae Matching,
f) Fingerprint Classification.

III. FINGERPRINT RECOGNITION

Fingerprint recognition (also known as Dactyloscopy) is the process of comparing known fingerprint against another or template fingerprint to determine if the impressions are from the same finger or not. It includes two sub-domains: one is fingerprint verification and the other is fingerprint identification [3].

Verification specify an individual fingerprint by comparing only one fingerprint template stored in the database, while identification specify comparing all the fingerprints stored in the database. Verification is one to one matching and identification is one to N (number of fingerprint templates available in database) matching. Verification is a fast process as compared to identification.
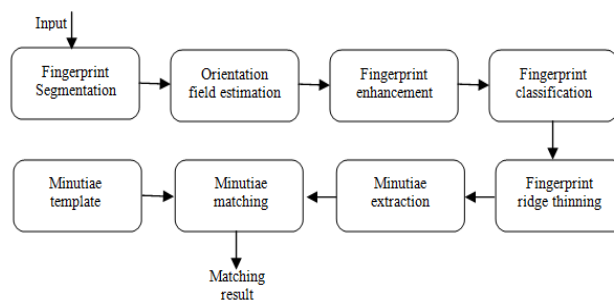

Fig.5 Fingerprint Recognition System

Figure.5 shows the basic fingerprint recognition system. First of all we take a fingerprint image. After taking an input image we can apply fingerprint segmentation technique. Segmentation is separation of the input data into foreground (object of interest) and background (irrelevant information). Before extracting the feature of a fingerprint it is important to separate the fingerprint regions (presence of ridges) from the background. This is very useful for recovering false feature extraction. In some cases, a correct segmentation is very difficult, especially in poor quality fingerprint image or noisy images. Orientation field plays an important role in fingerprint recognition system. Orientation field consist of four major steps (1) pre-processing fingerprint image (2) determining the primary ridges of fingerprint block (3) estimating block direction by projective distance variance of such a ridge (4) correcting the estimated orientation field. Image enhancement is use to improve significantly the image quality by applying some image enhancement technique. The main purpose of such procedure is to enhance the image by improving the clarity of ridge structure or increasing the consistency of the ridge orientation. Fingerprint classification is used to check the fingerprint pattern type. After classification of fingerprint

we can apply fingerprint ridge thinning which is also called block filtering, it is used to reduce the thickness of all ridges lines to a single pixel width. Thinning does not change the location and orientation of minutiae points compared to original fingerprint which ensures accurate estimation of minutiae points. Then we can extract minutiae points and generate data matrix. Finally we can use minutiae matching to compare the input fingerprint data with the template data and give the result.

IV. FINGERPRINT MATCHING TECHNIQUES

There are many Fingerprint Matching Techniques. Most widely used matching techniques are these:

• *Correlation-based matching*: In correlation based matching the two fingerprint images are matched through corresponding pixels which is computed for different alignments and rotations. The main disadvantage of correlation based matching is its computational complexity.

• *Minutiae-based matching*: This is the most popular and widely used technique, for fingerprint comparison. In minutiae-based techniques first of all we find minutiae points on which we have to do mapping. However, there are some difficulties when using this approach. It is difficult to identify the minutiae points accurately when the fingerprint is of low quality.

• *Pattern-based (or image-based) matching*: Pattern based technique compare the basic fingerprint patterns (arch, whorl, and loop) between a previously stored template and a candidate fingerprint. This requires that the images be aligned in the same orientation. In a pattern-based algorithm, the template contains the type, size, and orientation of patterns within the aligned fingerprint image. The candidate fingerprint image is graphically compared with the template to determine the degree to which they match [3].

ALGORITHM:

Input   : Gray-scale Fingerprint image.
Output   : Verified fingerprint image with matching score.
Step 1. Initialized fingerprint in a binary form.
Step 2. Thinning on image from step 1
Step 3. Minutiae points are extracted from image. Data matrix is generated   to get the position, orientation and type of minutiae.
Step 4. Comparison & Matching of test fingerprint with template.
Step 5. Match the score of two images is computed, if matching score is 1 images are matched and if it is 0 then they are mismatched

V. CONCLUSION

In this paper we have presented types of fingerprint patterns and matching techniques. Fingerprint recognition using minutiae matching algorithm has been used for matching the minutiae points.

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