International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 8, pp: 581-587 www.ijaem.net ISSN: 2395-5252

Adaptable Finger Print Identification Using Minutiae Extraction Based-on Cross-Number of Method

[1]Kusumlata Gehlot, [2]Vishal Dutt
M.Tech Scholar, MDSU Ajmer, Ajmer India
Aryabhatt Collage Ajmer, Ajmer India

Date of Submission: 01-11-2020 Date of Acceptance: 15-11-2020

ABSTRACT: Fingerprint refers to an automated unique identification or verification of an individual. A set of ridgelines and valleys defines the fingerprint pattern. With the help of local ridge characteristics the uniqueness of fingerprint can be accessed. The points where ridge lines end or fork are called Minutiae. The extraction of loner points in a thinned ridge map is referred as minutiae extraction. The Minutiae matching refers to getting the finest match between two point fingerprint patterns. There are mainly two modules that are used for Finger print reorganization using Minutiae that are: - Minutiae extraction and Minutiae matching.

I. INTRODUCTION

Finger print reorganization is most widely used for biometric identification in today's world. It refers to an automated unique identification or verification of an individual. Fingerprint reorganization is mostly used in criminal investigation, forensic science, police and detective agencies.

The elemental work of the **Integrated Automated Fingerprint Identification Service** (IAFIS) is fingerprint recognition. It is the most famous police agencies.

The set of **ridgelines and valleys** is defined as fingerprint pattern**.** A single curve segment in fingerprint pattern is called ridge whereas the space between two adjacent ridges is called valley. In simpler language we can say that the darker area of a fingerprint is called ridges and the whiter area is called valley. With the help of local ridge characteristics and their position the uniqueness of fingerprint can be accessed.

Fig 1 Fingerprint Photo

1. I. Ridge: - A single curve segment in fingerprint pattern is called ridge**.** The ridgelines remain parallel to each other, but at some points they intersect each other and terminate. The fingerprint lines mainly form three ridge pattern namely, **loops, whorls and arches**.

1. II.1. Loops: - The 60 percent of the pattern types consist of loops. It begins on one side of the finger, curve around or upward, and exit the other side. Loops are mainly of two types: **Radial loops** and **ulnar loops.** The radial loop slope toward the thumb, while ulnar loops slope toward the little finger.

Fig 2.1 Loops (highlighted in white)

1. II.2. Whorls:-

The circular or spiral pattern in fingerprint forms **Whorls**. Whorls can be divided into four groups: central pocket loop (a loop with a whorl at the end), double loop (two loops that create an S-like pattern), plain (concentric circles), and

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accidental loop (irregular shaped). It consists of about 35 percent of the pattern types.

Fig 2.2 Whorls (highlighted in white)

1. II.3. Arches: - The narrow mountain like structure which slope upward and then downward is called **arches**. It includes plain arches and tented arches. It consists of about 5 percent of the total pattern type. Tented arches extend to sharper point than plain arches.

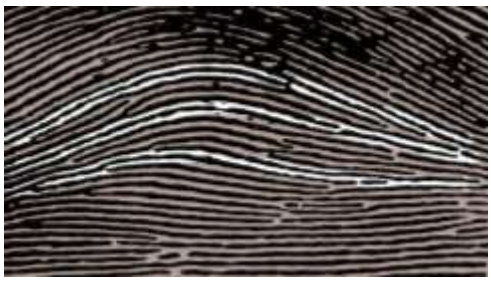

Fig 2.3 arches (highlighted in white)

1. III Minutiae: - Specification of the fingerprints can be accessed by local ridge characteristics. The automated system that is mostly used for fingerprint recognization is Minutiae matching. The points where ridge lines forks or ends are called Minutiae.

1. III.1. Minutiae Points: - The most important feature of a fingerprint pattern is Minutiae points. They are widely used for the fingerprints matching. The specification of these minutiae points are used to access the uniqueness of a fingerprint image. A fingerprint print image that has 25 to 80 minutiae points is called good quality image. The quality depends on the fingerprint scanner resolution and the placement of finger on the sensor.
Minutiae points are of different types. Some of the types are:-

- **Ridge End:-** It is the point where the ridge ends abruptly.
- **Ridge Bifurcation:-** It is the point where the same ridge passes in two or more ridges.
- **Ridge Dots**:- These are very small ridges.
- **Ridge islands**:- These are slightly bigger than dots. They occupy a middle space between two divaricating ridges.
- **Ponds or Lakes:-** These are the empty space between two divaricating ridges.
- **Spurs**:- It is a notch protruding from a ridge.
- **Bridges:-** These are the small ridges that join two longer adjacent ridges.
- **Crossovers:-** These are formed when two ridges cross each other.

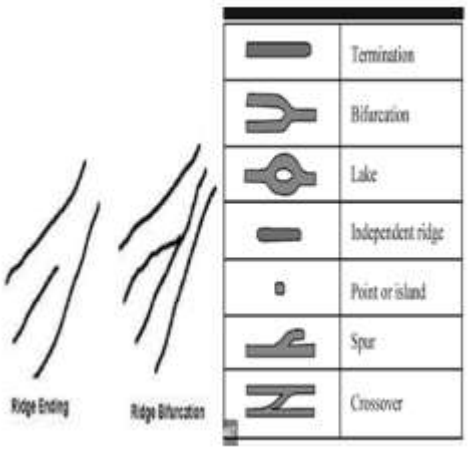

Fig 3.1 some common minutiae points

The most essential procedure in automated fingerprint identification and classification is extracting the minutiae points from fingerprint images. In this work we propose two methods for fingerprint image enhancement. The first one is carried out using local histogram equalization, Wiener filtering, and image binarization. The second method uses a unique anisotropic filter for direct grayscale enhancement. The results achieved are compared with those obtained through some other methods. Both methods show some improvement in the minutiae detection process in terms of either efficiency or time required.

II. COMPONENTS OF FINGERPRINT RECOGNITION SYSTEM USING MINUTIAE

There are mainly two modules that are used for Finger print recognization using Minutiae that are: - Minutiae extraction and Minutiae matching.

Minutiae extraction:- Minutiae extraction refers to the extraction of singular points in a thinned ridge map. If perfect segmentation can be obtained then this technique is very useful and time saving, but it is not always possible to obtain a perfect ridge map and this cite as a limitation of Minutiae extraction.

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Minutiae matching:- The Minutiae matching refers to the finding the best match between two point patterns. However even if the minutiae are exactly located but finding the best match is intractable. It is because of deformations in sensed fingerprints. The Minutiae matching become very difficult due to the existence of the deformations.

2.1.MINUTIAE EXTRACTION TECHNIQUES

There are many steps to extract minutiae. Some of them are as follows:-

2. I.1 Binarization-The method of transforming grayscale image pixels into either black or white pixels by selecting threshold is called binarization. In MATLAB, the value zero of pixel means it is black whereas the value one of pixel means it is white. Multitude of techniques can be used for completing the process. In the end of the process all pixels of the image are either converted into one or zero, and the image is converted into binary format. It is considered as easy to achieve compared wither other image processing techniques. However sometimes it is difficult to determine appropriate threshold levels. The resulted image may contain large dark areas or large faded areas.

Fig I.1 Binary image resulting from global thresholding

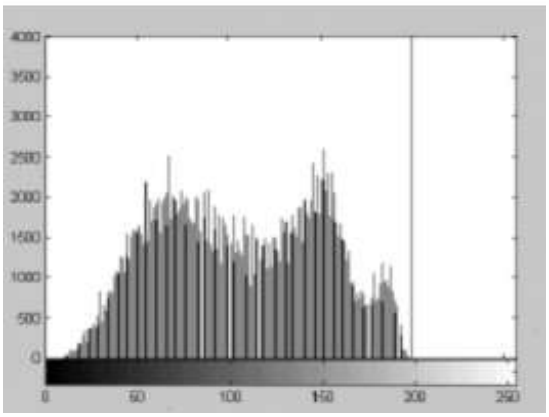

Fig I.2 The histogram resulting from the original grayscale image.

2. I.2 Thinning- The morphological operation performed on binary images is known as thinning. In other words we can say that the process of reducing the thickness of each line of patterns to a single pixel is called thinning. The main aim of thinning is to reduce the fingerprint to lines one pixel wide. The technique is applied on the image by using MATLAB's thinning function. By the successive deletion of the pixels from the different sides of each image this task is achieved. Finally the image being thinned wills no longer posses any points which match the deletion templates. The resulted image will be the thinned representation of the original image. After thinning of the original image false minutiae are introduced to the finger print image.

Fig I.2.1 A Fingerprint image

Fig I.2.2 Finger print after thinning

2. I.3 Minutiae Angle :-The minutiae angle is measured by increasing counter-clockwise starting from the horizontal axis to the right. There are three possibilities, such as.

FigI.3. Minutiae Points Parameters

2.II Minutiae Matching-- The most important operation in finger identification system is matching. The input fingerprint is compared with

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the stored databases. The main objective of matching is to achieve high reliability. Due to large variability in different impressions of the same finger the reliable matching of fingerprint becomes difficult. The variations may occur due to many reasons. The main factors that are responsible for variations are:-

- Displacement
- Rotation
- Noise
- Pressure
- Changing
- skin conditions

Because of these variations the fingerprints of the same finger may look different whereas the fingerprint of different finger may look same. In the working of the minutiae matching the input templates are compared with the stored templates of the fingerprint.

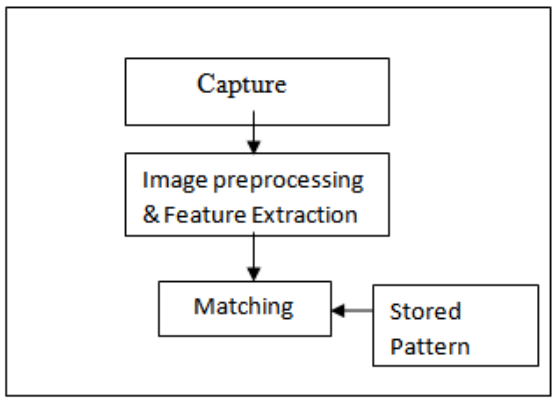

Fig II.1 Fingerprint matching step

Minutiae matching can be used for identification or verification of the fingerprint. Instead of pixel wise matching or ridge pattern matching of the fingerprint, point pattern matching i.e. minutiae matching is used to achieve identification or verification. There are many algorithms proposed for the minutiae matching.

Fingerprint matching can be separated into two categories, which are verification and identification. It is the comparison of a claimant fingerprint against an enrolled fingerprint, where the intention is that the claimant fingerprint matches the enrolled fingerprint. In order to prepare for verification, a person initially enrolls his or her fingerprint into the verification system. A representation of that fingerprint is stored along with the person's name or other identity. The person identifying him or her, and then applying the fingerprint to the system such that the identity can be verified authenticates each access.

Verification is also termed, one-to-one matching. On the other hand, identification is a fingerprint matching where fingerprint of unknown ownership is matched against a

a database of known fingerprints to associate with an identity.

Identification is also termed, one-to-many matching. In other ways, the objective of identification is to search that owns the current biometric data, while the verification is to make sure that biometric data belongs to specific person.

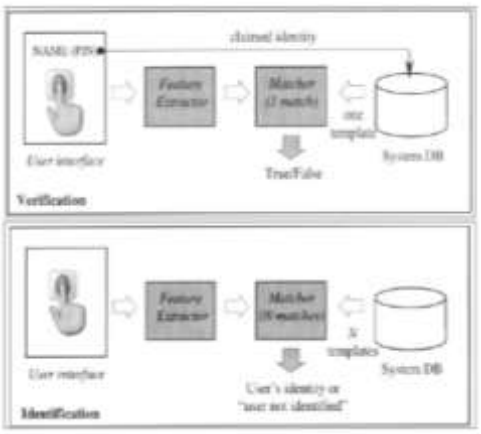

Fig II.2 Matching: Verification and Identification

3.I Structural Feature Extraction Algorithm as Fingerprint Feature Extraction on Local Structures

This algorithm subsists 5 steps, the first step is image enhancement using DRD filter (Dominant Ridge Direction) on every block (16*16). Image binarization occurs in the first stage of ridge extraction. The minutiae extraction process is performed after dilution. Figure 5 shows ridge extracted and thinned image. Minutiae points is achieve using crossing number method (CN) on point P, by this formula 1:

$$CN = 0.5\sum_{i=1}^{8} |P_i - P_{i+1}| \; with P_9 = P_1 \qquad (1)$$

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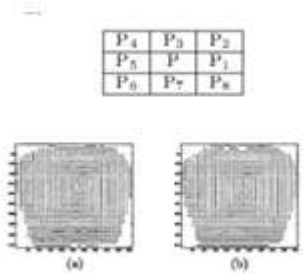

Figure 3.1. (a) Block-control image (Each line represents the major ridge direction on eachBlock Maitha.)
(b) Smoothed block control image.

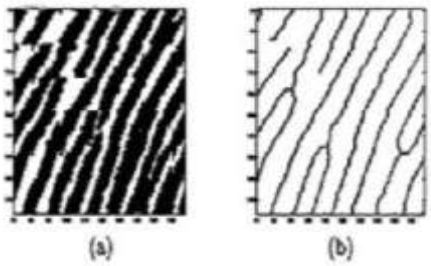

Figure3.2. (a) pattern Image and (b) trim image.

Pi is a pixel element of the binary belonging to 3x3 P windows.
If CN = 1, end point (EP) is access and if CN = 3, bifurcation point (BP) is access. Other values of CN are not useful.

4.I Minutiae Extraction Algorithm proving Crossing Number process

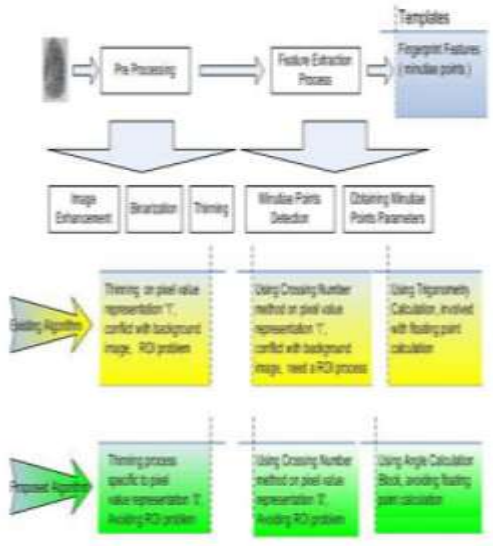

Fig4.1. Schema of fingerprint minutiae extraction algorithm.

Minutiae Pointsdisclosure This process will detect minuity points and define the type of minuity based on the crossing number methoddescribed in 2.3.
This algorithm is of concern over the pixel value representation '0', in the results, the ROI process is not necessary.
Obtaining Minutiae Points Parameters: this process calculates the direction of minutiae points defined in using Angle Calculation Block. This method uses simple calculation and avoiding floating point calculation.

4.II Minutiae Extraction Algorithm using Crossing Number rules
After image transform step, minutiae extraction process is tested.
Minutiae point detection depends on pixel value (’0’ or ’1’).

Two rules are applied: first rulesprocess only pixel with ’1’ value and second rulesare dedicated for pixel with ’0’ value. rules 1 count Crossing Number value on pixel value ’1’ or P=1, and rules 2 do this process on pixel value ’0’ or P=0.
Transform: binarization and thinning algorithm on pixel representation of ’0’ will precede the minutiae point detection process (on ’1’pixel value or on ’0’ pixel value).
The Crossing Number calculation is base on formula 1described in 4.1.

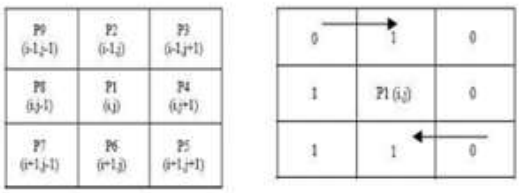

Fig5.2 Pixel neighbourhood and Pixel Transition.

4.III Accessing Minutia Points Parameters using Angle Calculation Block
Accessing parameter of position and type of minutiae is not difficult; it is depending on area of pixel P and the CN value. If CN=1 itcorrelates to the End Point (EP) and if CN=3, it correlates to Bifurcation Point (BP) of minutiae. Proposed algorithm can be seen on figure 9.
To reduce the erroneous minutiae detected at the edge of the fingerprint image, perform a

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procedure to examine the candidate minutiae point to see if the edge of the image has been tested.

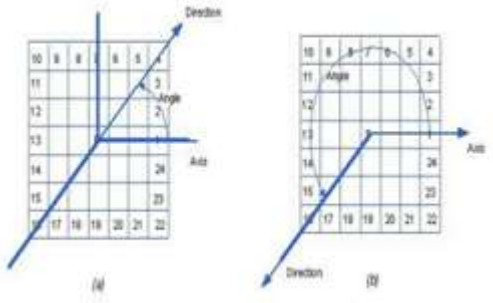
This process does not check the existence of the pixel value '0' to the right, left, top or bottom of the candidate's minimum mark for a specific distance.

To obtain the angle of the Minutiae point, an angle calculation block is used for each Minutiae type.

This block is 7x7 so the scale of the angle is 360/24 = 15o, evaluating the tree line that exists at the edge of the block and calculating the shortest distance between the two lines.

In the middle of these two lines is the direction or angle of the BP Minutia points. For example, 14.a., line 1 = 1, line 2 = 7 and line 3 = 16 are obtained, the shortest distance between two lines is line 1 and line 2 which is 1 and 7 or distance is 6. From this example, the middle distance of the two lines is line position = 4, and using equation (2), theangle of the Minutia point is 45o. The process line for the EP is tracing the existence condition and calculates the angle using equation (2), for example figure 14.b.225o. The steps to find the line position forthe angle of BP minutiae are:

1. Find each three rows of bisected feet.
2.Find the distance between the lines.



3. For smallest distance, line position is position of the first line added by half of the smallestdistance.
4. Count the angle using equation (2).

$$Angle = (linepositon - 1) \times 15^{0} \qquad (2)$$

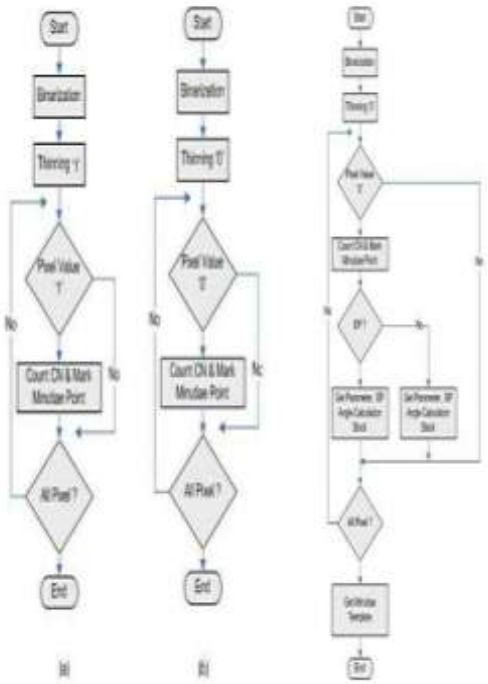


Fig4.3.1. Proposed algorithm, (a) flowchart 1 and (b) flowchart 2 and proposed algorithm in accessing minutiae points parameters.

Fig4.3.2 Angle calculation block for calculating the angle of minutiae points direction.

5.Experiments Results :-

The experiment was performed in MATLAB for minutiae extraction using binarization and thinning technique.

The input image of fingerprint was taken and using algorithms for minutiae extraction and the results for the same are as follows: -

Fig 5.1 Input image

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Thinned image: -

The thinning technique is often used to obtain the skeleton of an image. Thinning algorithms are applied to the image. These are applied to binarized images, in a grayscale, where information of interest such as pixels in black is processed in a 3-row window of 3 rows. The white color is obtained immediately after the black pixel, that is, it is removed when all the conditions below are true.

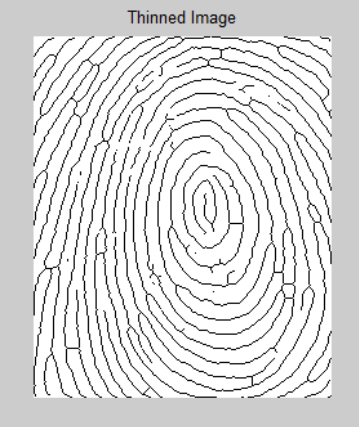

Fig-5.2 Thinned image

Minutiae of fingerprint: -

While extracting minutiae two things are observed in the image namely dots (the red dots in the image) and incipient (the blue dots in the image. Unlike dots, which are common ridge units, rip-off normalization units that remain "immature" at the time of differentiation inhibit the formation of the primary ridge. A disease is often much thinner than a dot, yet its presence can be greatly affected by pressure.

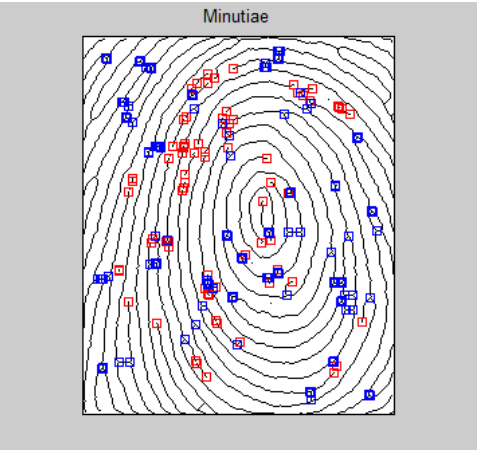

Fig-5.3 Minutiae of fingerprint

CONCLUSION:-

In this paper fingerprint were identified using minutiae. The minutiae extraction is used to find the reference point for fingerprint based detection. The fingerprint images can be cluster together broadly into five major groups (i.e. arch, tented-arch, left-loop, right-loop, whorl) using singular point detection. The reference point can be if the image is not noisy. If we cluster the images into five major groups manually by visual checking then it is easy. But for automated system it becomes quite difficult. There are many algorithms proposed for minutiae extraction. The minutiae matching technique is highly sensible and reliable. In this the input fingerprint and the stored databases are computed and compared with each other.

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