# Person Identification Using Fingerprint by Hybridizing Core Point and Minutiae Features

M. Ezhilarasan, D. Suresh Kumar, S. Santhanakrishnan, S. Dhanabalan and A.Vinod

Department of Information Technology
Pondicherry Engineering College
Puducherry-605014, India

***Abstract-*** **Fingerprint recognition refers to the automated method of verifying a match between two human fingerprints. Fingerprints are one of many forms of biometrics used to identify an individual and verify their identity. The non-changeability of Fingerprints during the human life span and the uniqueness of each individual's fingerprints are the basis for using fingerprints for identification purposes. The main objective is to provide a high secure unibiometric system using the fingerprint of individuals. The fingerprint trait is chosen because of its availability, reliability and high accuracy. Moreover the fingerprint based biometric system can be implemented easily.**

## I. INTRODUCTION

The concept of Fingerprint identification system is in use since 400AD [1]. Before the introduction of Galton points in 1890 person identification was based on Fingerprint patterns which were mainly loops, whorls and arches. The minutiae points were then used to identify a person uniquely [2]. The core point is the uppermost of the innermost curve and is unique to every individual. There are about 100 ridge characteristics found in the human fingerprint. The ridge termination and the bifurcation are common among those. We are considering only these two minutiae points. There are numerous existing systems that use only the core point or only the minutiae points. Some systems have a combination of these two features. A hybridized form of such a system is discussed here. This system is an enhanced version of the existing systems that uses the core point [4] and the minutiae features [7] simultaneously. The Fingerprint has many advantages which makes the system simple, flexible and cost-effective. Some of these advantages are Ease of use, Uniqueness, Reliable and High accuracy.

Section II deals with the basic processes in the fingerprint identification systems. The Section III involves the existing system and some of its limitations. In the Section IV the proposed module is discussed. Section V deals with the results and discussions of proposed system. Section VI is the conclusion. The need and the method of the proposed module is explained with the algorithm. The results obtained are presented in the final section.

## II. BASICS OF FINGERPRINT RECOGNITION

The Fingerprint identification system will have the basic modules of sensing, binarization and thinning. The core point detection and the minutiae feature extraction methods vary based on different criteria. The different modules involved are as follows.

### A. FINGERPRINT SENSING

The fingerprint image is sensed by the sensor and the image is loaded to the program. The loaded image is now stored as an array.

Figure 1: Original Image

### B. BINARIZATION

In Binarization, the gray scale image pixel value will be converted to 0 or 255 with a level of threshold. Threshold is set by using adaptive thresh [8]. If values of image I is less than threshold value, set I value to 0 (black) else set to 255 (white). After setting the threshold value save the image back to I.

Figure 2: Binarized Image

### C. THINNING

Thinning means reducing binary objects or shapes in a fingerprint image to strokes. If the image is reduced to a single pixel wide then this process ends otherwise it is repeated until the pixels are one pixel wide [8].

Figure 3: Thinned Image

### D. CORE POINT DETECTION

Core point is the uppermost of the innermost curving ridge [3]. The core point is found using the Poincare Index Algorithm. If the value of Poincare index is equal to 360 degree (threshold), it is core point. If the value of Poincare index is greater than 180 degree(threshold) [2], it is delta point The Poincare index is represented as

$$P_{(G,C)}(i,j) = \sum_{k=0}^{7} angle(d_k, d_{(k+1)mod8} \quad (1)$$

Figure 4: Core Point

### E. MINUTIAE EXTRACTION

The minutiae points such as the ridge endings and bifurcations are extracted using the crossing number of pixels algorithm [7]. The crossing number of a pixel in a binary image is defined as half the sum of the differences between pairs of adjacent pixels in the 8-neighborhood. Its value is 1 for termination minutiae, 2 for an intermediate ridge pixel and 3 for a bifurcation or more complex minutiae. Crossing Number of pixels (CN) is calculated using the following formula

$$cn = 0.5 \sum_{i=0}^{\infty} |P_i - P_i + 1| \quad (2)$$

Figure 5: Bifurcations and Terminations

### F. DISTANCE CALCULATION

The coordinate of the core point (X1,Y1) and the minutiae points (x2,y2) are used to calculate the distance[6] between them by using the following formula

$$d = \sqrt{(X1 - x2)^2 + (Y1 - y2)^2} \quad (3)$$

### G. MATCHING

Matching phase defines the similarity (distance) metric between two fingerprint representations and quantifies it. The Matching is done by comparing the matching scores of the Template and the Input image. The format of the matching score depends on the x and y co-ordinates and the distance d.

$$m^i = x^i, y^i, d^i \text{ where i=1...n} \quad (4)$$

## III. EXISTING WORKS

The commonly used fingerprint identification system is based on minutiae matching. Only ridge ending and ridge bifurcation minutiae types are used in those systems [6]. The traditional chain code contour chasing algorithm is used for feature extraction. The existing systems are based on the core point detection [3] and the singular point detections [5]. The presence of the singular points with respect to the core points is found. The x, y values of the points is noted. The singular points are thus indexed and the pattern is matched for identification of the Fingerprint [4]. Another existing system was based on the distance between the reference point and the minutiae points viz. the ridge endings and ridge bifurcations. The reference point was calculated by the center point algorithm. The distance is stored in an array and this is used for matching.

The traditional algorithms resulted in high FAR and FRR values. Thus the systems did not provide the expected accuracy and security [7]. The system considering the core point and the singular points has a drawback that when the finger print is stored in a database in a particular angle it should be verified again in the same angle. If the orientation changes then there is a high chance of False Rejection as the x, y values of the core point and also of the other singular points will change. The system considering the distance between the reference point and the minutiae points also has a drawback. When the finger's position changes the reference point's position also changes. Thus the distance between the reference point and the minutiae points changes and hence the FRR increases.

## IV. PROPOSED WORK

We have proposed an algorithm called "ORIENTAL NORMALIZATION". The main purpose of this algorithm in fingerprint identification system is to improve the matching accuracy of the fingerprints and thus providing the highly secured fingerprint identification system. This algorithm attempts in overcoming the drawbacks of the existing fingerprint identification system. The problems with the existing system are as follows:

1. When an image is sensed and stored in a particular angle again the image has to be verified in the same angle.
2. When the fingerprint position changes the reference point and minutiae point's positions also changes.

The main objective of the Oriental Normalization algorithm is to remove the angle and the positional difference between the input and template images. This is achieved by standardizing the image to a particular angle and position. The sequences of steps involved in the algorithm are:

1. The output of the core point detection module is taken as the input. (Figure 6.1)
2. The (x, y) co-ordinates of the core point are marked.
3. The position of the image is now standardized by fixing the co-ordinates of corepoint as origin.
4. The point farthest from the core point is found.
5. A line is drawn from core point to farthest point. This is the core point axis. (Figure 6.2)
6. The angle between the Y-axis and the corepoint axis is calculated as theta.
7. Now the image is rotated with an angle theta so that the core point axis coincides with the Y-axis. (Figure 6.3)

The proposed system consists of eight modules for calculating the required information from the fingerprint image and to store it in the database. The matching phase involves only the detection of the fingerprint and all the other processes are done internally and the final value is compared with the template stored in the database. The complete pictorial representation of our system is given below and each modules are explained subsequently.

The oriental normalization involves the application of the proposed oriental normalization algorithm. The output of this phase is the normalized image that is not affected by the positional and the angle difference.

Figure 6.1: Original Tilted

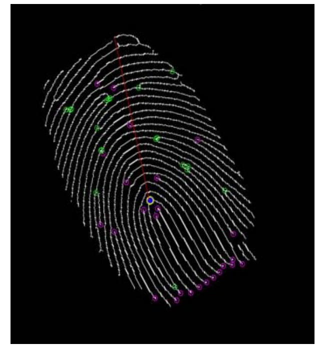

Figure 6.2: Core Point Axis Image

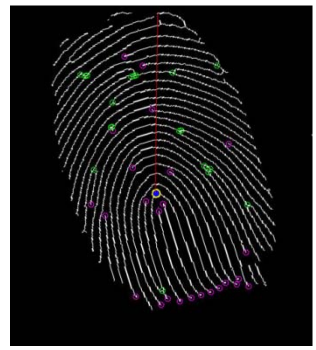

Figure 6.3: Normalized Image

## V. RESULTS AND DISCUSSIONS

The proposed system was tested on Fingerprint database, namely the FVC 2000, FVC 2002, FVC 2004 and FVC 2006. These 4 databases consist of fingerprint images enrolled in TIFF format and the quality of the fingerprint varies. Every user consists of 3 different fingerprint trials included. Each fingerprint varies in position, orientation, quality and impression levels [9]. The proposed system yields 99.46% on an average when compared with every database.
The system reduces the False Rejection Rate by normalizing the orientation of the input image and thus increasing the overall accuracy of the system. The only constraint is that the input image should be clear if it has to be orientally normalized.

Table 1 Results of Fingerprint Recognition

| *Databases* | *Existing system %* | *Proposed system %* |
|---|---|---|
| FVC 2000 | 98.17 | 99.31 |
| FVC 2002 | 99.24 | 99.39 |
| FVC 2004 | 98.17 | 98.91 |
| FVC 2006 | 99.37 | 99.46 |

## VI. CONCLUSION

The Fingerprint Recognition overcomes the traditional methods of authentication. The existing system has positional and oriental drawbacks. The False Rejection Rate is thus higher in those systems [4]. The proposed system overcomes these problems and provides a maximum accuracy of 99.46%.

ACKNOWLEDGEMENT

This work was supported under the AICTE Research Promotion Scheme Grant No.8023/BOR/RID/RPS-124/2008-09. Main analyses of the results in this paper use FVC fingerprint database.

## REFERENCES

[1] Davide Maltoni, Dario Maio, Anil K. Jain, Salil Parphakar,"Handbook of Fingerprint Recognition", New York, 2003.

[2] Anil K.Jain, Patrick Flynn, Arun A. Ross,"Handbook of Biometrics"NewYork 2008.

[3] Ashish Mishra , Dr.Madhu Shandilya," Fingerprint's Core Point Detection Using Gradient Field Mask" International Journal of Computssser Applications (0975 – 8887), Volume 2 – No.8, June 2010.

[4] Atipat Julasayvake and Somsak Choomchuay," A Algorithm For Fingerprint Core point Detection"IEEE 2007.

[5] H B Kekre, V A Bharadi," Fingerprint Core Point Detection Algorithm Using Orientation Field Based Multiple Features" International Journal of Computer Applications (0975-8887) Volume 1-No.15.

[6] Yilong Yin, Jie Tian, Xiukun Yang," Ridge Distance Estimation in Fingerprint Images: Algorithm and Performance Evaluation" EURASIP Journal on Applied Signal Processing, 2004.

[7] Chaohong Wu, "Advance Feature Extraction Algorithms for Automatic Fingerprint Recognition Systems", Dissertation on The University of New York, April 2007.

[8] M. Usman Akram, Anam Tariq and Shoab A. Khan, "Fingerprint image: pre- and post- processing", International Journal on Biometrics, Volume 1, 2008.

[9] Jayant V Kulkarni, Jayadevan R, Suresh N Mali, Hemant K Abhyankar, and Raghunath S Holambe (2006), 'A New Approach for Fingerprint Classification based on Minutiae Distribution', *International Journal of Computer Science*, Vol.1, No.4, pp. 253-258.