

Minutiae Based Fingerprint Recognition

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Abstract: This paper addresses the basic technology concept about fingerprint biometrics. Biometric basically a technology which is based on physical and behavioral characteristics of human. This technology has increased to establish the security and reliable personal authentication that helps to identify a human being on their special characteristics. Biometric technologies such as face, iris, retina, finger, hand geometry include in physical characteristics of human where as gait pattern, voice, signature are involves in behavioral characteristics of human. Among various biometric traits fingerprint are known to have most secure and proven higher performance. This paper based on the fingerprint identification technology. The current trend of fingerprint sensing and identification methods which enhance the human-machine interaction are described in this paper.

Keywords: *Biometric system, Fingerprint Recognition, Minutiae, Identification.*

1. INTRODUCTION

Biometric technology is basically used to identify the human characteristics. This technique are divided into two categories i.e. physical based characteristics (fingerprints, face, iris, retina, DNA, hand geometry, palm print etc.) and behavioral (voice, gait pattern, signature etc.). On the basis of these characteristics a human is identified by biometric technology and every individual has its own unique features such as universality, uniqueness, permanence and collectability [1]. Fingerprint biometric is one of the most widely used biometric today. It has been use for biometric recognition since long because of their higher acceptability, unchallengeable and uniqueness [2]. The biometric technologies included in this are fingerprint technology by 60%, face and iris by 13%, keystroke by 0.5% and signature by 2.5% [3]. The fingerprint biometric traits are unique and stay unchanged throughout an individual life time. So the biometric identification system is an efficient method to recognize human identity. Fingerprint identification is the method of identification using the impressions made by the minute ridge pattern found on the fingertip of human being, as shown in figure below.

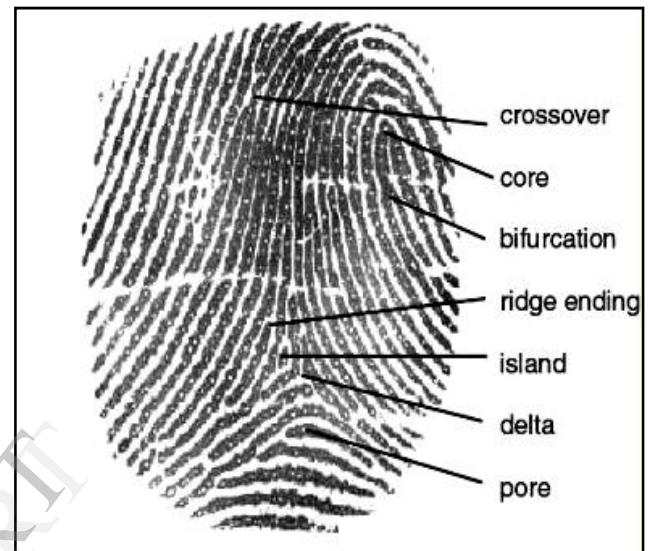


Figure 1: Pattern of fingerprint: Crossover, Ridge, Delta, Pores, Ridge Bifurcation and Core.

The flow pattern of fingerprint including the overall ridge flow pattern, ridge frequency, location and position of singular points (core and delta), type, direction and location of minutiae points, ridge count between pairs of minutiae and location of pores as shown in figure above. These entire features define the user individuality [4].

2. MINUTIAE BASED FINGERPRINT RECOGNITION

Minutiae are the points of interest in a fingerprint such as bifurcations and ridge endings. The process of matching fingerprint is based on minutiae matching pattern [5]. Some examples of fingerprint minutiae are:

- i.) Ridge endings - a ridge that ends immediately.
- ii.) Ridge bifurcation - a single ridge that divides into two ridges.
- iii.) Short ridges, island or independent ridge - a ridge that begin, travels a short distance and then ends.
- iv.) ridge enclosures - a single ridge that bifurcates and connect up shortly then continue as a single ridge
- v.) spur - a bifurcation with a short ridge branching off a longer ridge

vi.) crossover or bridge - a short ridge that runs between two parallel ridges

| | |
|-------------------|--|
| RIDGE TERMINATION | |
| BIFURCATION | |
| INDEPENDENT RIDGE | |
| DOT OR ISLAND | |
| LAKE | |
| SPUR | |
| CROSSOVER | |

Figure 2: Examples of fingerprint minutiae

The image of fingertip of human find enough minutiae in one image that is stored previously by biometric device matches with the same fingertip of human in another image. If minutiae matched together by their distance relative to other minutiae around it, then the points are said to match up. Before minutiae matching can be done with the surface area of scanner the fingerprint must be preprocessed [6]. The preprocessing of image done in four levels.

- Level 1: First the fingerprint is thinned.
- Level 2: After thinning process to find minutiae such as bifurcations and endpoints simple.
- Level 3: In the next level edge enhancement is used to fill in gaps in ridge detail. The gap is obtained by the thinning process.
- Level 4: At last level the gaps have been filled in the region coloring begins. Sometimes forged area occur from the thinning process due to some conditions of the initial input, therefore after the area small faulty area are removed from the image.

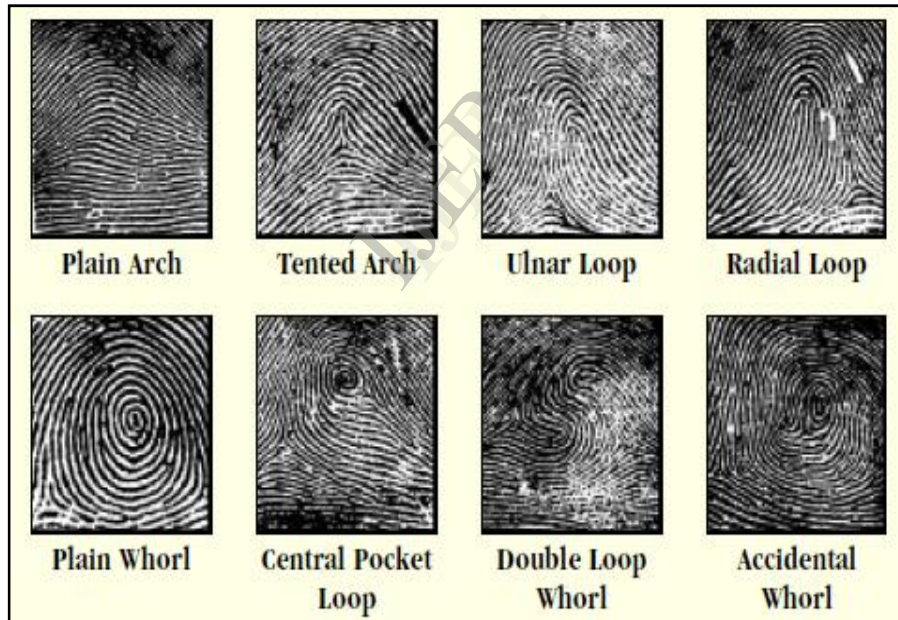


Figure 3: Fingerprint images that have been enhanced by different visualization purposes.

3. IDENTIFICATION SYSTEM

The identification of human is done in two stages: enrollment and authentication. The system compares two fingerprint images: a reference image and a test image. It is assumed that

a reference image is that image which is stored in the database for first time and available for the person to be identified. The test image is obtained and used in real-time. The enrollment and authentication process is shown in figure below.

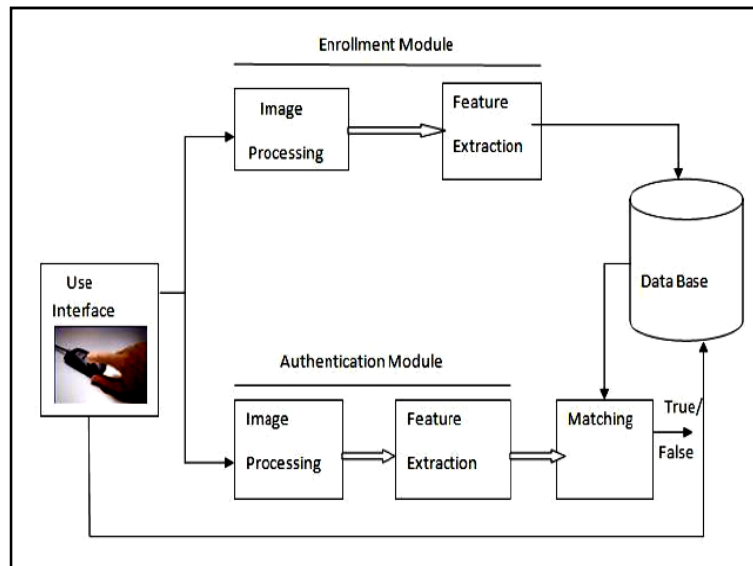


Figure 4: Fingerprint Identification System.

It has to be compared to the reference image within a short time compatible with the application. The operation sequence applied to the reference image and the effective fingerprint matching is carried out on each test image, as shown in the figure above. The reference image is carefully filtered to reduce noise and to use the whole gray-scale dynamics. Since this operation is performed only once for each person to be identified, the filtering operation speed is not a primary requirement. The minutiae coordinate and the neighboring minutiae list is extracted for each detected minutiae [7]. The test image is acquired by the same device as the reference image. It is filtered by the same coarse filter applied to the reference image leading to comparable images. The filtered test image is scanned by a moving window technique searching for possible correspondences between the reference minutiae regions and the test image. If some correspondences are found, a triangular matching is applied and a possible

fingerprint matching is defined. Finally, this tentative matching has to be verified by dynamic time warping to overcome the strong local deformations.

4. COMPARISON WITH OTHER BIOMETRIC TECHNIQUES

Every biometric trait has its own feature and implications. No single biometric is expected to effectively meet the requirement of all the applications [8]. The match between the biometric and application is based on the application and the properties of biometric traits. Various biometric traits mentioned below in the table, among all biometric fingerprint recognition has very good balance in between all the desirable properties.

Table 1: Comparison of various biometric traits.

| Biometric identifier | universality | Distinctiveness | Permanence | Collectability | Performance | Acceptability | Circumvention |
|----------------------|--------------|-----------------|------------|----------------|-------------|---------------|---------------|
| DNA | H | H | H | L | H | L | L |
| Ear | H | M | H | M | M | H | M |
| Face | H | L | M | H | L | H | H |
| Facial thermo gram | H | H | L | H | M | H | L |
| Fingerprint | M | H | H | M | H | M | M |
| Gait | M | L | L | H | L | H | M |
| Hand geometry | M | M | M | H | M | M | M |
| Hand vein | M | M | M | M | M | M | L |
| Iris | H | H | H | M | H | L | L |
| Odor | L | L | L | M | L | M | M |
| Retina | H | H | M | L | H | L | L |
| Signature | L | L | L | H | L | H | H |
| Voice | M | L | L | M | L | H | H |

5. FINGERPRINT APPLICATIONS

Fingerprint imaging technology includes security and access control. As a result, military, government, and financial institutions are increasingly looking at fingerprint imaging systems as a means of security.

Specific applications include:

- Fingerprint identification systems are being employed by South African banks for use in their automated teller machines (ATM) machines. They are used to identify senior citizens that use ATM machines to collect their monthly pensions.
- MasterCard and Visa have begun to use fingerprint identification systems.
- Charles Schwab & Company employ fingerprint identification systems to perform security checks.
- Annual and seasonal pass holders at Walt Disney World in Orlando, Florida use a fingerprint identification system to gain access into the park.
- Purdue Employees Federal Credit Union (PEFCU) has installed fingerprint imaging systems in their satellite banks.

6. CONCLUSION

The conclusion of this whole paper is that the fingerprints recognition is suggested to be implemented because it is easier, reliable, feasible, secure and easily authorized to everyone. And there is no any worry that anyone can stolen my finger are can be loosed anywhere so other body can use it. In fingerprint recognition system user has to place his fingers on the finger scanner and then scanner will recognize the account which belongs to that person and match up from the previous database which is enrolled and database stored permanently by biometric device. In this paper we discussed that it is very beneficial and help for security purpose because for user there is no need to scratch the credit card and then enter code if code is forgot or if some time card cannot read in ATM and many more problems can occur in card system. So in this paper we explain the biometrics with detailed term, how fingerprint system works, fingerprints types and fingerprint recognition through minutiae pattern based. Comparison of biometric recognition with other biometric traits and the major application area also discussed in this paper.

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