Fingerprint Recognition System and Tehniques: A Survey

Rahul Sharma, Nidhi Mishra, Sanjeev Kumar Yadav

Abstract— Fingerprint recognition is one of the most well-known popular technique used in biometrics Fingerprint recognition is the problem of searching and matching a fingerprint from the given database. There are various algorithms and technique whicg gave the accurate results for the fingerprint recognition system. For enhancing the performance and accuracy of biometric fingerprint recognition system a lot of researchers claimed that their algorithms and techniques are better than others.

Index Terms—Biometrcs, Fingerprint, feature extraction, minutiae matching, verification, SPIRAL, Wavelet Transform

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1 INTRODUCTION

The fingerprint is a physiological biometric characteristic to identify a person. As the name implies fingerprint is the impression or the print made by human finger due t fingerprint, as the name suggests is the print or the impression made by our finger because of the patterns formed on the skin of our palms and fingers since birth. With age, these marks get prominent but the pattern and the structures present in those fine lines do not undergo any change. . Fingerprints are raised ridges of skin on the hairless surfaces of hands and feet (Dermal Ridges).Primates and other animals have fingerprints. They provide traction and every ridge contains glands [9]). There are three principles of fingerprints:-

1. A fingerprint is an individual characteristic
2. Fingerprints remain unchanged during a lifetime.
3. Fingerprint has general ridge patterns that permit them to be classified.

The main aim of this paper is to study the various technique and algorithms for Fingerprint Recognition System such as latest minutiae based, correlation based and other global, local methods for fingerprint matching and status of success of concurrent methods. The problem is to develop a Fingerprint Recognition System that returns relevant results to a query fingerprint image in a relevant time.

This paper is organized as follows:In first section we discuss the history of fingerprints.In next section we describe various types of fingerprint recognition system.In next section we discuss the outcomes of algorithm considered in literature and draws results from different paprs on the theme.In last section,we draw a conclusion out of all the discussion followed by a list of references.

1.1. HISTORY OF FINGERPRINT

Fingerprints and handprint patterns have been used as a

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means of personal identification for thousands of years but recently becoming automated due to the advancement in computing capabilities.In 1684, Dr. Nehemiah Grew studied and described the ridges, furrows and pores of both the human hands and feet.

After few years professor Johannesh create a system of classifying fingerprints. He described and illustrated nine fingerprint pattern types in detail and named each pattern type and devised rules for their individual classification He showed that fingerprints were unique from person to person. Classification He showed that fingerprints were unique from person to person.In 1892; a prominent anthropologist Sir Galton published his definitive work, as the use of fingerprints for identification purpose. The International Association for Identification praised his work,

1.2 FEATURES OF FINGERPRINT RECOGNITION SYSTEM

Fingerprint recognition is based upon unique and invariant features of fingerprints According to FBI, fingerprints differ even for ten fingers of a same person [1]
Features of interest

1.2.1 LOCAL FEATURES
or "Minutia Points" are the unique characteristics of fingerprint ridges that are used for positive identification [4].It's possible to have the same global features, but the local features remain unique.

1.2.2 GLOBAL FEATURES
Global Features are the characteristics that any human can see with the naked eye[5]
- Pattern Area
- Core Point
- Delta
- Type Lines
- Ridge Count
- Basic Ridge Patterns

Pattern Area - is the part of the fingerprint that contains all the global features. However, some local features may be found outside the pattern area.
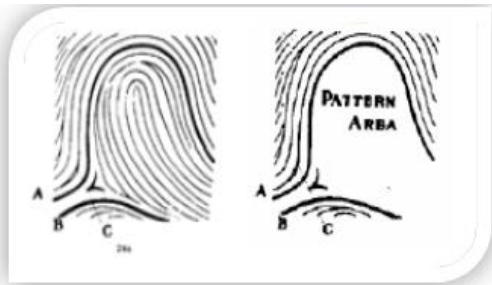

Figure 1.1 Pattern Area

Core Point - is the approximate centre of the fingerprint, and is used as the reference point for reading/classifying the print. More specifically it is defined as the topmost point on the in-nermost upwardly curving ridgeline.
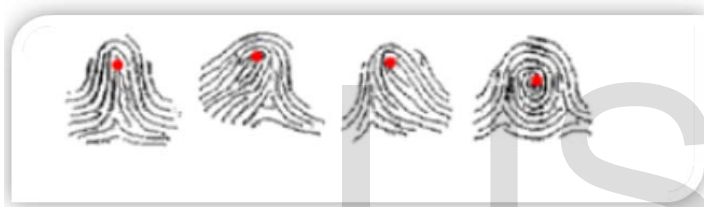

Figure 1.2 Core Point

Type Lines - are the two innermost ridges that start parallel, diverge, and tend to surround the pattern area.
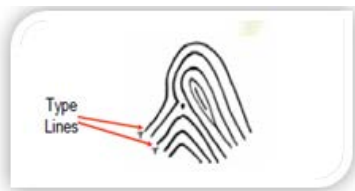

Figure 1.3 Type Lines

Delta- is the point on the first bifurcation, abrupt ending ridge, meeting of two ridges, dot, fragmentary ridge, or any point on a ridge at or nearest the center of divergence of two type lines, located at or directly in front of their point of divergence.

Figure 1.4 Delta

Ridge Count - is the number of ridges between the delta and the core. This is done by drawing an imaginary line from the Delta to the Core and each ridge that touches this line is counted.

1.2.3 FINGERPRINT CLASSES

There are 3 specific classes for all fingerprints based upon their visual pattern:

1. Arches
2. Loops
3. Whorls

Classes	Description	Figure
Arches	A fingerprint pattern in which the ridges pattern originates from one side of the pattern and leaves from other side	
Loops	A fingerprint pattern in which the ridge pattern flows inward and returns in the direction of the origin.	
Whorls	Ridges form circularly around a central point on the finger.	

Table 1.1 Fingerprint Classes

Arches can be broken into two sub-groups:

Plain arch :- This has a gentle rise.

Tented arch:-This has a steeper rise than plain arches.
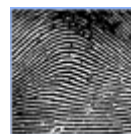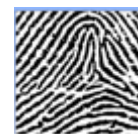

Figure 1.5 Plain Arch

Figure 1.6 Tented Arch

Loops-

Loops can be divided into two groups:

Radial loops:- These flow downward and toward the radius (or the thumb side)

Ulnar loops:- These flows toward the ulnar (or the little finger side). The ulnar loop is more common.

Figure 1.7   Ulnar   Figure 1.8   Radial

Whorls have a circular pattern and have at least two deltas and a core. Whorls look a little like target shapes or whirlpools – circles within circles. Whorls make up 35% of patterns seen in human fingerprints and can be sub-grouped into four categories-Plain whorls,Central pocket loop whorls,Double loop whorls Accidental loop whorls.

2.TECHNIQUES OF FINGERPRINT RECOGNITION SYSTEM

 Fingerprint Identification is one of the most well-known and publicized biometrics

Figure 2.1 Fingerprint showing all features

 Because of their uniqueness and consistency over time, fingerprint have been used for identification for over a century, more recently becoming automate (i.e. a biometric due to advancements in computing capabilities).Fingerprint identification is popular because of the inherent ease in acquisition, the numerous sources(ten fingers) available for collections by law enforcement and immigration.

The earlier work in the field of fingerprint recognition system was done by Moayer[2][3] in which he treated fingerprint as a 1-D character string or 2-D tree and verifying two fingerprint by grimmer matching. These methods are well suited for the high quality images and failed on poor quality images.

2.1 FEATURES ENCODING

➢ Manual Based-Human experts use a combination of visual, textural, minutiae cues and experience for verification. It is still used in the final stages of law enforcement applications.

➢ Image Based-It utilizes only visual appearance. It requires the complete image to be stored (large template sizes).

➢ Texture Based-It treats the fingerprint as an oriented texture image. It accurate less than minutiae based matchers since most regions in the fingerprints carries low textural content.

➢ 1.2.4Minutiae Based-It uses the relative position of the minutiae points. It is the most popular and accurate approach for verification .It resembles manual approach very closely. From a software perspective, the minutia is also used to align the images for database comparisons.

There are some advantages and disadvantages of image based feature encoding.
Advantages-
    i.   Image itself is used as the template
    ii.   Requires only low resolution images
    iii.   Fast
Disadvantages-
    i.   Image itself is used as the template
    ii.   Requires accurate alignment of the two prints
    iii.   Not robust to changes in scale, orientation and position

3. SURVEY ON TECHNIQUES USED IN FINGERPRINT RECOGNITION SYSTEM

Many authers and researchers used various types of techniques for fingerprint recognition.

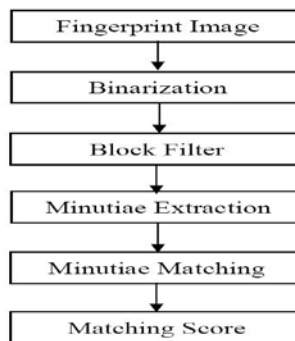### 3.1 FINGERPRINT RECOGNITION USING MINUTIA SCORE MATCHING-

Figure 3.1 Minutia score matching technique[13]

This method is mostly applicable for the matching the minutia points.steps used I this matching are Ridge pointing and Ridge bifurcation.

3.2. WAVELET PACKET CORRELATION METHOD IN BIOMETRICS

Correlation filter is an accurate approach to detect and locate low contrast character strings in complex table environment.It uses shift-Invariance It comparing the proposed wavelet packet filters to standard filters, We see a significant improvement in accuracy

3.3. NEUROCOMPUTING-

Authorin [11] introduces LDSSs(long digital straight segments) technique for fingerprint recognition. Each digital straight segment is measured by using the four parameter:x,y coordinate, slope and length. This information need about 500-600 bytes to store.

As a result,LDDS is a best technology compared to orientation field. For capturing the global structure of the fingerprint .This paper shows that the combining the minutiae and LDSSs features gave the better performance as compared to the minutia based method.

3.4 .A HYBRID SYSTEM FOR FINGERPRINT IDENTIFICATION

Due to the poor performance of minutiae based method, for real time authentication, author in [10] introduce the hybrid fingerprint matching system which combines the minutiae features and wavelet statistical features.In this research fingerprint matching is done by the following method:

Minutiae based method
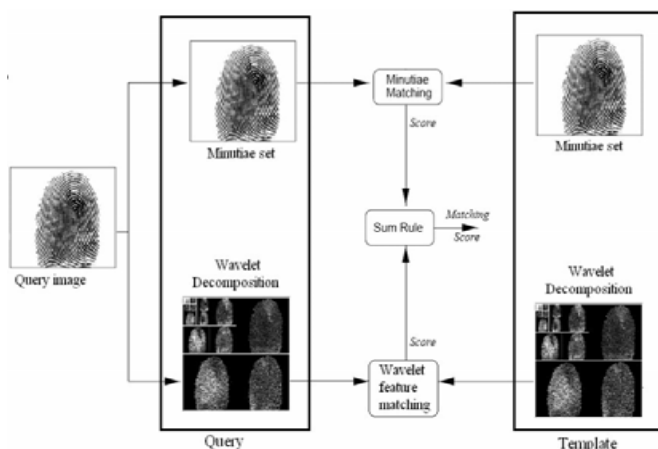
Wavelet transform based method

Figure 3.2 Hybrid system for fingerprint recognition[10]

The performance of hybrid fingerprint recognition is measured by FRR(False Reject Rate) and FAR(False accept Rate).This method is well suited for real time authentication system with a number of fingerprint as compared to conventional minutiae based method.

3.5. CONSENSUS FINGERPRINT MATCHING WITH GENETICALLY OPTIMIZED APPROACH.

Author [4] introduce a new approach in which first suggest a consensus matching function then devise a genetically guided approach to optimize the consensus matching function for simultaneous fingerprint alignment and verification

The experimental results of proposed algorithm shows that the consensus function can lead to a substantial improvement in performance while the local matching operation helps to identify promising initial alignment configuration, thereby

Authors in [3] propose two new methods to detect the fingerprints of different persons based on one-dimensional and two-dimensional discrete wavelet transformations (DWTs).

In first method several fingerprints of a person are taken in a random manner followed by a two-dimensional DWT. Four filtered signals (level-one (approximation), level-two (horizontal details), level-three (vertical details), and level-four (diagonal details)) A, B, C and D are again transformed at 9 levels DWT and the approximations are stored instead of the original images. The transformed signal matrices $T_{i,n}$ = [$A_{i,n}$ B_i $C_{i,n}$ $D_{i,n}$]T; where n = 1, 2, 3, …, M, and M is the number of stored matrices of user i. To recognize the fingerprint of a person, his image is scanned and the same job is done to determine the matrix $T_{i,n}$. Finally, a convolution is made with stored vectors yi of $T_{i,n}$ and the corresponding vectors of the present scanned image and corresponding convolution vectors vi are stored.

In second method, several fingerprints of a person are taken in a random manner as in the previous method (in context of translation and rotation) then an RGB conversion is performed on them. The contrast of the images is increased using a Canny filter then colour inversion is performed on them. The results section of this paper considers only three fingerprints in the process of finding similarities and dissimilarities. Here, only Canny filter is used for image processing.

Authors in [6] introduce the task of recognizing characters in natural Scenes like clutter and placement, Different font style and Variation in light conditions. Author implemented two common descriptors: shape context and wavelet. In shape context method, extract the relative positions of pixels in an edge image. For each location, we impose a log-polar grid and bin the pixels in the edge image into a histogram. Second Wavelet transforms have been used for texture representation, image compression and character recognition

We concluded that the recognition performance of shape context is poor while the performance of wavelet is slightly less than the performance of the raw data descriptors.

Authors in [5] used level 2 daubechies transform and only the second level LL image is used for the analysis as that contains most of the important texture information. Daubechies deals with problems associated with JPEG compression and random additive noise. Authors propose a combination of three texture descriptors namely Standard Deviation, Kurtosis and Skewness. DWT is the transform used for analysis. Canberra

distance metric is used for similarity estimation. This approach is very simple compared to minutia point pattern matching algorithm. It is robust as DWT is rotation invariant transform.

4. PRESENT AND FUTURE USE OF FINGERPRINT RECOGNITION

Fingerprint recognition system is widely used in forensic applications like criminal investigations, terrorist identification and other security issues. As fingerprint recognition technology develops, it is expected that more affordable and more portable fingerprint recognition devices will become available, and finger-print recognition will be considered a safe and convenient personal identification system. Eventually, fingerprint recognition will be used to secure the safety and reliability of a variety of businesses in the industrial sector, including the personal devices and financial industry.

Fingerprint Recognition System is one of the most highly used methods for human Recognition which is automated biometric systems that have been only available in recent years. The quality of a fingerprint identification system not only depends on the accuracy of the system but also in the time that it takes to compute the answer.

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