

# Fingerprint Recognition System

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**Abstract:** Fingerprint recognition is among the most common techniques used in biometrics. Fingerprint recognition, the issue of scanning and matching fingerprints from the database. Biometrics security system has become increasingly popular nowadays and many companies are looking to have access to this technology to improve their environment's security measures, privacy, and confidentiality. There are numerous algorithms and techniques that have provided accurate results for the fingerprint recognition system. Fingerprints have been widely and effectively used for proof of identity in recent years. Because it is authentic, stable through life, unique among the people, public acceptance and least risk of invasion. Fingerprint technology is used to identify a person based on their physical attributes, which is a biometric system. Fingerprint matching is the most common biometric technique used to provide authentication. First, fingerprint identification process scans an unprocessed image, performs pre-processing and then features of those images are identified as vectors and protected as image records in fingerprint databases. A broad study on various features of fingerprint recognition systems is explained in this paper.

**Keywords:** Authentication, Enhancement, Fingerprint Identification, Minutiae, Recognition, Wavelet, Wave Atom.

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## INTRODUCTION

To identify an individual, the fingerprint is a biometric feature of physiology. As the name implies, fingerprints are prints or prints produced by a human finger due to fingerprints, as the name suggests, prints or prints made by a finger on the surface of our palms and fingers since birth[1]. Such marks become prominent with age, but there is no shift in the pattern and structures present in those fine lines. Fingerprints are elevated ridges of the skin on the hairless surfaces of the hands and feet (Dermal Ridges). They provide traction, and each ridge contains glands. Fingerprints are based on three principles[2]:

A fingerprint is one characteristic of an individual. During one lifetime, fingerprints remain unchanged. Fingerprint has general ridge patterns that allow classification. Fingerprint recognition is an automated process for

recognizing a person's identity based on comparing recorded fingerprint images to fingerprint images data. These are eye-catching bio-metrics used to check computer systems. The fingerprints are the traces or patterns that occur in human fingers at any age and that pattern never changes over time. Throughout recent years, the fingerprint identification method has drawn the attention of so many researchers due to its many advantages[3]. One of the greatest benefits is that the legal community very well understands this. This identification technique is very simple, accurate, least expensive and easiest way to recognize an individual. This recognition technique has also been widely acknowledged in authentication for its precision as the likelihood of the identical finger of two different persons is exceptional. Fingerprint never changes until there is some physical disorder like injuries or those who deal with burning or hot products in the mechanical or metal industry that can harm

fingerprints[4]. Fingerprints are useful. Of example, if parents have their child's fingerprints and place them in a file, and if that child is lost, childhood fingerprints are used to make a match when these are remembered in the future stage of life. There are some disadvantages in an automated fingerprint identification system.

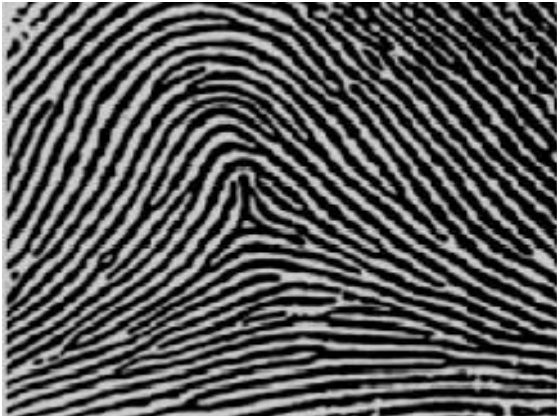
*CLASSIFICATION OF FINGERPRINT PATTERNS*

*Arches:*

The pattern whose ridges route is from one side to the other with no rotation type called as arches. Normally, the delta is not allowed with any arch style. When a delta point is present, no recurring ridge point occurs in the center[5].

Arches are subdivided into four types:

- Radial arches
- Tented arches
- Plain arches
- Ulnar arches



**Figure 1: Arches**

*Loops:*

The pattern whose ridges travel inward & return to the origin in line is known as loops. Ridges are an entry, re-curve and finishes on either side of the imprint on the e way to the side where the ridges come in[6]. Four forms of loops are as follows:

- Plain loop
- Lateral Pocket loop
- Twinned loop
- Central packet loop



**Figure 2: Loops**

*Whorls:*

The whorls are called the Patterns whose ridges shape a circular structure around a central point. Depending on the pattern consisting of two or more delta points in whorl patterns, the following four classes are classified:

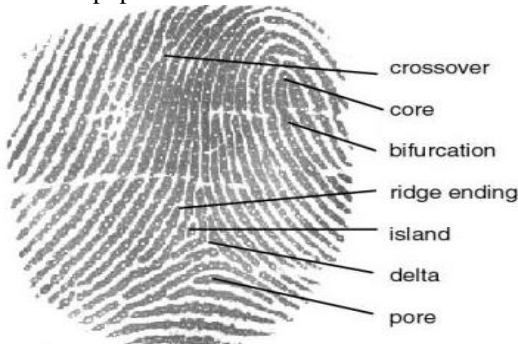
- Plain whorls
- Central pocket loop whorls
- Accidental whorls
- Double pocket loop whorls



**Figure 3: Whorls**

### *Techniques of Fingerprint Recognition System*

Identification of fingerprints is one of the most well-known and popular biometrics.



**Figure 4: Fingerprint Features**

Due to their reliability and accuracy over time, fingerprints have been used for identification for more than a century, becoming more recently standardized (i.e., a biometric due to advancements in computational capabilities)[7]. Identification of fingerprints is popular because of the ease of acquisition, many sources (ten fingers) available by law enforcement and immigration for collections. Some researchers have done the earlier work in the field of fingerprint recognition method in which they treated fingerprint as a 1-D character string or 2-D tree and through grimmer matching checked two fingerprints. Such approaches are well adapted for images of high quality, and failed on images of poor quality.

#### *Features Encoding:*

**Manual Based:** Human experts use a mix of visual, textural, precise signs and verification experience. And it is still used in the final phases of law enforcement applications[8].

**Image Based:** This uses visual appearance only. It allows the image to be stored in complete form (large prototype sizes).

#### *Texture Based:*

Treats the fingerprint as a picture of a directed texture. It is less accurate than minutiae-based matchers since most fingerprint regions carry low texture content.

#### *Minutiae Based:*

It uses the minutiae points relatively location. It is the most common and effective verification method. It closely resembles manual approach. The minutia is also used from a software perspective to coordinate the images for comparison with databases.

**Advantages and Disadvantages of Feature Encoding:**  
**Advantages:**

- The image is used as the template itself.
- Needs images with a low resolution only.
- Fast.

**Disadvantages:**  
 Needs exact alignment of both prints.  
 Not stable for size, orientation and position changes.

#### *Existing Methods*

##### *Minutiae Based Approach:*

Minutiae signify to a specific point in the forensic science & biometrics area of a fingerprint. The main feature used to make comparisons between patterns is this minutiae. It consists of the bifurcation ridge or a ridge that ends in a fingerprint. Recognized minutiae in a fingerprint pattern are identified through a series of characteristics, e.g. the location of minutiae, direction & form of minutiae, e.g. the ending of the bifurcation. For images, fingerprints are validated by equating minutiae marks. Minutiae are stored as values of attributes, for example minutiae location is within the pattern of fingerprints[9].

Fingerprint recognition systems built on Minutiae are the effective method which achieves a high precision rate. It covers four levels, and is described as:

- Minutiae extraction
- Orientation field assessment

Ridge extraction

Post processing

The correct demonstration of a fingerprint pattern is determined by the accuracy of the extraction and saving of the minutiae information presented in the fingerprint image. Given that numerous commercial large-scale systems rely on fingerprint identification mechanism, a good presentation of the fingerprint pattern is very much needed. A minutiae point is recognized in the manner below. When the brightness value of the pixel is transposed, the ridge ends transform into bifurcation & vice-versa. Minutiae location defined as tip of ridge or valley. Minutiae's extraction process is known as fingerprint images or fingerprint gray scale images. Various options are available, such as binarized fingerprint images, thin binarized images, un-thinned binarized images, run representation-based images, chain-based images, morphology-based images, and cross the image based on numbers.

*Pattern Recognition Approach:*

Fingerprints consist of a mixture of ridges & valleys that are considered patterns. These patterns use pattern recognition methods to authenticate. Identification of patterns is the strongest attribute of input images as it defines patterns of comprehensions and the relationships maintained. The methods of pattern recognition are known as Structural & Theoretic Decision. Descriptors Relationships are used as structural tool to describe a sequence. To define a pattern in the decision theoretical method, area, length & texture descriptors are used. The most important fingerprint identification system category is to expose the better descriptors, which are described in a better manner. The pattern-based fingerprint identification method is created by generating data from input data images. The image is preprocessed to render the image clean and noise-free. When the input parameters are given, if they suit a function vector database & based on the result, authentication is permitted or rejected to the person.

*Wavelet based Approaches:*

Wavelet theory is widely used in the processing of signals. But then, the conventional wavelet transformation revealed some constraints on the processing of 2-D images. The technique of image processing is a collectively partial differential equation and the wavelet theory can perform better by keeping the edge of the image information. Wavelet transform approach can be used to perform the authentication on the fingerprint patter. Wavelets help to cut the data images input into different components of the frequency. Then, each item is analyzed using a scale method of determination. In the wavelet based approach, the fingerprint images are separated by using discrete wavelet transform. For training purposes, three stages of decomposition of the fingerprint images are performed. Mean & standard deviation is used in the time of decomposition process[10]. To distinguish these fingerprint patterns, which are rotated between 0 and 360 degrees & every move is also increased by 10 degrees. A set of wavelet statistical values and the co-occurrence function are described after that. The directional solving power of wavelet mines, texture information in diagonal directions in LL, LH, HL and HH can be clearly stated. In wavelet-based fingerprint recognition systems, preprocessing of fingerprinting or post processing is not required. In comparison to minutiae-based method, wavelet-based pattern recognition technique is fast enough. Another benefit of the wavelet is that it performs at least three levels of texture splits which make a perfect automatic fingerprint identification system. This is the disadvantage of texture analysis systems, since images are observed on a single scale.

## CONCLUSION

The method for the identification of fingerprints generally uses the biometric approach. Of example, these have a number of applications, terrorist identifications, criminal investigations and other security issues. Fingerprint is a physical biometric

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feature that is used to identify an individual. Fingerprint never changes until there is some physical disruption such as injuries etc. Such fingerprints are differentiated over age, and the probability of two people having similar fingerprints is outstanding. The important thing to get accuracy and robustness is the dignified standard noise-free fingerprint picture for fingerprint identification mechanism.

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