Evolution of Maintaining Fingerprint Records: From Fingerprint Slip to AFIS System

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Fingerprints are the unique patterns formed by ridges and furrows on the surface of human fingers; it is an impression or reproduction left on any material or surface by the frictional skin of fingers. The development of fingerprint starts forming at the embryonic stage and remain unchanged throughout the life of an individual, making them a unique identifier for each person. Fingerprints are unique identity of an individual. Fingerprints play a crucial role in linking individuals to crime scene, to identify a person and maintaining criminal records. It helps in solving the crimes, it is one of the most important pieces of evidence found at crime scene. The British government played a crucial role in developing and utilizing the fingerprint identification in 1868. Sir William Herschel, serving under the British government in India, began using fingerprints to prevent fraud, marking the first large-scale administrative use of fingerprint identification. He also submitted a request to the home office to use fingerprints extensively throughout India. Then In 1880, Dr. Henry Faulds suggested to use fingerprint not only for identification purpose but also for criminal investigation in criminal cases. Later, the world's first fingerprint bureau was established in Calcutta, Bengal in 1897. This marked as the beginning of systematic recording and documentation of fingerprints in India. The Fingerprint Bureau was setup to collect and analyse the fingerprints; identifying individuals and prevent crimes.

There are basically 3 main principles of fingerprints:

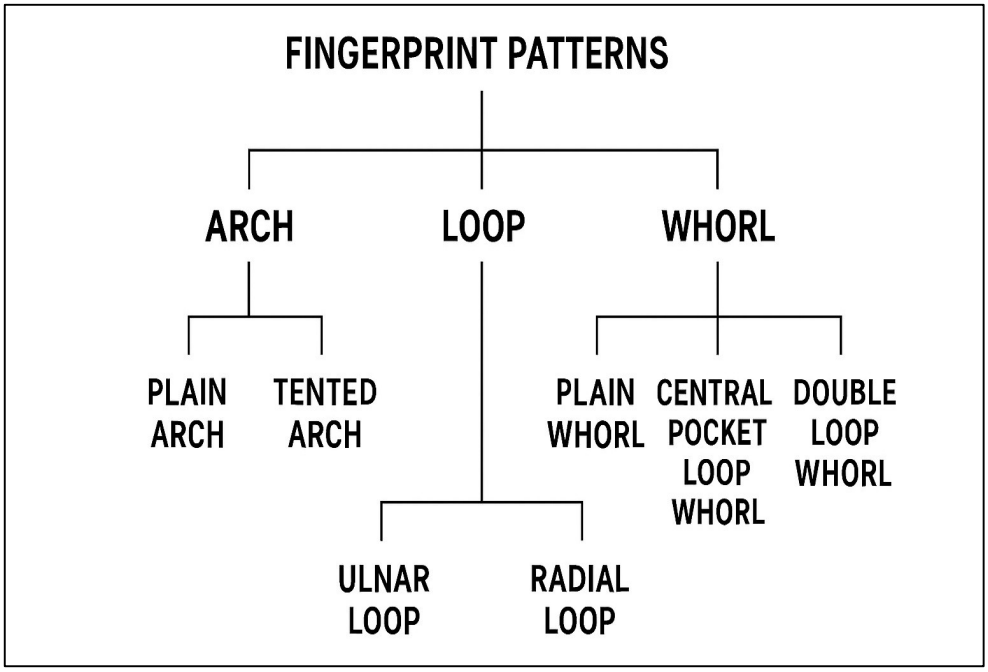
- Uniqueness – Every individual has a unique fingerprint. It states that "No two individuals possess the same ridge characteristics." The individuality of fingerprints is not based on pattern or shape, but on the ridge characteristics called 'minutiae.' This uniqueness makes fingerprints one of the most reliable tools for personal identification.
- Permanence – It states that fingerprints are permanent and remain unchanged throughout life. Even superficial injuries like cuts, burns, or abrasions may temporarily damage the skin, but once healed, the original ridge pattern reappears.
- Classifiable – The fingerprints are classified on the basis of their general pattern given by Sir Francis Galton, known as the Tripartite Classification. This system of classification allows systematic recording and easy retrieval of fingerprint records for comparison and identification.

About the author:

Mr. Parth Khillari is a highly determined and composed student who approaches every task with sincerity and commitment. His hardworking nature is reflected in the way he balances academic responsibilities with a positive and cooperative attitude towards his peers. He is respectful and considerate, always willing to give way to others while still maintaining his own sense of discipline and focus. One of his strongest qualities is perseverance, once he starts something, he ensures it is completed with dedication and thoroughness. His calm demeanour, coupled with his persistence and sense of responsibility, makes him a reliable and promising individual.

Fingerprints are classified into 3 types:

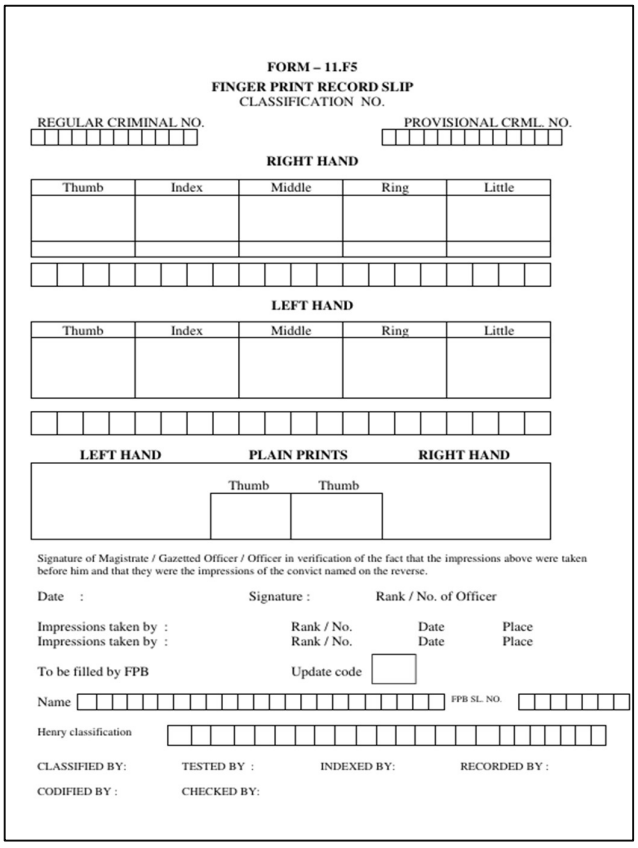
1) Arch: A pattern type in which the friction ridges enter on one side of the impression, flow or tend to flow out to the other side and a make a wave like structure in the centre.
2) Loop: It is most common pattern of fingerprint. A pattern type in which the ridges enter from one side of impression and exit on the same side.
3) Whorl: A type in which the ridge patterns are generally rounded or circular in shape.



The practice of preserving fingerprints started in response to the increased need for an established identification method at the end of the 19th century. With the application of fingerprints, police agencies were able to identify criminals, solve crimes as well as prevent criminal activity. This commenced a new era of identification in forensic science. Initially, criminal fingerprints were recorded on fingerprint cards, referred to as slips with the help of ink. The fingers are carefully rolled on ink pad and the same are again rolled on the fingerprint slip with sufficient pressure to avoid smudging and clear prints. Fingerprint slip typically designed with allocated areas for each finger's impression is then used to capture the print. Each finger is carefully rolled from one side to the other side on fingerprint slip, allowing for the full impression of the ridge pattern. The same process is followed for each finger in their allocated area or region. The slip is labelled with all required information and other relevant details.

Fingerprint slip contains:	
Identification Details • Name (including aliases) • Date of birth or approximate age • Father's/Husband's name • Address	**Criminal Record Information** • FIR number, case number, and section of law • Date of conviction • Sentence details • Jail and administrative number

• Gender • Height, build, and identifying marks • Deformities (if any)	• Police station and district • Signature of prosecuting officer verifying conviction
Fingerprint Data • Ten-digit rolled and plain impressions • Classification number (based on ridge pattern) • Bureau serial number • Duplicate slip status (if applicable)	**Administrative Fields** • Number of copies made • Identifying officer's name and signature • Date and district of submission



FORM – 11.F5

FINGER PRINT RECORD SLIP

CLASSIFICATION NO.

REGULAR CRIMINAL NO. PROVISIONAL CRML. NO.

RIGHT HAND

Thumb	Index	Middle	Ring	Little

LEFT HAND

Thumb	Index	Middle	Ring	Little

LEFT HAND PLAIN PRINTS RIGHT HAND

Thumb Thumb

Signature of Magistrate / Gazetted Officer / Officer in verification of the fact that the impressions above were taken before him and that they were the impressions of the convict named on the reverse.

Date : Signature : Rank / No. of Officer

Impressions taken by : Rank / No. Date Place
Impressions taken by : Rank / No. Date Place

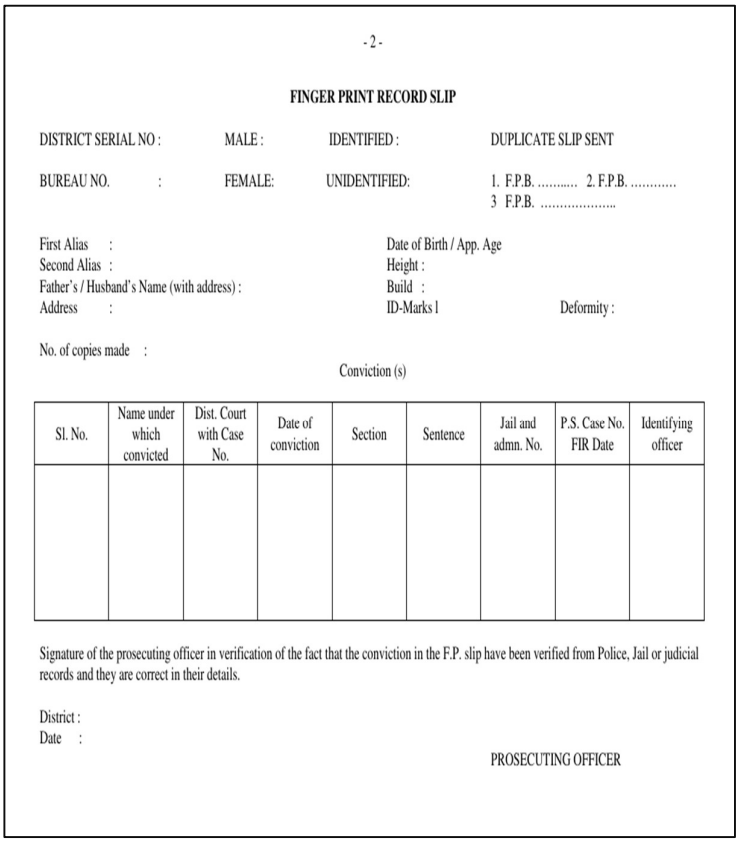
To be filled by FPB Update code

Name FPB SL. NO.

Henry classification

CLASSIFIED BY: TESTED BY : INDEXED BY: RECORDED BY :

CODIFIED BY : CHECKED BY:



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FINGER PRINT RECORD SLIP

DISTRICT SERIAL NO : MALE : IDENTIFIED : DUPLICATE SLIP SENT

BUREAU NO. : FEMALE: UNIDENTIFIED: 1. F.P.B. ..... 2. F.P.B. .....
3 F.P.B. .....

First Alias :
Second Alias :
Father's / Husband's Name (with address) :
Address :

Date of Birth / App. Age
Height :
Build :
ID-Marks l Deformity :

No. of copies made :

Conviction (s)

Sl. No.	Name under which convicted	Dist. Court with Case No.	Date of conviction	Section	Sentence	Jail and admn. No.	P.S. Case No. FIR Date	Identifying officer

Signature of the prosecuting officer in verification of the fact that the conviction in the F.P. slip have been verified from Police, Jail or judicial records and they are correct in their details.

District :
Date :

PROSECUTING OFFICER

Fingerprint Record Slip

While traditional fingerprint recording has played a vital role in personal identification, it has its own set of challenges. One of the important or primary issue is the potential for smudging or smearing of the ink on the fingerprint slip, which can affect the quality of the prints thus affecting the intensity of the case. Additionally, the process is time-consuming, particularly when dealing with large numbers of individuals where we need to collect the fingerprints of multiple people. Also, it takes too long for comparison between two fingerprint slips. In addition, physical storage of fingerprint cards or slip come with challenges like bulkiness, risk of loss or damage, mishandling or degradation over certain time. These issues can impact directly on the investigations that rely on fingerprint identification. In contrast, the advanced Automated Fingerprint Identification System is a biometric system that stores, analyzes and compares fingerprint data efficiently.

In 1960s, FBI began dreaming about a system that would automatically match fingerprints. The concept with computers, scan, store, and compare impressions or prints faster than any human. Special Agent Carl Voelker of the FBI's Identification Division had come to understand that physically searching criminal files by hand was becoming less feasible. To address this problem, he sought out engineers Raymond Moore and Joe Wegstein at the National Institute of Standards and Technology (NIST). Describing his situation, he asked for their assistance in building an automatic solution to the FBI's process of identifying fingerprints.

At around the same time in Japan, somewhere halfway around the world, NEC Corporation seized that dream and made it their mission. By 1971, they had already started working on developing what would soon become the world's first Automated Fingerprint Identification System (AFIS). AFIS is a biometric system that uses advanced algorithms to capture, store, analyze and compare fingerprint data. The system operates by scanning fingerprint images, enhancing their quality through image processing techniques, identifying unique patterns or features, and matching those features with a database of known prints to identify individuals.

Components of AIFS:

- Fingerprint scanner/Mobile fingerprinting device – It gives input to the system and used for capturing digital fingerprints ensuring clarity and details.
- Processor – It extracts the unique patterns and characteristics from the fingerprint images, process and compress the data, making it ready for rapid comparisons.
- Database – It is the large collection where fingerprint records are stored. A digital system that organizes and stores fingerprint records, allowing quick and accurate recognition for identification and forensic use.
- Algorithms – In the context of AFIS, algorithms are advanced computational methods that analyse and compare fingerprint features, initiating rapid and precise matching against stored records to support accurate identification.
- User interference – The bridge between humans and the technology**.** It is the accessible front-end of AFIS that enables users to input, search, and verify fingerprint data efficiently through intuitive, user-friendly tools.
- Reporting tools – It is a forensic data management utility that enables users to generate, organize, and export structured reports on fingerprint identification processes and system performance.

The three main steps of AFIS operation includes:

1. Image Enhancement: To improve the fingerprint image quality for accurate analysis and best result, techniques like contrast adjustment, noise reduction, and ridge enhancement are applied.
2. Feature Extraction: To identify distinctive fingerprint characteristics and other features. In these the algorithms detect minutiae points like core, delta and ridge flow.
3. Feature Matching: To compare the extracted fingerprint template against a database, AFIS compares the fingerprint template to database records using pattern recognition and similarity scores, ranking matches by how closely they align.

AFIS offers several benefits, including speed and efficiency, high accuracy, and scalability. It can rapidly process and match fingerprints in real-time, reducing the time and effort required to identify individuals. AFIS is widely used in law enforcement, border control, and security applications. It helps identify suspects, solve crimes, and verify identities. In border control, AFIS streamlines immigration processes and improves security; AFIS enhances security by verifying individual identities and helping prevent fraud across multiple sectors. The development of AFIS has significantly enhanced forensic science and modern identification methods. Its

ability to deliver fast, accurate, and scalable fingerprint matching has made it essential in law enforcement and security operations. As biometric technologies continue to develop, AFIS is expected to evolve further, Helping make identification systems more accurate and efficient to work. In India, the advanced version of AFIS that is NAFIS (National Automated Fingerprint Identification System), developed by National Crime Control Bureau (NCRB) in august 2022. NAFIS is India's centralized national-level implementation of an Automated Fingerprint Identification System; integrates with the Crime and Criminal Tracking Network & Systems (CCTNS) allowing law enforcement agencies to access fingerprint data in real time. The evolution from manual fingerprint documentation to automated AFIS technology has altered the disciplinary landscape of forensic science and personal identification. Renowned for its speed, precision, and scalability, AFIS now plays a crucial role in modern law enforcement and security frameworks.

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