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1. Learning Outcomes

After studying this module, you shall be able to -

- Know about the History of Fingerprint examination
- Learn about the Classification system of Fingerprint
- Identify the various classifying characteristics of fingerprint

2. Introduction

A fingerprint is an impression formed by the friction ridges present on a human finger. We have studied in the earlier modules that it is an individual characteristic and also according to the principles of fingerprint-

- Every fingerprint is unique. No two fingers have yet been found to have the same ridge patterns.
- A Fingerprint will remain unchanged during an individual's lifetime.
- Fingerprints have general ridge patterns that can be systematically classified.

The three classes of fingerprints are: loops, whorls, and arches.

The innumerable lines present in the palmar surface that constitutes a fingerprint are commonly referred to as the ridge characteristics or minutae. The various types of ridge characteristics have been dealt in the last the module (FSC_P3_M3).

The fingerprint patterns present on the human fingers are unique, detailed and cannot be altered and that's why they are used as long term markers of human identity. Fingerprints retrieved from the scene of crime are used as an important tool in forensic science. Fingerprint analysis has been used to identify suspects and solve crimes for more than 100 years, and it remains an extremely valuable tool for law enforcement. One of the most important uses for fingerprints is to help investigators link one crime scene to another involving the same person. Fingerprint identification also helps investigators to track a criminal's record, their previous arrests and convictions, to aid in sentencing, probation, parole and pardoning decisions.

3. History of Fingerprint Identification System

According to the evidences present, the Chinese used fingerprints to sign legal documents. However, it is not sure that this practice was carried out as a part of ceremonial custom or was used as a means of personal identification. Also, years before Bertillon began work on the system, Sir William Herschel, an English Civil Servant positioned in India acquired finger patterns of the natives to sign their contracts. Herschel's motives of using fingerprints remained unclear and nothing was published about his activities until Henry Fauld, a Scottish physician published his views on the importance of using fingerprints in the field of personal identification. In a publication of 1880, Fauld suggested that the human ridge patterns can be employed in the field of criminal investigation. He was not only convinced that they offer an infallible means of identification but also offered to set up a bureau of fingerprints at the Scotland Yard so as to test the practicability of fingerprints. However, by this time the Bertillon system had been readily accepted and hence Fauld's offer was rejected.

About two decades later another Englishman, Sir Francis Galton did an extensive research on the science of fingerprints that provided the much needed stimulus and the Police agencies began recognising the value of fingerprints. The book named *Finger Prints* was published by Galton in the year 1892 in which he wrote about the fundamental principles of fingerprints while categorising them into three classes i.e. Arches, Whorls and Loops. The British Government adopted fingerprints as an appendage to the Bertillon system on the insistence of Galton.

With developments taking place in the field of fingerprinting, the next major task was to have a classification system that would solve the problem of filing numerous fingerprints in a logical and searchable sequence. Dr. Juan Vucetich, an Argentinian Police Officer worked out a concept in the year 1891. Although, the classification system devised by Vucetich has been refined over the years, is used by many Spanish speaking countries.

Another fingerprint classification system was proposed by Sir Edward Richard Henry in the year 1897 which was adopted by the Scotland Yard, four years later.

Today, the United States and many English-speaking countries rely on Henry's system of classifying fingerprints for the filing purposes.

4. The Ten-Digit Fingerprint Classification System

The original classification system as proposed by Henry took into consideration all the fingers and converted the ridge patterns present on them in the form of letters and numbers that could be easily arranged in the form of a fraction. This system adopted by the Scotland Yard in the year 1901 could only accommodate files of upto 100,000 sets of prints and as the number of collections grew in size, it was necessitated to expand the existing classification.

In US, the Federal Bureau of Investigation faced with the difficulty of ever growing number of collections of set of prints expanded the Ten-Digit Fingerprint classification system by adding extensions. These revisions are collectively termed as the FBI system and are widely used by most of the crime investigating agencies in the United States today.

In order to appreciate the value of classification, one might imagine a large reference library in which all the topics are filed by the last name of the author. Anyone wishing to locate a topic by subject alone would be faced with an impossible task. Library filing systems, however, enable one to find a topic quickly, without knowing the author's name. Similarly, using the Henry Classification System, a 'John Doe' set of fingerprints could be searched and located in the file. Positive identification of criminals, with or without reliable names, had entered a new era.

In the Henry System, sets of fingerprints were given a primary classification, based on the distribution of patterns in the fingers. There are 1024 possible primary segments in the database, and further extensions were achieved by assessing the specific features of each digit. In order to conduct a search, subject fingerprints were classified in exactly the same manner as those in the database. Only the segment bearing the same classification required individual comparison to determine identity.

The Henry System allowed for the filing and searching of entire sets of fingerprints but was not useful in the search of individual 'cold' crime scene impressions. The Battley System was developed to address this need. At time of arrest, an extra set of fingerprints was taken on a serrated form. Each digit was classified, first by pattern type, and then by other extensions. The individual digits were then separated and filed. A crime scene impression was examined to determine the most probable digit(s), classified and searched.

Thus, in the Ten-Digit classification system, the Ten-Digit fingerprint slip is analysed under the following seven classification system:

1. Primary classification
2. Major division classification
3. Secondary classification
4. Sub-secondary classification
5. Second sub-secondary classification
6. Final classification
7. Key classification

5. Primary Classification System

The primary classification takes into consideration all ten fingers and this system is used by the Federal Bureau of Investigation to lessen down the possible number of suspects.

The occurrence of arches is 5-10% and that of loops and whorls are 60-65% and 30-35% respectively. Also, the frequency of plain and tented arches and composite patterns is relatively low in comparison to the frequency of loops and whorls. Thus, for the purpose of primary classification system plain and tented arches have been grouped under the loops types along with radial and ulnar loops. And the composite patterns have been grouped under the whorl types.

The ten fingers of two hands are grouped into five pairs in the following manner:

Pair I- Right Thumb and Right Index (RT & RI)

Pair II- Right Middle and Right Ring (RM & RR)

Pair III- Right Little and Left Thumb (RL & LT)

Pair IV- Left Index and Left Middle (LI & LM)

Pair V- Left Ring and Left Little (LR & LL)

The second part of each pair is taken in for numerator while the first part of each pair is taken for denominator.

R. Index	R. Ring	L. Thumb	L. Middle	L. Little
-----	-----	-----	-----	-----
R. Thumb	R. Middle	R. Little	L. Index	L. Ring

On considering the first pair, the possible combination of patterns existing could either be a loop or a whorl on the right thumb. Similarly, the right index could show these two patterns only. Therefore, the possible combination of patterns on the first pair would be:

Loops	Whorls	Loops	Whorls
-----	-----	-----	-----
Loops	Whorls	Whorls	Loops

Hence, the above possible combinations will also hold true for pair-II, III, IV, and V also.

So, in all 1024 combinations are possible. These 1024 combinations could be represented in a chart having 32x32 cabinets arranged horizontally and vertically which could provide location for all combinations of loops and whorls, of the 10 digit taken in 5 pairs.

For practical purposes, different numerical values have been assigned to the patterns according to their occurrence in different pairs. The loops have a zero value in primary classification system whereas the whorls are assigned certain numerical values according to their occurrence in different pairs.

		Value for loops	Value for whorls
Pair I	RT & RI	0	16
Pair II	RM & RR	0	8
Pair III	RL & LT	0	4
Pair IV	LI & LM	0	2
Pair V	LR & LL	0	1

When all the ten fingers possess whorls, on assigning the numerical values, the arrangement of primary formula would be,

$$\begin{array}{cccccc}
 \mathbf{16} & + & \mathbf{8} & + & \mathbf{4} & + & \mathbf{2} & + & \mathbf{1} \\
 \hline
 \mathbf{16} & + & \mathbf{8} & + & \mathbf{4} & + & \mathbf{2} & + & \mathbf{1}
 \end{array}$$

But, under such conditions when the patterns on all the digits are loops, then the situation would be

$$\begin{array}{cccccc}
 \mathbf{0} & + & \mathbf{0} & + & \mathbf{0} & + & \mathbf{0} & + & \mathbf{0} \\
 \hline
 \mathbf{0} & + & \mathbf{0} & + & \mathbf{0} & + & \mathbf{0} & + & \mathbf{0}
 \end{array}$$

The five pairs provide 1024 possible combinations and the numerical value totals out to be 31/31 in case of whorls and 0/0 in case of loops. So, a value of 1 is added to both the numerator denominator so that the final figure becomes 32/32 for whorls and 1/1 for loops. Hence, the complete primary formula will fluctuate between 1/1 to 32/32.

Let us understand the primary classification system with the help of an example.

If a whorl was found on the R. Index finger and the R. Middle finger, the following fractions would result:

$$\begin{array}{cccccc}
 \mathbf{16} & + & \mathbf{0} & + & \mathbf{0} & + & \mathbf{0} & + & \mathbf{0} \\
 \hline
 \mathbf{0} & + & \mathbf{8} & + & \mathbf{0} & + & \mathbf{0} & + & \mathbf{0}
 \end{array}$$

If we add 1 to the top and bottom, we end up with a fraction of 17/9.

$$\frac{16 + 0 + 0 + 0 + 0 + 1}{0 + 8 + 0 + 0 + 0 + 1} = \frac{17}{9}$$

Therefore, we can eliminate all suspects that do not have this fraction and a single suspect can be individualized from this fraction.

6. Extensions to Primary Classification System

1. Major Division Classification System

In this system, right and left thumb fingers are considered. This division is formed by counting the ridges in loop patterns and for the whorl pattern, ridge tracing is considered. The value of right thumb is taken as numerator and the left thumb taken as denominator.

In case of the presence of loops, to perform the ridge counting, the number of ridges cut by an arbitrary line joining core and delta are counted and hence, are denoted by I, M, O types where the I type denotes the number of ridges upto 12, M type denotes the number of ridges between 13-19 and O type denotes the number of ridges between 20 or more.

For arches, plain and tented arch will always be considered under I types as they do not have any ridge count.

For whorls, the ridge tracing is performed by tracing the basal radiant of left and right tri-radius.

O type is valid for accidental, central-pocket and double loops.

2. Secondary Classification System

In secondary classification system the patterns appearing on the right and left index fingers are considered wherein the right index is taken as numerator and left index is taken as denominator. The types of patterns identified under this system are A, T, U, R, W, C, S, X where these connotations implies Arches, Tented arches, Ulnar loops, Radial loops, Whorls, Composites, Double Loops and Accidental, respectively.

3. Sub-Secondary Classification System

In this system, the patterns appearing on the left and right Index, Middle and Ring fingers are analysed. It can be performed in two ways:

- Lettered Group
- Ridge Counting and Ridge Tracing

Lettered Group

If A (arches), T (Tented arches), R (Radial loops) appear on the middle and ring finger, then this method is employed. The patterns appearing middle and ring fingers of right hand is taken as numerator and are denoted by small letters and the patterns appearing on the fingers of left hand are taken as denominators and no connotation is used whereas for the index finger of both the hands respectively, the patterns appearing are denoted by capital connotations such as in this example,

	I (Index)	M (Middle)	R (Ring)
Right	A	T	R
Left	W	C	S

The above given patterns can be denoted by:

A t r

W -- --

In case of loops, ridge counting is done in the following manner:

	I (Index)	M (Middle)	R (Ring)
I	1-5	1-6	1-7
M	6-12	7-13	8-14
O	13 or more	14 or more	15 or more

For whorls, ridge tracing is carried out in the same way as in Major division classification system.

4. Second Sub-Secondary Classification System

It is used when under the Sub-Secondary classification system ridge counting and ridge tracing is employed and is based on the U, C, W, S, X patterns present on middle and right fingers. The patterns on the right are taken as numerator and the left are taken as denominator.

5. Final Classification System

The value of Final classification system is arrived at by counting the number of ridges in case of loops on the right and left little fingers and placing them as numerators and denominators respectively.

In case of whorls also, ridge counting is performed in a manner in which for right little finger, ridge counting is performed between the left tri-radius and core and for the left little finger, ridge counting is done between right tri-radius and core. Ridge count of plain arch is taken as 1.

In case of double loops ascending core is taken as constant for ridge counting and descending core is not considered.

6. Key Classification System

It involves the ridge counting of loops or whorl patterns appearing on the right thumb only. Pattern is represented by small alphabets. In case of right thumb the left delta is considered.

7. Summary

- A fingerprint is an impression formed by the friction ridges present on a human finger.
- Fingerprint analysis has been used to identify suspects and solve crimes for more than 100 years, and it remains an extremely valuable tool for law enforcement.
- Dr. Juan Vucetich, an Argentinian Police Officer worked out a concept in the year 1891. Another fingerprint classification system was proposed by Sir Edward Richard Henry in the year 1897.
- In the Henry System, sets of fingerprints were given a primary classification, based on the distribution of patterns in the fingers.
- Extensions were added to the Henry system of classification by the FBI.
- Thus, in the Ten-Digit classification system, the Ten-Digit fingerprint slip is analysed under the following seven classification system:
 - 1) Primary classification
 - 2) Major division classification
 - 3) Secondary classification
 - 4) Sub-secondary classification
 - 5) Second sub-secondary classification
 - 6) Final classification
 - 7) Key classification