Types of Fingerprints

Based on ridge patterns, there are four types of fingerprints as follows

Table 2: Types of Fingerprint Patterns [49]

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Ridge Pattern</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Loops</td>
<td>65%</td>
</tr>
<tr>
<td>2</td>
<td>Whorls</td>
<td>25%</td>
</tr>
<tr>
<td>3</td>
<td>Arch</td>
<td>7%</td>
</tr>
<tr>
<td>4</td>
<td>Composite</td>
<td>2 to 3%</td>
</tr>
</tbody>
</table>

Sometimes accidental varieties with no specific ridge pattern may also available.

**Loop**: - In this type ridges starts from one side, run in parallel lines and then curve backward to terminate in the same side. When these ridges start and end on the medial side of the finger tips then it is called as Ulnar Loops, where as when it starts and ends on the later side of the finger tip, it is termed as Radial Loop.

![Fig-2: Radial Loop](image)

![Fig-3: Ulnar Loop](image)

**Whorl**: In this type, the ridges follow a circular path. When there are multiple ridges running one around the other forming an oval or circular structure, the pattern is known as concentric. Sometimes single ridge running in spiral manner may also be observed.

![Fig-4: Spiral Whorl](image)

![Fig-5: Concentric Whorl](image)
Patterns of Fingerprints

**Arch:** In this type of fingerprints, the ridges start from one side and after running upward, it takes downward course to end on the opposite side forming a curve or arch. When the ridge makes a wave-like curve, the pattern is known as Plain Arch, whereas when there is a formation of acute angle at the curving point, the pattern is called as Tented Arch.

![Figure-6: Plain Arch](image)

![Figure-7: Tented Arch](image)

**Composite:** In this variety of fingerprints, there is a combination of more than one pattern of the ridges. It may be in the form of whorl and loop or two whorls or two loops or even may be whorls, arch and loops.

![Figure-8: Composite pattern](image)

In the Loops and whorls, the main pattern of ridge is surrounded by two series of divergent ridges termed as Type Lines. The point of outermost ridge which is nearest to the divergent type lines is called as Delta and the central point of the ridge pattern is known as Core. Hence in case of loops, the core is the distal most point of the innermost ridge from the delta and in case of whorls, there are two deltas one on each side. Arches have no delta.
Figure-9: Minutiae Structures of Fingerprints

Minutiae Structures: Ridges show minutiae structures within their course. These may be spur, dot, lake, island, bifurcation, fork, short ridge eye etc. Those are more important for the personal identification of an individual. 15-20 points of similarity in the minutiae are essential to establish positive identification. [50]
The Fundamental Principles of Fingerprints:[51,52]

1. A fingerprint is a unique characteristic. No two individuals have yet been found to possess identical ridge features which makes fixation of identity infallible.

2. A fingerprint will remain unchanged during an individual’s entire lifetime.

3. Pattern of fingerprints can be systematically classified.

4. Fingerprints can be procured from highly putrefied bodies, either from the peeled off epidermis of the fingers or even from the dermis when the epidermis is lost.

5. Fingerprints can be taken even from mummified dead bodies by dipping the dissected out fingertips in weak alkaline solution, when the fingertips along with the ridges get their normal shape and sizes or by injecting glycerine into the fingertips.

6. Chloride ions from the fingerprints can give a rough idea about the age of a fingerprint.

7. Fingerprints can be transmitted from one country to another, by telecommunication system.
Methods of recording dermatoglyphics:
A number of methods for recording dermatoglyphics vary in their requirements for equipment, time and experience and in the quality of the prints produced.

Standard methods:
All the methods are relatively easy to use, rapid and inexpensive. However, they vary in the quality of prints obtained.

Ink method: Purvis Smith described a modified printing method using a roller and a plastic foam roller sleeve. The detailed description of this method has been explained in materials and methods. This method is not suitable for use with non cooperative children and those with very fine ridges.

Inkless method: This process utilizes commercially existing patented solution which produces black impressions like ink and specially treated sensitized paper. The technique, generally followed by forensic departments, is appropriate for printing hands or feet with appreciable dermal patterns, such as those of older children and adults. [53]
This method has been utilized in the present study for obtaining the fingerprint impressions of the subjects.

Transparent Adhesive Tape Method:
In this method, the print is produced by applying a dry colouring pigment to the skin and copying it off with the transparent adhesive tape. The colouring agent may be coloured chalk dust, Indian ink, printers ink, powdered graphite, carbon paper, graphite stick or common oil pasted crayon etc. This method is inexpensive, quick and easy to employ with all types of subjects. Prints are clear and do not smudged. They can be preserved for an indefinite period of time. [54]

Photographic method:
This technique is based on the principle of aggravated total inner reflection which appears when an object is hard-pressed on a prism. The magnified image is captured by a camera. It requires comparatively expensive gears. Recently, even ordinary photographic method has also being tried out. [55]
**Patterns of Fingerprints**

**Special methods:**
These methods are not widely used. However, they may have some advantages that the standard techniques cannot offer, such as permitting the study of the correlation between the epidermal patterns and the underlying bone structures (radio/dermatography) [56], study of sweat pores (hygrophotography)[57], or study of the spatial shape of ridged skin areas, for eg, in primates (plastic mould method). [58]

In 1989, some authors have developed a method wherein the exploring region is blackened with graphite smeared on a piece of cardboard. The print is taken by the Tesa film and then stuck to a transparent film strip or photo printing foil. Such a negative could be enlarged five to six times.

An automatic apparatus for taking finger prints without ink and also to count ridge numbers between any 2 given points was developed in 1990. [59] Technologies have been improved in the finger print identification. With a single small chip, technology provides the basis for fingerprint identification devices that can prove the user's identity using a fingerprint. Optical fingerprint scanner is a device for computer security featuring superior performance; accuracy resilience depended on unique NITGEN fingerprint Biometric methodology.

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