

Fingerprint and Poroscopy: Analysis Used for Personal Identification

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Abstract:

Fingerprint is used worldwide for the purpose of personal identification. In recent time, a number of researches and advancement has occurred in the dactyloscopy which leads to its acceptance as valuable evidence in court. A number of powder and chemical methods are evolved for the development of latent prints varying from oldest black charcoal methods to modern cyanoacrylate fuming methods. Fingerprint provide the detail information at three level. In the first level, the analysis of fingerprint is performed, ridge characteristics are analyzed in the second level and study of edges and pores of ridges in the third level.

AFIS (Automated Fingerprint Identification System) is a computerized biometric identification system for a fingerprint which uses digital images to obtain, store and analyze the prints, reducing the workload of fingerprint expert. When fragmented or partial prints are found at crime scene, with a low number of ridge characteristics, third level of detail of fingerprint identification i.e. poroscopy is used for personal identification as the sweat pores are unique in respect of size, shape, pore frequency, interspacing, show permanence and remain same during the whole life. This review paper focused on discussing all the advancements in the analysis of fingerprint and poroscopy for personal identification.

Key Words: *Personal Identification, Dactyloscopy, Poroscopy, Pore Frequency.*

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Introduction

Forensic science is the new emerging field in the world of science which proves to be exigent in the investigation of criminal and civil cases. In simple words, knowledge of all-natural sciences is applied in the law, serving fair decisions. The forensic field gives access to various services which aid in solving the buried mystery of the crime. Nowadays the crime rate is increasing with a speedy rate universally. Crime is any act which is against the law. Many factors are affecting the atrocity rate because no one is born as a criminal, it is the social, environmental, biological, many more factors that affect the mental and emotional status of a person, resulting in the commencement of heinous crimes. There is various evidence present at a scene of crime as every person leaves a unique mark at scene of crime which can be categorized as physical, biological, or trace evidence. Evidence form a connecting link between the three; crime scene, accused and victim.

Personal identification is considered as an imperative factor from decades in the process of investigation as it confirms the presence of the person during the time of crime and also helps in proving the guilty. In simple words it can be defined as the process of establishing identity of a specific person. In the case of mass disasters, mass murders, or the cases where the decomposed body is found, personal identification is necessary to identify the deceased (**Kanchan, 1-2**).

The need to perform personal identification of the accused arises in case of the heinous crime where the suspect leaves its prints in some form that is enough to prove the presence of a suspect at the crime scene.

In 1883, Alphonse Bertillon gave the science of anthropometry i.e. measurement of eleven body parts that were unique to every individual for fulling the aim of identification and continued to be applied for an aforesaid reason until and unless the famous William-West case came where the two have exactly same body measurements late 18th century (**Seigel, 474**).

The science of fingerprint evolved for individualization which forms the pillar of personal establishing uniqueness of an individual in recent times with chief evidentiary value in court.

The most commonly found evidence at crime place are fingerprint patterns as these are the impression of the palmar and plantar pattern formed by skin ridges (dermal ridges). The ridges present on skin possess various sweat pores through which perspiration comes out and leave the impression of fingerprint pattern when comes in contact with surfaces.

Friction ridges are present on the plantar and palmar region of hands, foot, and also on tails of some primates. They started to form in the ninth and tenth week of fetal life and around 14 week sweat pore and ducts are begin to form. Dermatoglyphics is the science which deals with the analysis and classification of fingerprints (pattern and characteristics) and is used by Sir William Herschel for the first time in India for establishing the identity of an individual. The fingerprints are proved to be an excellent way of establishing the identity of an individual.

Principles of Fingerprint

1. Fingerprint is an important identical characteristic and no two fingers yet have been found to possess the same or identical minutiae.

This principle forms the foundation of acceptance of fingerprint as valid evidence in a court of law. In this, it is stated that individuality is based on minutiae i.e. ridge characteristics because the fingerprint can be the same for two different sources. The point to point examination of minutiae is performed during examination process. The number of points for proving similarities or dissimilarities between the two prints varied from 8-16 in different countries.

2. Fingerprints are permanent i.e. once developed they remain unchanged for life.

Skin consists mainly of two layers epidermis- the outermost and dermis- the innermost. Dermal papillae form the boundary between the two layer, once dermal papillae developed during fetal life, the fingerprint pattern and ridge characteristics remain same throughout the life. Even the practice of corrosives substances like acids or burning cannot change the fingerprint pattern.

3. Fingerprints are classified on the basis of their pattern.

There are basically three patterns of fingerprints: - Arches, Loop, Whorls (**Saferstein, 642-644**).

There are three types of evidentiary fingerprints found at the crime scene; patent print or visible print, plastic print, and latent prints. Patent print is known as visible print as they are easily visible by naked eyes and need a little enhancement for comparison for example blood-stained print. A plastic print is also known as an indented print with 3D appearance. They are the impression made on soft surfaces like butter, soap, etc. A latent print is the one which is not visible by naked

eyes, just an impression due to the release of perspiration. They required different physical and chemical methods for their development (Nordby, 364).

Level of Fingerprint Identification

Fingerprints are the most valuable evidence found at the crime scene. Latent prints are those prints which cannot be seen by naked eyes, they need to be located using light sources and developed with different methods such as powder method, chemical methods and then further directed for analysis and comparison. Francis Galton in 1892 described the ridge characteristics which aid in the establishment of fingerprint system as the finest system for identification. There is basically three levels of identification: -

- First Level (Fingerprint Pattern)
- Second Level (Ridge Characteristics)
- Third level (Ridgeoscopy and Poroscopy) (Kesharwani, 2014).

First level

In the first level of identification, fingerprint patterns formed by the flow of ridges are examined for individualization. The fingerprint pattern varies from individual to individual and also from finger to finger of the same individual. There are three broad fingerprint patterns: - Arches, Loop, and whorl. Arches are found in 5% of population. The ridges entering from one side and exiting from another, it does not have delta. It is further of two type's plain arches which have a wave like upraise in middle and tented arches have a pointed peak in middle. Loop is the most prevailing pattern found in 65% of population. In this ridge entered from one side shows recurring and exiting from the same side having a core and one delta. It is further classified into an ulnar loop in which loop is facing in direction of little finger and radial loop whose loops open in direction of the thumb. Whorl is found in 35% people, having one core and two deltas. It is of following types plain whorl, central pocket loop, in these two types a single ridge starting from center forms the entire pattern in continuation either in form of a spiral, oval or any circular pattern, if the line drawn between two deltas intersect any of the ridges than it is said to be plain whorl and if do not intersect any spiral ridge than it is central pocket; double loop having two loops combined in a single pattern and accidental; in this, there are two or more patterns present making the print unfit for analysis (<http://www.forensicsciencesimplified.org>).

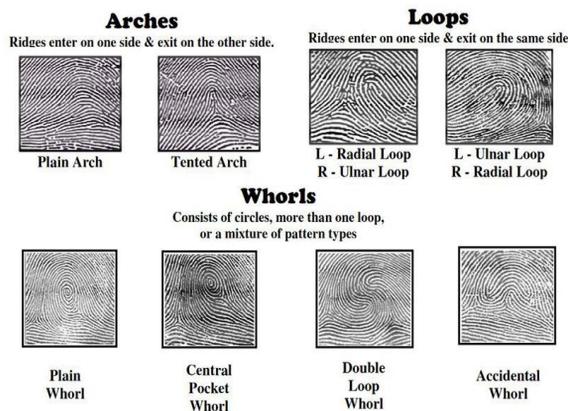


Figure No. 1: Showing First Level Details of Fingerprints

This level of identification is not suitable for personal identification because two different persons can also have the same fingerprint pattern.

Second level

Galton characteristics are examined in this level, which forms the groundwork for personal identification. There are various ridge characteristics also called as minutiae such as ridge ending, enclosure, bifurcation, trifurcation, etc. A careful comparison of numbers and the relative location of these characteristics are required for identification purposes.

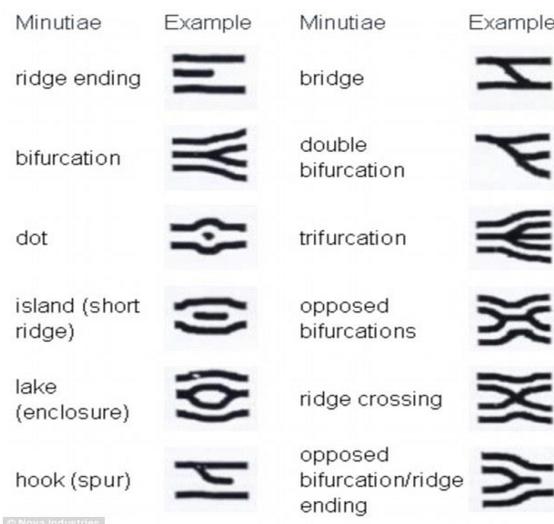


Figure No. 2: Showing Different Ridge Characteristics

Third level

Sometimes at crime place fragmented or smudged prints are found which do not have enough clear area for identification using minutiae, so the third level of identification is applied. In this Ridgeoscopy is

included, which further has two parts that are edgeoscopy: a study of edges of ridges and poroscopy: study of pores on ridges.

Poroscopy

Poroscopy is the study of pores in respect to their shape, size, interspacing and relative position with each other on ridges for the use of personal identification. Edmond Locard was the first person to use the concept of poroscopy for identification in the case of Boudet and Simmonin. He was also known as the father of poroscopy. The sweat pores last forever and do not undergo any kind of change during whole life, further even in small portion of print they are found in large numbers, hence proved to be good for comparison purpose (**Locard, 357-365**). The size of pores varies from small, medium to large, further show difference in shapes (circular, oval, triangular, etc.) and interspacing (close with little space, chain like with no space) also (**Bindra, 2000**).



Figure No. 3: Showing Third Level Detail of Fingerprint

Review of Literature

Locard (1912) proved that pores are unique and remain same throughout the life, can be used for identification of a person when there is an insufficient number of ridges are present in a print, further added examination of 20-40 pores are enough to give an opinion. He discussed that the size of pores may vary from 88-220 Micra, even the pores that are present close to each other have different size further the diameter and area of the largest pore are three times and nine times of the smallest one respectively. Pores can be of an oval, elliptical, rhomboid shape, pore frequency can be determined either as an average number of pores per unit area or an average number of pores per unit ridge length.

Bindra et al. (2000) carried out work on the inked and latent impression of both fingerprint and palmprint (plain and rolled), he added one more feature of pores i.e. interspacing which is the space between two pores, pores can be very close that is having very less spec in between (two pores on 1 cm of ridge length), or sometimes show no space and form chain like structure, along with other features which are

described earlier Locard. They concluded that hypothenar region had maximum number of pores and minimum numbers of pores are found in thenar region, further the rhomboid and round shape pore the commonest of all. He also concluded that for studying pores, ninhydrin method is best to develop latent prints on porous surface and the use of photostat toner is best for non-porous surface, furthermore iodine fuming can be used on both the surfaces.

Chaudhary and Kumar (2003) proved that during performing the act of writing on paper the writer leaves the latent print of palm portion and finger which come in contact with the paper, further development of print and examination of ridges with pores help in individualization.

Kaushal and Kaushal (2011) discussed about the importance of fingerprints and their analysis in the use of human identification. They detailed about the arches, loop, and whorl pattern found in a fingerprint, further added the system ACE-V used for the examination of the second level, i.e. analysis, comparison, evaluation, and verification of minutiae and mentioned about the practice of AFIS in comparing questioned prints from antemortem data.

Preethi et al. (2012) worked on the plain thumb impressions of 200 individuals (100 men and 100 women) of South Indian population who were in the age group of 18-60 for establishing personal identification and sex determination by the use of pore size, pore structure, and pore frequency. They inferred that shape and size of pores were of no use in determining sex but the frequency of pores can be used to determine gender as it was observed that females have more pore frequency as compared to males.

Sravya V et al. (2012) conducted a survey on the use of fingerprint as a biometric system in various fields. They focused on the major drawbacks that are; condition of finger surface can effect the captured images of fingerprint, leading to degradation of authentication, and imitation of print or fake fingerprint and discussed about multimodal biometric system i.e. use of more than one biometric for identification to overcome these problems, especially in industries related to chemicals as the surface of hands get degraded due to continuous exposure to chemicals.

Tarase (2013) discussed about the uniqueness and permanent nature of fingerprint and its skin ridges which prove to be a valuable tool in individualization. He gave the detail of the formation of these ridges, their pattern, and different ridge characteristics. The main purpose of their paper is to provide knowledge

regarding the correct procedure for the comparison of chance prints collected from the scene of crime with the specimen and after comparing concluded that S1 print show similarities in characteristics while S2 did not show any similarity.

Singh (2013) studied the ethnic difference in relation to poroscopy in the prints taken from 186 Brahmins and 167 Rajput's of Himachal Pradesh. They compared pore frequency (1 cm and 1 cm²), interspacing, size, shape, and position of two communities, and after systematic analysis concluded that there is a difference in the size of pores of both communities.

Pate et al. (2017) carried out their study on hospital staff, patients, etc. after taking the subject consent in a hospital to determine is there any correlation exist between the gender, blood group, and fingerprint of an individual that can be more helpful in individualization. They excluded individuals who have permanent scars on their fingers or having some sort of skin disease. They found that in loop pattern occurrence of Rh-positive (B positive most common, AB positive least) and Rh-negative are equal, but in arches and composite Rh-negative is more common and in whorls, Rh-positive is more common, more correlations are observed in terms of blood group also and further concluded that more research on this side can lead to great achievement in the identification process.

Dhoot and Murlidhar (2019) studied the use of edgeoscopy for the purpose of sex determination and concluded that the science of edgeoscopy is more useful for understanding the anatomy of fingerprint and forensic medicine further ridge shape present in thumb impression is more suitable for the determination of sex.

Sharma et al. (2019) carried out their work on the comparative study of sweat pores and their characteristics in finger bulbs and provide valuable knowledge on the use of pores for identification when ridge number is low and concluded that for middle portion, the thumb and ring finger show a significant correlation between pores per unit length and pores per unit area, same is observed for periphery portion of index and ring fingers.

Oklevski et al. (2019) focused on the problems and challenges in the use of poroscopy for individualization, as many experts and scientists do not prefer the detailed study of pores because of their microscopic nature and time-consuming study but now can be examined easily by using a digital process. They worked on both inked prints and latent prints to find a correlation between the number of ridge characteristics, pores in various region of first phalange and time used in taking prints from ink,

further developed latent prints from various surfaces and concluded that better pores are found in the central region of phalange with respect to time period and study of poroscopy in latent prints require more advancements.

Govindarajulu et al. (2020) performed an analysis of variation in homeostasis and ambience of a cross-section of adult and criminal records using a microscope for evolving use of fingerprints with main focus on pores and ridges for performing individual profiling and inferred that the criminals show significant differences in left and right ridge width, the further difference was also observed in the pore structure of left and right hands but no such difference was found in the fingerprint of normal people.

Discussion

Forensic science involves the application of all other sciences (Biology, Chemistry, Physics, Computer science, etc.) in the investigation process for solving the clandestine behind the crime for serving the justice to the victim and saving innocent from punishment. There is various evidence found at the crime scene, but amongst all fingerprints are the most familiar type of evidence. Fingerprints are easy to develop once located and are used for the personal identification of a person, further it is accepted in a court as reliable evidence to prove or disprove the identity of an individual. Fingerprints are developed by several powders and chemical methods depending upon the surface on which the print is used for example on a black colored, fluorescent powder is applied to develop print on multicolored surface, chemical methods like ninhydrin and iodine fuming is used for porous surface, for developing print on non-porous surfaces cyanoacrylate method is used etc. Once prints are developed, they are lifted and processed for examination. Fingerprint provide examination at three levels, first level is the examination of pattern, if the pattern is different than no further examination is required and if the pattern is same than the examiner moved to second level i.e. examination of ridge characteristics in respect of their relative location to each other by 3D-Direction, Description and distance as mentioned in the study of Tarase (59-72). Sometimes, the prints are so distorted or partial that ridges are present in a very low number and cannot be used for proving or disproving identity, then the third level performs its role i.e. ridgeoscopy which includes edgeoscopy and poroscopy. Locard in his research gave the concept of poroscopy which is the study of sweat pores, they are unique, permanent, and do not get change with time. They are easily observed in prints using a microscope or visualizer and used for personal identification. The pores are present in large numbers even in a small portion of print. Their size,

shape, interspacing, frequency, and relative location are unique features as discussed by Bindra (2000) in his observations for every individual and formed the basis of identification. There are some factors that can affect pore characters such as consistency of ink, debris on paper, spread of ink, humidity or sweating, etc., which were discussed by Ashbaugh in his study on pores, so one should keep in mind these factors during the collection of specimen print. Poroscopy is also used to determine the sex of individual, proved by the study of Preethi et al. as it is proved in many studies that pore frequency tends to be higher in females as compared to males. In the study conducted by Sravya et al. It was found that sometimes in the industries where chemicals are used on daily basis, the surface of finger get degraded and fingerprint cannot be used as biometric in those fields. The study of Pate et al. proved that there is a significant correlation between blood group and fingerprint pattern, further research in this view can put feathers in the personal identification process.

Conclusion

Personal identification of victims and suspect is very important in criminal cases for justice to be served in truthful manner, as stated in the study of Kanchan (1-2) for example cases where the skeletal remains are found personal identification of the victim is of more importance. Study of William Herschel and Edmond Locard already proved that fingerprints and pores are unique, permanent and do not undergo change with time interval which forms the foundation of their use in individualization. Fingerprints are readily available at the crime scene in the form of latent prints, which are developed, analyzed, and compared for proving or disproving the identity of a person. When the prints found at crime scene are fragmentary in nature, do not have enough number of ridge characteristics than size, shape, relative position of sweat pores are used for personal identification, which is covered under third level of fingerprint. There is evidence that fingerprint pattern have correlation with blood group and number of pores per unit area help in determining sex which aid in identification. Poroscopy and fingerprint is the best way to establish identity of a person.

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