

Fingerprint Studies and Dactyloscopy

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Abstract:

Fingerprints are a unique characteristic which is used by the law enforcement agencies for criminal identification and also help to reconstruct the crime scene. Fingerprints are unique to every person; even identical twins with identical DNA do not share the same fingerprint pattern. Fingerprints are likely to be found on every surface to which the offender touches, there are numerous methods for locating and visualizing such prints. This review paper focuses on the use of non-conventional methods. For locating and developing the chance prints, various conventional methods are available but they are proved to be toxic in nature for humankind, therefore investigators must focus on the use of non-conventional methods that are easily available, cheaper, and non-toxic in nature. Non-conventional methods produce better results on various surfaces than the conventional one. Using the non-conventional methods results in betterment for forensic services in the long run as these methods do not cause health hazards, non-destructive nature, and also saves the expenses.

Key Words: Fingerprint, Non-Conventional, Forensic, Non-Toxic, Non-Destructive

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Introduction

In forensic science, fingerprints treated as a unique and individualistic characteristic that is helpful in the identification of a person. The science of study of fingerprints is called dactyloscopy. Fingerprints are made of deep valleys called furrows and raised portion called friction ridges/ papillary, which together ensures a firm grip and resist slippage. The friction ridge is formed inside the womb and grows eventually as the baby grows. It consists of millions of tiny dots which are meant for discharging perspiration/ sweat. The sweat content is largely composed of 98% of water and the remainder is composed of organic acids, salts (sodium chloride), urea, and a small amount of albumin. Each fingerprint ridge is represented in various shapes and sizes such as bifurcation, trifurcation, ridge ending, dot, enclosure, etc. are called minutiae. For the comparison purpose, the type and location of these minutiae impart the uniqueness of the fingerprint pattern of an individual (Siegel, 150-151).

It is one of the most important tool for criminal identification, due to its uniqueness and permanency. No two people share exactly fingerprint patterns, even the identical twins have a different pattern of fingerprint, although they have identical DNA. It is likely to encounter on every possible surface to which the offender often comes in contact (mutual exchange principle), unknowingly. Fingerprints do not change with time (permanent damage to the finger is the only way a fingerprint can change), which makes it a more reliable technique for identification. Attempts were made by the gangster named John Dillinger, he intentionally applied the corrosive substance to prevent himself from the police officials. But he shot, the prints were taken and successfully matched with the prints taken at his previous arrest, proving his efforts non-profitable (Cummins, 982-983).

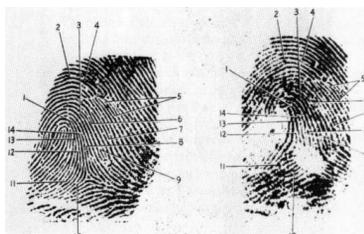


Figure No. 1: Prints of John Dillinger Before and After Death

The analysis of fingerprints has been in practice for a very long time and still, it is widely used for criminal identification and in solving the crimes. The analysis and comparison of Fingerprints are based on three principles (i) It is a unique characteristic and no two fingers have same ridge characteristics, (ii) It remains

unchanged (iii) Have unique ridge patterns which are systemically classified. Fingerprints not only aid in criminal identification but also useful in determining the background checks of suspected person, mass disaster identification, biometric security. The analysis of fingerprint replaces the practice of anthropometry, which faced the failure during the Will west and William west case, who coincidentally shared the same all bodily measurements (<http://www.forensicsciencesimplified.org>)

Fingerprints are obtained from the scene of crime as well as from the persons who are suspected to be involved in the crime. A ten print card is used for the collection of fingerprints for the comparison purpose and to establish the identity, suspects are asked to imprint the impression as rolled or plain prints or both. Fingerprints are classified into three basic patterns that are in use namely: Arches, Loops, and Whorls.

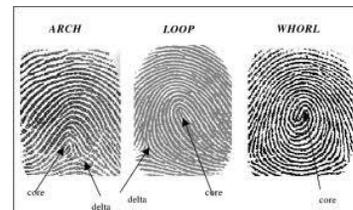


Figure No. 2: Different Types of Fingerprint Patterns

Arches are found in 5% of the total population, which is least in comparison to other types of patterns. It is further divided into plain arches and tented arches. The plain arch forms a wavelike pattern, by emerging a ridge from one end of the pattern and exit on the opposite side. On the other side, the tented arch is similar to a plain arch on formation, except that it forms a sharp thrust/ spike in the center, instead of a smooth curve as in plain arch. Arches also have a distinctive feature which makes it different from the other two patterns that it does not contain type lines, deltas, or cores.

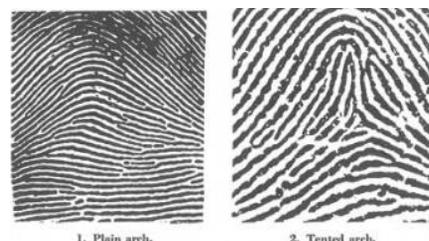


Figure No. 3: Plain Arch and Tented Arch

In about 60-65% of the population, a loop pattern is found. A loop must have one or more ridges emerging from one side of the print, recurving, and exiting from another side. It is further divided into two types: Ulnar loop and Radial loop. Ulnar loop opens towards the

little finger, whereas radial loop opens the thumb. A loop must have atleast a core and a delta.

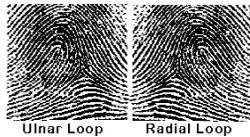


Figure No. 4: Loop Patterns

The next type is whorl which is found in approximately 30-35% of the total population. It is divided into four distinct groups: plain whorl, central pocket whorl, double loop, and accidental. Plain loop and central pocket loop have atleast one ridge in the form circular, spiral or oval that makes a complete circle. Double loop has two loops within the pattern combined to each other. The pattern that is not able to distinguish falls under the category of accidental whorl pattern. A whorl pattern must have a core and atleast two deltas (**Siegel, 152-155**).



Figure No. 5: Whorl Patterns

At the scene of crime fingerprints are likely to be found on every surface to which the offender touches with his hand/s. Depending on the type of surface on which the fingerprints are located they are classified as patent prints, plastic prints, and latent prints or chance prints. Fingerprints which are formed due to some colored material stucked to the finger region are called patent or visible prints. Finger impressions which are located on soft surfaces (wax, soap) are called as plastic prints. Patent and plastic prints do not require any developmental procedure as they are visible to the naked eye and easy to locate. The prints which are formed due to the deposition of sweat and perspiration on to the surface and are invisible to the naked eye are called latent prints. Latent prints are hidden and unseen and require various developmental techniques that would visualize the print. Powder technique is the most common method used by law enforcement agencies. Powders used for the development process is consist of two component: pigment component used

for visualization such as lead oxide, antimony trisulphide, lampblack, lead iodide, mercuric sulphide, another component is binder act as an adhesive agent such as silica gel, kaolin, rosin, and starch. The choice of powder depends on the surface on which the print has to be located. Grey and black powders are widely used by the examiners. In the case of multicolored surfaces like magazines, fluorescent powder gains more attention. Powders are available in different colors and are applied to the located prints by using a camel hair brush of soft bristles. Brush with hard bristles could damage the print.

Next developmental technique is a chemical method, in which one of the method is iodine method, which is the oldest method and likely to be used prior ninhydrin and silver nitrate chemical techniques. Iodine crystals sublime at room temperature and combine with the fatty acids process called iodine fuming. Although the iodine prints are not permanent and require immediate photography to maintain the record. The most popular chemical technique is Ninhydrin. It reacts with the amino acids present in trace amount in perspiration and forms a purple-blue color compound called Ruheman's purple named after Ruheman. It is used both porous and non-porous surfaces. The rate of reaction is hastened by heating the surface at about 100 degree celsius. DFO is a substitution for ninhydrin used on porous surfaces and produces 2.5 times better prints. Another chemical method is silver nitrate, reacts with chlorides, and form silver chloride. The prints must be photographs immediately after the development of prints, as the silver components eventually fill the background. A huge improvement to silver nitrate is a physical developer that contains a reducing agent, produces prints on surfaces which have been wet at one time. In 1982, Japanese scientists developed a novel method for the development of latent fingerprints, called cyanoacrylate fuming or superglue method, which is performed in a developing chamber using super glue and water and allows the vapors to adhere to the print to make it visible. The method is also used on uneven surfaces and hard to dust surfaces like bottles, knives, dead bodies, etc. where other methods do not work (**Saferstein, 448-458**).

These conventional techniques for the development of latent fingerprints could be harmful for the investigator who is continuously in touch with the practice of using such chemicals. Apart from these methods, experts are still working on the development of other conventional and non-conventional methods. There are various unconventional techniques which are used today for the development of latent fingerprints at scene of crime. Using unconventional techniques proved to be a good choice over conventional methods. Latent fingerprints once

developed and visualized, they must be permanently well preserved for future comparison and courtroom evidence. An organization is initiated by the U.S Federal Bureau of Investigation popularly known as AFIS, a biometric identification technology which is widely used to obtain, store, and analyze the fingerprints (Rouse, 2007).

Review of Literature

Garg et al. (2011) performed a study for the development of latent fingerprint. They used a household item which is easily available and non-toxic i.e. turmeric for the visualization of latent prints. According to them the results obtained by using turmeric on different surfaces are much good in shape. They also observed that the prints can be developed on writing surfaces using turmeric without degrading the data therein can be used for personal identification. They also suggested that turmeric powder can be used on the majority of surfaces except for skin due to lack of contrast.

Kumari et al. (2011) represented a new visualizing agent for the development of latent fingerprint. They believed that the chance fingerprints can be developed without the use of conventional methods. Instead of using chemical methods, they used food coloring agents (lemon yellow, orange-red, and green) and festive colors (gulal). The results produced were enough clear to distinguish the pattern and ridges were much clear when used on different surfaces (paper, aluminium foil, CD top surface).

Jossan et al. (2015) conducted a study on the evaluation of non-conventional household products for the development of latent fingerprints. They use many household items including custard powder, cornflour, Baking powder, and Ranipal, and observed that these household items produce much better results than the conventional powders on different substrates. They also concluded that the powder which is fine-grinded results in better visualization of prints on different surfaces.

Thakur and Rakesh (2016) developed a new developing reagent for latent fingerprints. The latent fingerprints which are accidentally left by the perpetrator are developed by using the non-conventional method i.e. they used Fuller's earth (Multani mitti). They suggested that the latent fingerprints which are old as 6 days are successfully developed using the Fuller's earth on the surfaces such as black cardboard, clear glass, coverslip box, steel surface, laminated wooden sheet, and plastic surfaces. They also suggested that it is a non-toxic reagent and produces much reliable results than using the chemical reagents for the same print and surface.

Chauhan (2017) conducted an experiment in which he used four non-conventional items i.e. heena, vermilion, coffee powder, and gram flour on different surfaces. He suggested that the results produced by these items in the development of latent fingerprints were clear enough and individual and class characteristics were clearly visible which could help in the identification of an individual to be nabbed.

Sekar and Nur (2017) developed a natural latent fingerprint powder. They suggested that the chemical methods used for visualization are often toxic and harmful to human health. They used durian seeds for extraction of powder of fine particles, which is cheaper and less expensive. They observed that the powder of durian seeds produced better visualizations and play a significant role in analyzing the old fingerprints. They also explained that the starch component of seeds adheres to the aqueous and oily substances of the latent fingerprints, this was the main reason for the development of prints by using durian seeds.

Kamble et al. (2018) developed a new powder technique for the development of latent fingerprints. They suggested that some conventional powders are expensive and toxic to humankind; therefore they developed a new technique for the visualization of latent fingerprints. In their study, they used different soil colors for the development process on different surfaces and successfully obtained latent fingerprints on different surfaces except for skin and cotton.

Discussion

This review paper exclusively focusses on the use and importance of the non-conventional methods for latent fingerprint. Although there are numerous conventional and advanced techniques which are used by the investigators at scene of crime in present time. But these chemical techniques are proved to be harmful to the human life due to their toxic nature. In certain cases, in the unavailability or nil accessibility of chemical powders, the investigation is slowed. Therefore to overcome such crisis, the household items which are easily available in every house, played a vital role in developing the latent print and ensures justice.

Many authors support the idea of using non-conventional methods, instead of using chemical reagents due to their non-toxic nature. In 2015, Seerat and her group conducted a comparative study using different household products such as turmeric, mustard oil, red chili, and marigold powder, to develop the latent fingerprints on different non-surfaces. The results obtained were clear and identifiable which helps in further identification of an individual. These efforts also suggest the use of non-conventional

methods due to ease of availability, less cost, non-toxic nature, and easy to use.

Conclusion

After the review of many research papers, this paper concluded that the conventional methods which are one of the important aspects in the development of latent fingerprints are toxic and results in many health hazards. To overcome this problem many non-conventional methods are developed which are non-toxic, non-destructive, less expensive, and easily available as compared to chemical agents. They

produced much better results and can be used on various types of surfaces including plastic bottles, CDs, wooden surfaces, mirrors, transparency sheets, types of papers, and personal belongings. The drawback of these conventional methods is that they are not useful for the visualization of prints on human skin and wet surfaces. So there is a need to work more in facilitating the methods for locating and developing the prints on human skin and wet surfaces using conventional methods so that there could be less risk for the investigators.

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