

Methods and techniques for revealing latent fingerprints

Research Article

UDC: 343.982.06

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Abstract

Since the past, crimes were part of human life and identification of authors was important. That was the reason and a starting point to find the right way of identification. Based on the fact that fingerprints are unique for every person in the world and don't change along the life it was necessary to create a base system of fingerprint that today is known as Automated Fingerprint Identification System (AFIS). Since the start of the scientific era over people identification based in fingerprints until nowadays are discovered a lot of methods and techniques about revealing latent fingerprints in the crime scene, such as: Physical methods (Powdering methods: Fingerprint White Powder, Fingerprint Black Powder, Fluorescent Powders and Magnetic Fingerprint Powder), chemical methods (Example: Ninhydrin Solution, Iodine Fuming Silver, Nitrate Solution). Although in 19th century was discovered the DNA profiling as a method of identification, the fingerprint system continues to be useful and important part of judicial proceeding.

Keywords: Identification, fingerprints, methods, system

1. Introduction

As we know, forensic history had clearly shown that fingerprint is unique and permanent. They are unique because even identical twins that have the same DNA have different fingerprints. This uniqueness allows fingerprints to be used in different fields, such as: Biometric security, electronic registration and the most important is its usage in criminal situations. They have been used to identify suspects and solve crimes for a long time, and it remains an extremely valuable tool for law enforcement. Fingerprint identification also helps investigators to find a criminal record, previous arrests or criminal offences. Each ridge is a raised skin layer, which contain rows of pores that connect to sweat glands. They are permanent and don't change during the life, except in special cases, for example when any cut or burn goes deeper than the outline layer of the skin. The sector of forensic that studies and analysis fingerprints is called fingerprinting. That's very reliable method and now has been accepted by all courts of law. Fingerprints were used as signatures in ancient Babylon in the second millennium BCE and later in ancient Rome and Egypt. They have been found on ancient Babylonian clay tablets, potteries, bricks and tiles. In order to protect against forgery, they would impress their fingerprints into these parts where the contract had been written. The science of fingerprint identification has evolved over time from early use of fingerprints to mark business transactions in ancient Babylonia to their use today in technology, by government institutions, employers as well as police department across the world. They continue to be the most popular biometric tool for establishing identity of persons. Recording important evidence in the form of fingerprints, shoeprints or other impressions is often problematic. These images aren't clear in some cases and because of that, these images may be extremely fragile as well as difficult to see. They serve as a guideline for a process but useful and effective they will only be if they are executed by well-trained experts.

2. Methods of revealing latent fingerprints

To reveal latent fingerprints, we use different methods, such as: Physical methods (powdering methods), chemical methods and other different methods.

2.1. Physical methods (Powdering methods)

The use of powders is one of the oldest and most common techniques for development of latent fingerprints. Fingerprint dusting is relatively simple and relies on the adherence of powder to the latent print residue to provide good visibility and definition of fingerprint detail. Latent print visualization with powder or “dusting”, involves the application of finely divided particles that physically adhere to the aqueous and oily components in latent print residue on nonporous surfaces.¹ The factors that are thought to play a role in promoting powder particles to adhere to fingerprint ridges are: Particle size, particle shape, surface chemistry of the powder particle, electrostatic charge on the particle, adhesion to grease or liquid. In absence of the nowadays powders early practitioners used a variety of locally available ingredients, to make their own dusting powders including: Charcoal, lead powder, cigar ashes etc. Powdering method or physical method prefers various powders for the development of latent prints on the crime scenes. It is easier to apply the powder on the smooth surface in detecting and developing the latent fingerprints, for example: Glass, plastic, other synthetic materials, ceramic etc. Powder should be used according to the requirements of the background colour of the surface where the latent print exists. The choice of powder depends by several factors. The wrong choice of powder may lead to wrong results. Powders should not be used where surfaces are heavily contaminated because the particles won't be able to reach the surface between the constituents in the fingerprint residues and the contaminant and will adhere across the entire surface.

2.1.1. Black powder

Fingerprint Black Powder practically, it is the only black powder which is mostly used in detecting and developing the latent prints on the crime scenes. This is done by brushing fingerprint powder over a latent print.² If the surface of the object found on the crime scene is of white colour then it will produce the better result in making the contrast and black colour shall provide the readable data. Black fingerprint powder isn't used just in white background but it can be used in the other light-coloured surfaces too. Common ingredients in black powder include graphite, charcoal, lampblack, photocopier toners and anthracene. Powders may also contain a number of compounds. Dactyl black is made from a combination of graphite, lampblack and gum acacia. Haddonite black is similar to dactyl black but uses powdered acacia instead of gum acacia. With these powders we can use different brushes, such as: Nylon brushes, fibreglass brushes, camel hair brushes, carbon fibre brushes etc. Nylon brushes tend to be too stiff and carry too much powder, camel hair brushes are too stiff and cover too small an area while carbon fibres are used in cases where needed less powder is because they lose fibre too easily and they tend to carry small amount of powder. A characteristic of fibreglass brushes is that they work better after a break-in period. Powders in general can be applied in two forms: With painting and twirling. In the painting method, the brush is swept gently and we move it in opposite directions of the surface. While with the twirling form, the brush is twirled between the thumb and index finger, but these methods sometimes may be combined. A latent print should always be

¹ Charles E. O'Hara & James W. Osterburg, *An Introduction to Criminalistics* (1960), pg. 78

² Barry A.J. Fisher, *Techniques of Crime Scene Investigation* (1987), pg. 80

photographed or lifted as soon as it is identifiable. Attempting to improve an identifiable latent print prior to photographing or lifting, frequently results in destruction rather than improvement. With all of the modern technology available these powders are still common and one of the most effective methods of fingerprint development. This kind of fingerprint powder is used because it adheres easily to the oily residues from the fingers and other body parts. Another strength part of this powder is that it can be used in porous and non-porous surfaces.

2.1.2. White powder

White powder can be used for dark surfaces. This powder produces better results in the contrast of black colour or other dark surfaces, and after revealing latent fingerprints it should be photographed immediately. If this print is lifted with the transparent tape and replaced on the other black sheet the print will get faded after short time and that's why the direct photography is preferred here. It produces better result in the shape of fingerprint impression. Something that characterizes white powder is the fact that this powder isn't pure or homogenic substance. White powders may contain more than one type of particle. For example, in some types it contains large flakes of magnesium silicate with small granules of titanium dioxide. The small granules coat the surface of the flakes, suggesting that the flakes act as the carrier for the titanium dioxide granules.

2.1.3. Grey powder (Aluminium powder)

Grey powder or "argenteratum" is the most used powder in revealing latent fingerprints. It's confirmed that this is indeed the most effective powder for fingerprint detection. Aluminium flake, used as a metallic paint pigment, is manufactured by passing aluminium grit through a ball mill, where stearic acid is added as a milling agent. The final product is composed of flat, platelike particles of aluminium (5 to 10 µm long and about 0.5 µm thick) containing from 3 to 5% w/w stearic acid. The research group was able to produce an even more efficient fingerprint powder by increasing the stearic acid content to about 10% w/w. It was found that this modified aluminium powder gave a lower background and thus better contrast in developed fingerprints.³ This is similar to white powder because like white powder the grey one is also used on the objects having dark background. Grey powder is the most effective powder on glass, on mirrored surfaces, polished wooden objects or on the steel vessels but shows similar performance to alternative powders on other surfaces. Another reason why this is widely used is because this powder is easy to apply and it develops good contrast marks on many smooth surfaces.

2.1.4. Fluorescent powders

Fluorescent powders are good developers of latent fingerprints. They are mostly used in multicoloured surfaces, because they provide better results than the others and this leads to better contrast and photography can easily be done. There are different fluorescent colours of these powders. But mostly used fluorescent powders are: Red Fluorescent Powder, Green Fluorescent Powder, Orange Fluorescent Powder and Yellow Fluorescent Powder. Although they all take part in fluorescent powders, not all of them are used with the same brush. For example: Orange

³ CHRISTOPHE CHAMPOD, CHRIS J. LENNARD, PIERRE MARGOT, MILUTIN STOILOVIC, *FINGERPRINTS AND OTHER RIDGE SKIN IMPRESSIONS* (2004), PG. 137

Fluorescent Powder should be used with an orange feather brush, the yellow one with white feather brush etc. Before lifting the developed latent print, it should be photographed.

2.1.5. Magnetic powders

Magnetic fingerprint powder should always be used with a magnetic brush. Such powder is attracted by the magnet of the magnetic brush and is specially made of having the properties of magnetic. This powder is applied on the plastics, walls, human skin and glazed papers by using a magnetic applicator. The shape of this applicator may be just like a pen or a rod. The ordinary fingerprint powder when applied by simple brush fills the surface of the grooves of plastic, walls and glazed papers and thus they spoil the chance print found on the spot. When a magnetic fingerprint powder is used by magnetic applicator it removes the excess powder from the grooves and the print that is developed is much clear and comparable. Magnetic-based powders consist of colorants wrapped around iron filings. They are applied with the use of a magnet embedded inside a plastic or non-ferrous metal wand which attracts the filings and creates a clump or ball of powder. When the iron fillings are “rubbed” over the print surface, the colourant is deposited as it comes into contact with the oily residue. This process develops the image with little or no abrasive contact to the residue thus making magnetic-based powders ideal for more delicate type evidence. They are designed to work on some porous surfaces and non-porous surfaces like plastic, styrofoam, rubber etc. Magnetic wands are useful in many situations, however, they are not ideal when processing prints upside down. The magnet does a fine job of managing the powder when the wand is held in a normal magnet-down position, but loses its effectiveness when used in a magnet-up position. Lastly, magnetic powder is easy to clean up simply by passing the wand over any filings left behind.

When latent prints appear, they can be lightly brushed by adding powder and subsequently brushing excess powder away. This is done in the direction of the ridge flow to prevent damage to the impression. It is important to note that the magnetic powder ball formed with a magnetic brush is much softer than conventional filament brushes and typically causes less damage to fragile latent prints. Magnetic powders are usually less effective on ferromagnetic substrates such as steel or nickel and are therefore not recommended on those substrates. The magnetic attraction may cause contact between the applicator and substrate, damaging latent prints in the process. In addition, magnetized particles from the powder will cling to the substrate and resist removal. Magnetic powders with the Magna-brush were considered, but the emission from iron was not found as effective as that from lead and subsequent studies utilized lead powdering in combination with electronography. The first application proposed for electronography was the revelation of fingerprints deposited on patterned backgrounds. Once the fingerprint had been developed using the lead powder, only the developed areas emitted during subsequent electronography and the resultant fingerprint image was free of background. There are two distinct types of magnetic powder: Magneta Flake and Black Magnetic Powder (traditionally called Magna-powder). Magneta Flake is produced by milling spherical carbonyl iron with 3 to 5% stearic acid in an appropriate solvent to produce a smooth edged flake with particle sizes in the range 10 to 60 μm . Black magnetic powder has a substantially different microstructure, consisting of large magnetic carrier particles of elemental iron (20 to 200 μm) and smaller non-magnetic particles of iron oxide (Fe_3O_4) with a particle size in the range 3 to 12 μm . The larger particles act as a carrier medium for the smaller particles, which adhere to the fingerprint ridges and develop the mark.

2.2. Chemical methods

A sweat transferred from the ridge, leaving a fingerprint contains many chemicals that can interact with reagents. Among the chemicals that are used to improve the visibility of fingerprints are: Ninhydrin, iodine, silver nitrate or cyanoacrylic acid esters. Some methods are used in chemical reactions too that lead to visible changes, but can often cause damage or destruction of the material or article on which the imprint is located.

2.2.1. Silver Nitrate Solution

Silver Nitrate is a colourless, transparent, tubular crystal which becomes grey or grayish black on exposure to light. It develops latent prints on absorbent and non-absorbent materials. The Silver Nitrate solution reacts with the sodium chloride of the latent print to form silver chloride which is an unstable salt and immediately breaks up into its components silver and chloride on exposure to light including sunlight. This method is particularly useful for paper, cardboard and even unpainted wood. Prints that are to two years old can be developed by this method.⁴ It is important to note that the developed print by this method can remain for many years. Silver nitrate is just like a poison and therefore, due care is needed in this technique. Splash goggles, gloves and protective clothing should be worn properly.

2.2.2. Ninhydrin Solution

This method is the most popular chemical developer that reacts with amino acids deposited in the perspiration. It is an easy method to use and it is capable of raising prints that are many months old. To develop fingerprints on a porous surface is needed a 0.6 percent solution of ninhydrin powder that is dissolved in acetone or ethyl alcohol and is sprayed onto the surface. Prints usually begin to appear within an hour or two.⁵ Both silver nitrate and ninhydrin methods can be used on the same print but it is notable that ninhydrin solution should be used before the silver nitrate method. Ninhydrin spray is fairly recent. By using this spray very old prints can be developed, where the powders are not likely to adhere the prints and the iodine fuming and silver nitrate are also not likely to succeed. The object on which the print is located can be dipped in or sprayed with a ninhydrin solution, which reacts with the oils in the print's residue to create a bluish print. One of the drawbacks of using ninhydrin is that the reaction is very slow, often taking several hours for the print to become visible. To accelerate the reaction, the object containing the print can be heated to 80 to 100 degrees Fahrenheit.

2.2.3. Iodine fuming technique

Iodine fuming technique is the vapour method. According to dictionary meaning, 'Vapour' is the gaseous form of a liquid or solid substance. In this technique, the object containing the latent fingerprint is placed in an enclosed chamber along with iodine crystals. In this process a chemical reaction takes place between the oils deposited by the fingers and iodine fumes.⁶ For this reason, the latent print must have been deposited fairly recently since the moisture and oils dries up rapidly, especially on porous surfaces such as paper, cardboard or wood.

⁴ B.S. Nabar, *Forensic Science in Crime Investigation* (2009-2010), pg. 63

⁵ Frederick Cunliffe, *Criminalistics and Scientific Investigation* (1980), pg. 276

⁶ James E. Girard, *Criminalistics Forensic Science and Crime* (2008), pg. 141

2.3. Other methods

Except powdering and chemical methods there are some other methods and techniques for revealing latent fingerprints.

2.3.1. Laser Method

The word LASER is short form of Light Amplified Stimulated Emission of Radiations. This equipment plays an important role in the hands of the scientists of forensic science laboratories.⁷ Now they are also being used in the development of fingerprints. They are not a panacea (universal remedy), but merely a high technology based tool which can visualize latent prints sometimes missed by other techniques. This technique has great future though it is yet to be inducted in the country on a large scale. It is becoming more often for the forensic experts to examine any likely surfaces (doors, doorknobs, windows, railings, etc.) with an alternate light source. These are laser or LED devices that emit a particular wavelength, or spectrum, of light. It is an easy process and can be used on papers, plastics, glass, skin of dead bodies, metals etc.

2.3.2. Electronographic Method

Where the offence relates to the homicidal cases then this technique can be useful in the determination of latent fingerprints. In cases of throttling the latent fingerprints can be traced on the deceased's skin. In addition to this the cases of dragging, the dead bodies by the hands of the offenders can be determined in tracing the chance prints. Electronographic method can be used to develop the latent fingerprints on the deceased skin by dusting the area with fine lead powder. The surface is irradiated with hard X-ray beam, which passes through a series of filters like copper and aluminium to remove the soft components of irradiated X-ray beam. The electrons emitted by lead atoms affect the X-ray film placed on the top of the object-giving rise to the developed print. This technique is useful even on living skin.⁸

2.3.3. Silicon Rubber Fingerprint Lifter

This method is effective in lifting impressions from dust. A baffle walls of clay or a readymade metallic baffle wall encloses the print. The silicon casting material is gently poured adjacent to the impression and allowed to flow over it and the cast is removed after it has dried.

2.3.4. Cyanoacrylate (Super Glue)

Cyanoacrylate (Super Glue) was firstly used in Japan and USA, but now is used in different countries across the world. Cyanoacrylate technique is so simple to use. The object having chance print is placed in contact with the fumes, which cause the ridge structure of the latent fingerprints on the object to appear white.⁹ Cyanoacrylate fuming works well on nonporous object surfaces such as metal, plastic and glass. Most latent prints developed by this technique are visible by oblique lighting. In fingerprint fuming, the vapors of cyanoacrylate react with the chemicals that are found in fingerprints. Including here organic compounds like amino acids, glucose, lactic acid, peptides, ammonia, riboflavin and isoagglutinogens as well as inorganic chemicals like potassium, sodium, carbon trioxide and chlorine.

⁷ B.S. Nabar, *Forensic Science in Crime Investigation* (2009-2010), pg. 63

⁸ B.S. Nabar, *Forensic Science in Crime Investigation* (2009-2010), pg. 64

⁹ Barry A.J. Fisher, *Techniques of Crime Scene Investigation* (1987), pg. 88

Once the super glue in the container reaches its boiling point, it will begin to boil away into the surrounding atmosphere, creating a concentration of gaseous cyanoacrylate. If latent fingerprints exist somewhere inside the tank, they will eventually be exposed to the gaseous cyanoacrylate. The whole reaction can take over two hours but however it should be checked by investigator because sometimes the latent fingerprints can overdevelop which isn't good for identification.

3. Automated fingerprint identification system (afis)

The Automated Fingerprint Identification System (AFIS) is a biometric identification methodology that uses digital imaging technology to obtain, store and analyze fingerprint data. The AFIS was originally used by the United States Federal Bureau of Investigation (FBI) in criminal cases. Lately, it has gained favour for general identification and fraud prevention.

The Henry Classification System was an important force driving the development of the Automated Fingerprint Identification System (AFIS). The original AFIS technology was designed to expedite the manual searching of fingerprint records, with a goal of eventually reducing matching time from months to hours. At that time, most forensic fingerprint cards were sorted according to the Henry system, so the first AFIS solutions attempted to follow this process by comparing prints to Henry sorted fingerprints cards. Unfortunately, Henry's finger pattern definitions proved extremely difficult to convert them into computer descriptions. More importantly, the Henry-based AFIS suffered from the same limitations as the traditional manual matching system, it required a trained technician and it was not fully automated. Also, the Henry system worked only if all fingerprints were available, a luxury not afforded to most crime scene investigators. In short, AFIS technology is based on the ability to electronically scan and identify fingerprint characteristics and store them in digital form in a computer. Using ridge endings and bifurcations it is possible to create a digitized representation of the print, which can be stored in the computer.

4. Results

In Internal Affairs Sector of Tetovo, Republic of Macedonia most used methods for revealing latent fingerprints are powdering methods. And most commonly used is argentoratum (grey powder) and magnetic powder. These methods are used in different cases because they are simply used. In Table 1 are included results of identification of authors of crime in the last 4 years, since 2015 to 2018.

Table 1: Percentage of the realization based in fingerprints

	Investigations	Without signs	With signs	%
2015	560	468	92	16,5
2016	420	332	88	20,9
2017	340	265	75	22,1
2018	310	239	71	22,1

From the table we can see that the number of crimes is reduced while the percentage of identification of authors of crime is higher. This number is increasing because of excellent job of investigators in the crime scene. And this comes by different trainings of investigators and improvement of their abilities in the crime scenes.

5. Conclusion

Crimes were part of life since the earliest ages but the methods of revealing them have changed with the time. In most of crime cases there are signs which help us to identify the crime authors. One of the oldest and most commonly used techniques is fingerprinting and that's so because it's simply used and is a reliable method. Fingerprinting is used since the second millennium BCE (in Babylonia) and it continues to be used today, what describes the best it's function. There are different methods of revealing latent fingerprints, such as: Powdering methods, chemical methods and other methods. Powdering or physical methods can be used directly in crime scene and it doesn't require any sophisticated equipment. This method can be applied in laboratory but is mostly used in the crime scene. We choose the powder colour based in the surface colour, so if it's any dark colour we use the light one and the opposite. While in multicoloured surfaces we use fluorescent powders because they provide better results. But however, most used powder is grey powder or argenteratum and not just in our country but in other countries too. While the chemical methods need more advanced conditions and it can be used just in laboratory, because in this method we use different gases which can't be used in other conditions.

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