Investigation of the executive process of using fingerprint in scientific crime detection

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ABSTRACT

Nowadays, fingerprinting science is effectively helpful in the detection of crimes and arrestment of criminals and just judgment. The fingerprint as one of the most transparent documents in crime scenes can be the most critical factor for the identification of criminals. The science has helped criminal system for crime detection. In this study, the executive process of using fingerprint in scientific crime detection is analyzed. The method in this study is the library method. The results obtained from this study showed that fingerprint as physical evidence in crime scene has critically helped the criminal justice system.
Keywords: fingerprint scanner, fingerprinting, crime, criminal, crime scene

Introduction

Criminal investigations have passed multiple steps historically. Analysis of the methods of crime committed and the instruments used for that, and the signs remained from the criminal are the subject of crime detection science, and a branch of that can be scientific police. The advancements achieved today in the methods of crime detection have declined the number of undetected crimes and unknown criminals. Detection of forgery and forged documents, determination of types of weapon used for crime commitment, providing the picture of a criminal based on claims of witnesses, and analysis of fingerprints in the fingerprinting process can be the main conditions of investigations in crime detection science.

Moreover, fingerprinting is one of the main conditions of scientific investigations of police. Fingerprinting science is one of the most critical issues of scientific police. The fingerprint is the most focused issue in crime detection as evidence in criminal investigations and can be used in the identification of criminals and crime proving in criminal lawsuits. The fingerprint is not limited to a comparison of the crossed finger lines, but also it encompasses the lines on the claws and toes. The previous experiences show that countless identities are created by the designs of claws and toes. The method of identification is as reliable as the evidence obtained from the fingerprints. Now, the question arises: how fingerprint can help crime detection?

Methodology

The method used in this study is the library method, and the data are collected using various sources and books.

The importance of fingerprinting science

Fingerprinting is one of the most critical discussions of scientific police. Fingerprinting is obtaining the motifs on the fingertips of individuals and means the science of using fingerprint in the identification of individuals and crime detection. A historical and scientific overview of fingerprinting science on the analysis of some Islamic legal evidence, especially the Quran, shows that this issue is a critical field in crime detection. The introduction of criminal sciences can be studied and classified from various

dimensions (criminology, law, etc.). Many lawyers of criminology field (criminologists) have classified criminal sciences to 4 classes.

The first branch or the core of this science is summarized in different fields of criminal law (general criminal law, specific criminal law, criminal procedure, prison and prisoner rights, etc.). The second branch is relevant to empirical aspects of the sciences, which is generally utilized for crime detection and proving or is used to analyze the nature of the crime, nature of punishment, and the causes of crime commitment, and the evolutions relevant to punishment (criminology). The third branch belongs to the philosophy of criminal law. Finally, the fourth branch is called penal policy by the criminal lawyers and is called as criminal policy by the lawyers of criminology and human rights.

Identification by fingerprinting is on this basis that no pair of fingerprints are alike. There are multiple fingerprints in terms of form, design, or size; although there have been no pair of fingerprints with the same designs. Therefore, the most critical advantage of fingerprinting is the identification of criminals, because criminals always try to hide their real identity and every time commit a crime with different information. However, fingerprinting is the way to detect their real identity. In other words, if the fingerprints of criminals remained on the door, table, glass, or other points of the crime scene are collected and classified using fingerprinting science, it can be helpful for the identification of criminals. This can be helpful for the judicial authorities to do their tasks, especially, for criminals with criminal records who change their identity to hide their criminal records while arresting. In these cases, fingerprinting science determines the records and the real identity of the offender with the help of an archive of fingerprints. Besides, the judicial authorities use the information of this science and deal with the case, and apply the regulations of recidivism.

Criminal fingerprinting (hidden):

The fingerprints remained by touching something (evidence) in the crime scene by the criminals unwantedly are called hidden or criminal fingerprints in legal terms.

The criminals usually touch some objects and things in the crime scene while committing the crime and their fingerprints remain on the things. The fingerprints are invisible in the first look and are hidden, and should be discovered and appeared if necessary. This kind of fingerprinting is used to detect the crimes and to identify the criminal by comparing the fingerprints with the fingerprints of the criminals. Hence, this kind of fingerprinting is called hidden or criminal fingerprinting.

The most critical techniques of criminal fingerprinting are:

- The emergence of invisible fingerprints using a variety of ordinary and magnetic powders
- The emergence of invisible fingerprints using a variety of optical generation devices (UV, laser radiations, poly-light, x-ray, etc.)
- The emergence of invisible fingerprints using chemical substances including iodine, ninhydrin, silver nitrate, etc.
- The emergence of fingerprints using the adhesive steam method and other modern techniques

The fingerprinting process
Fingerprint classification

Classification of the fingerprint is used in identification systems. In the identification systems, the only identity of some part of the databank that is corresponding to entered fingerprint in terms of class is searched. In systems working with small populations, the class of fingerprint can be used as the only feature for identification. The oldest classification system used in manual systems is the method presented by Henry. There are 5 classes in this classification, which are respectively right-loop, left-loop, loop, spiral, arched, and tent-arched. Determining class for a fingerprint is taken based on the direction of continuing the edges around the core, and the number and arrangement of core points and the delta. The presented classification is appropriate for the manual process because the mentioned regulations are clear to attribute a fingerprint to a specific class. In an automated system, it would be better to split the number of databank into smaller parts through an increasing number of classes. However, because of the

transparency of the presented classification system, the majority of automated systems use the same classification.

Types of fingerprinting methods:
Various fingerprinting techniques have been changed a lot from the time they are created. Using digital scanning equipment can help a comparison of multiple samples and consequently, real identification.

There are 3 types of fingerprints including visible, plastic, and hidden or invisible fingerprints. A visible fingerprint is made by ink and is visible easily. Plastic fingerprints can be made by materials like wax, soap, etc. The last type is called a hidden or invisible fingerprint. The remained effects on a surface by sweat or natural oils are called hidden fingerprints. Detection of hidden fingerprints is hard to do.

Traditional method
In the most common fingerprinting method, the fingerprint is recorded using ink. Pressing the inked fingers on a paper is a method to obtain fingerprints.

Digital scanning method
In this method, a sensitive touchpad is used to record the fingerprints of a person or suspect. The image of the recorded fingerprint on the touchpad is then compared to thousands of images using the software. If there is no similar fingerprint in the computer database, it will be saved in the system.

Lifting method
In this method, the oil remained from hands is taken by the powders made of resin polymers. To have easy access to the identification process, the dark powders are used on light plates and vice versa. To enhance the fingerprints on the porous materials, chemicals like ninhydrin are used in this method. To place the object on the plate, a drip adhesive container is used. The adhesive on the containers sticks to the fingerprints and make them visible.

Laser method
The laser method is one of the most useful approaches to take a fingerprint. In this technology of fingerprinting, the laser can be used to take fingerprints from various surfaces.

Bullet fingerprinting is a specific method because it enables obtaining the image of fingerprint even after cleaning that from the surface. The method analyzes the interactions between the finger sweat and the metal. Surface imaging methods are taken using an atomic force microscope. This technique is considered as a reliable method for identification by the fingerprint because even washing the surface can never remove the layers of sweat. Various concepts are available about the fingerprint that needs understanding. The field of identification by fingerprint is expertise.

Fingerprint detection
For fingerprint detection, aluminum powder, ink, and blowing are used. In the rest of this section, the function of each method is explained.

Aluminum powder method:
In this method, the finger is washed by soap and is pressed on a white paper several times. By looking at the paper, there would be usually no effect of the fingerprint. The area of the fingerprint is specified by pencil and aluminum powder is poured on that. The particles of aluminum remained on the paper after blowing clear the fingerprints.

Ink method:

The clean finger is pressed on a paper and the point is specified by pencil. Then, a paper is coated by conventional ink and is scrubbed on the fingerprint. After a few seconds, the ink is washed. If the color of ink is blue, the fingerprint appears in blue.

Blowing method:

Through blowing on a conventional glass, on which a name is written, the lines can be cleared. This is because; the steam is condensed on the place. If the name is written on a conventional paper with a piece of wood, no line appears. However, if some solid iodine is placed beside paper under a cup, it would be converted to steam and a brown line is appeared after a few minutes depending on the ambient temperature. To determine the fingerprint, the same rule is used. Using this method, the fingerprint of ten years ago can be appeared.

Fingerprint registration:

To register the fingerprint, the light of a candle is moved under a glass plate in such a way that the light is in contact with the glass. As a result, a thin layer of smoke sits on the glass. After cooling, the finger is pressed on the smoke, and the fingerprint appears on the glass. Now, if the smoky finger is pressed on a white paper, the fingerprint appears clearly on the paper. The fingertip is smeared to 20% acid sulfuric and is pressed on several points of a white paper. Now, if the paper is held on a small spark and is heated, the fingerprint appears in form of tiny lines. The reason for black lines is that sulfuric acid on the finger lines connected to paper converts the paper to ash by heating that. The black lines showing the fingerprints are the same charred paper solutions. 1gr of potassium ferrocyanide is solved in 100gr water, and a one-per-thousand chlorophyll solution is obtained. After drying the paper, the finger is impregnated to chlorophyll solution and is pressed on several points of the paper. Hence, the fingerprint appears in blue color.

Fingerprints in the crime scene:

The detected fingerprints in the crime scene can be classified into 3 groups including visible (clear), plastic (soft), and invisible (hidden) fingerprints. Visible fingerprints are those, which are clear and are created by contact of the lines on the fingers and toes with the surface of objects coated by blood, color, or types of wastes. The fingerprints remained on soft paint, putty or hair can be called plastic fingerprints. The invisible fingerprints are those transferred to the fingers from natural body secretions like sweat, fats, and acids secreted from fatty glands around the ears, nose, and neck. Invisible fingerprints remain on all surfaces with contact to skin lines; although their emergence may be impossible in some cases. For example, the fingerprints remained on metal surfaces, glass, plastic, rubber; flabica, keeler wood, paper, and cardboard can be appeared by the existing equipment. However, invisible fingerprints can't appear in places such as jagged surfaces, dark clothes, and coarse-fabric clothes.

The authentication systems based on fingerprint

In the past, fingerprint-based biometric systems used to be applied for police and criminal issues. However, the systems today are applicable for controlling and security affairs of the organizations and institutes.

Take an image

The oldest method is the same method of using paper and ink. In this method, the finger is impregnated with ink first and is pressed on the paper. To enter the obtained image to a computer system, a flat scanner is used. The obtained image needs the supervision of an expert for manual detection. Another method, which is applicable today in many systems is the use of CCD cameras. In the recent approach that is called live scanning, an image with high quality can be obtained.

Thermal technique

In all mentioned techniques, the fingertip is in contact with the special point of the device, and the image is scanned. In an optical method, the finger is placed on a pyramid and the light is reflected on that. With the measurement of the light reflected from each part, an image of a finger is created. In the ultrasonic method, sound energy reflected from the fingertips is used to clear the edges and grooves. The electric field sensors act based on the measurement of the electric capacity difference of the fingertip that touches the sensor. Finally, the thermal sensors measure the difference of temperature of the skin and clear the grooves, and edges of fingerprint. The live scanning method can provide an almost high-quality image of the fingerprint. However, still, factors such as dryness of skin, skin diseases, sweating, dirtiness, and fat can cause the creation of waves in the fingerprint image.

Identification of unidentified bodies

Unidentified bodies can be identified using the identification method of living individuals. However, there are other methods to identify the dead bodies and vary based on the situation of the body:

1- bodies with healthy physical appearance and non-decomposed organs, such as newly dead bodies or those maintained in the fridge under suitable temperature. These bodies can be identified based on their physical information and showing the body to family, and individuals to identify that. Analysis of the content of documents and objects with the body, such as ID card, bracelet, and plaque is taken. Besides, fingerprinting and adjustment with the records, ID card, and other documents, taking a picture and presenting them to the relatives of lost individuals are the action taken in this process.

2- The face of the dead bodies is not identifiable for various reasons such as burning, accidents, shredding, the explosion of defective corruption, and the impossibility of fingerprinting. In this case, the clothes information, the signs on the body (tattoos, moles, natural lesions, healed fractures, surgical effects, previous defects of some organs, a special condition of hair, and teeth) are analyzed. The information is also compared with the information of suspected individuals. Identification in this method is done through measurement of height, analysis of sexual organs (e.g. ovary and fetus in women and prostate gland in men).

3- The bodies, whose death is registered a long time ago, and nothing remains from them other than bones: In this case, identification is difficult, and it should be specified at first that the discovered bones belong to humans or animals. After authentication of person, the sex, age, height, death time, and the race and the reason for death should be specified if possible. When the skeleton is completely available, an analysis of the said items is taken carefully and rapidly. However, in case that some part of the skeleton is available or the discovered bones are belonged to more than one person, identification is hard to do.

First of all, the methods of detection of human bones from animal bones are taken using the following methods:

1- Comparative method
2- Measurement method (macroscopic)
3- Fabric-identification method (microscopic)
4- Serology method (precipitate serum)

Identification of criminals

To identify the criminal using the genetic fingerprinting method, after extraction of DNA from samples and comparing the pattern obtained from a blood sample and with the pattern obtained from the sample containing a mixture of cells of the killer and the victim, the patterning belonged to murderer can be detected.

Genetic fingerprinting can be used to identify the collapsed bodies or those who are not identifiable for any reason.

On the other hand, this method can be used to identify the real parents in case of doubt. It can be also used to diagnose cancer.

In some types of cancer, a considerable increase or decrease in the number of microsatellite sequences can be observed.

Such changes can be measured using DNA fingerprinting, genetic differentiation, number of immigrants in each generation, and the amount of consistency. This powerful instrument can be used to measure the derivation time of species.

Confirmation of the accuracy of simulation claims is another good option of genetic fingerprinting.

Criminal investigation laboratories are equipped to gas chromatography, spectroscopy, auto-gamma sanitation machine, sanitation, beta-liquid, electrophoresis, atom absorption device, ultraviolet, infrared spectrometer, and types of comparative microscopes.

Extraction of the features in the fingerprint

The main features in a fingerprint include edges, and grooves, which are placed as one in between. The edges and grooves have the same direction locally and are parallel. In edge lines, there are irregularities such as bifurcation of the edge line and ending the edge line. In this case, it could be mentioned that local discretion is created. Such points are called features. The most common features extracted from fingerprint include features introduced by Galton. At the first, Galton introduced 4 features, and later, the features were developed by other scholars and were increased up to 18 specifications. Automated extraction of all features introduced by computers was hard, and even manual extraction needs expertise. In the majority of automatic systems, only two special features need to be extracted called end-edge and bifurcated edge (particle). The two features are more visible than other features in a fingerprint and the extraction algorithm of them is more reliable. The identification of fingerprint is taken based on the extracted chips. However, multiple methods are available to detect the chips of the fingerprint. In the majority of these methods, black and white images (gray surface) change the fingerprint into a binary image. During this phase, the edges are completely separated from the grooves. Then, the binary image is downsized, so that the edges can be converted to curves with the width of a single dot. In the next step, the chips are extracted from the downsized binary image. However, converting the gray surface image into a binary image may destroy a large amount of information of chips, and this is a very sensitive operation. Besides, the inside downsizing process is complicated in terms of calculations. The method of extraction of chips in this study is based on the edge-line following algorithm. In this algorithm, the direction of the edges and the structural information of edge lines (the width and distance of edge lines) are estimated automatically from the gray surface image. To obtain reliable results in the extraction of chips, the entered fingerprint is analyzed and the edge line parameters are estimated. Then, the edge line following algorithm is used to extract the chips. To save each fingerprint, adaptive comparison boundaries are created to eliminate unreliable chips from the desired limit. Besides, to determine the quantity of the chips, the concept of fuzzy sets on edges is used.

If the obtained chips are reliable, they would be recorded in a databank; otherwise, they enter the comparison phase. Some features of fingerprint saved in an automated system include location, direction, and types of chips. Hence, the issue of comparison of two fingerprints ends in comparison of two sets of points. The studies conducted over the century, guarantee the unity of fingerprint pattern based on chips for large populations. About 50-150 chips can be detected on a complete image of the fingerprint. In an automated system, extraction and comparison of about 10 chips is enough to conclude the sameness of two fingerprints.

Fingerprint matching

Matching is a process, through which the similarity of two fingerprints is measured. In the majority of systems, chips are used to match two fingerprints. In a method called filter bank, the image of the fingerprint is divided into several parts at the first. Then, a filter called Gabor Filter with different angles is applied in each section. The standard deviation is measured per angle for the desired point. As Gabor Filter is a directional filter, and the edges of fingerprint in each region have a dominant direction, applying a filter with various angles can weaken or empower the edges. If the selected angle for the filter is equal or near to the major edge direction in the desired point, it can empower them; otherwise, it can weaken the edges. In each step of using a filter, the standard deviation is measured for the desired point. Sum of the standard deviations can form the corresponding feature of the desired fingerprint.

Comparing and matching fingerprints
1- Comparing and matching fingerprints with fingerprints obtained from the crime scene:
After imaging, framing or emerging the fingerprints obtained from the crime scene, they would be compared with the fingerprints of suspected individuals. In the manual systems, the matching is done using a microscope or magnification device. In computer systems, they would be matched using the computer, and by comparing the features of two fingerprints. Even if there is no suspect, the computer compares the fingerprint with the previously saved fingerprints and provides the records of the owner of the fingerprint. Besides, the fingerprints obtained from the different crime scenes, the owner of which is not identified, are recorded and compared. If there are fingerprints of the criminal in two different crime scenes, computer discovers this issue and it can be specified that the crimes have been committed by one person.

2- Comparing and matching fingerprints below the documentation
Sometimes, the fingerprints below the documents, such as sale contract, cheque, promissory note, or salary list are the subject of dispute. In this case, 10-finger fingerprinting should be taken from the suspected individual or individuals. Then, the fingerprints should be matched with the fingerprints of disputing parties, so that the owner of the fingerprint is identified. About the documents belonged to dead parties (e.g. testament), the documents fingered at the time of living of that person should be investigated. The disputed fingerprint should be them compared with the clear fingerprints below the documents.

Important notes on matching and comparing fingerprints below the documents:
1. If more than one person has fingered below the document, it would be better to match the fingerprint with all fingerprints in the document. This is because; another name may be inserted below the fingerprint intentionally or unintentionally.
2. Maybe because of the bandage of hands or left handwriting, or because of bad will, the person may finger the document with a finger other than the index finger. Hence, it should be compared with other fingerprints.
3. For investigations, the original document should be presented, because photocopy may not be capable to provide details needed by the expert.
4. Identification of infants: identification of disputed infants is done from their sole. Because of the small size of the fingerprints of infants and to observe the health principles, a DNA test is currently used for this purpose. This test can be taken in the police station, General Directorate of Identity and Forensic Medicine Organization of Iran and can be used to say absolutely that whether an infant belongs to the claiming parents.

Conclusion
Scientific police or scientific crime detection is one of the branches of criminology. Fingerprinting is one of the most critical elements of scientific police.

Identification through fingerprinting is on this basis that 2 fingerprints are not the same. There are various fingerprints in terms of form, design, and size. However, to the date, no two fingerprints that are exactly alike have been found. Therefore, the most critical advantage of fingerprinting science is the identification of criminals; because criminals always try to hide their real identities and commit a crime with different identity every time. However, fingerprinting is the way to detect their real identity.

Even the most stubborn opponents of fingerprinting know that this technique is more careful than other identification methods based on testing hair, blood group, or any other method, except for DNA determination. The motifs and lines and the final form of fingertips are created in the uterus and form a complicated collection of heritage and the environment. This process is too complicated that even single-egg twins never have the same fingerprint.

Hence, the confusing factor should happen after remaining the effect. As the majority of experts in fingerprinting are trained, it seems that more than a human mistake, one should be careful of 4-step instructions of fingerprint detection in the world. The instruction (ACE-V) includes 4 sequential steps

including analysis, comparison, evaluation, and final confirmation. The hyphen shows that final confirmation should be taken by another person.

In step 1 of analysis, 3 main designs including loops, spirals, and curves are analyzed. With the detection of primary design, step 2 is focused on more elegant issues, such as the branches derived from the bulges and their endpoints. In many cases, step 2 is determinant. If an error is probable, step 3 analyzes the form of edge of bulges. After ending the analysis step, the sample is compared with previous samples. This step includes a revision to determine similarities or differences with previous samples extracted from the archive or the suspected fingerprint.

If the fingerprint of criminal remains on the door, table, glass, or other points of the crime scene, they can be collected and classified using fingerprinting science and they can help the identification of criminals and would be helpful for judicial authorities. The measure is critical for the experienced criminals, who commit a crime and change their criminal records. In these cases, fingerprinting science identifies the criminals with the help of archive of fingerprints. Besides, judicial authorities use the information obtained from the science and take the prosecution and apply regulations of recidivism. Hence, the science of fingerprinting helps the crime detection and arrest of criminals effectively. It can also cause a penal code to make just judgment. It could be mentioned that fingerprinting is the only way for the detection of the real identity of individuals.

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