Fingerprint Studies - The Recent Challenges And Advancements: A Literary View

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Abstract

The science of fingerprints – dermatoglyphics - had long been widely accepted, and well acclaimed and reputed as panacea for individualization, particularly in forensic investigations. Nonetheless, the occasional errors in identification that at times bedevil the practice had been raising alarms and skepticism and the possible discontinuity of its acceptance. In spite of this, while no yet any parallel or other equally acceptable diagnostic methods of personal identification exist at present, relentless efforts in scientific advancements are ongoing to make fingerprint a most reliable and errorless human identification reference point. This paper addresses this subject from literary point of view.

INTRODUCTION

Sir Francis Galton published his book, 'Fingerprints' in 1892, establishing the individuality and permanence of fingerprints. The book included the first classification system for fingerprints. Although Galton's primary interest in fingerprints was as an aid in determining heredity and racial background, but he soon discovered that while fingerprints offered no firm clues to an individual's intelligence or genetic history, he was able to scientifically prove what Herschel and Faulds already suspected: that fingerprints do not change over the course of an individual's lifetime, and that no two fingerprints are exactly the same. According to his calculations, the odds of two individual fingerprints being the same were 1 in 64 billion. Galton identified the characteristics by which fingerprints can be identified, these same characteristics (minutia) are basically still in use today, and are often referred to as Galton's Details [1]

A fingerprint is an impression of the friction ridges of all or any part of the finger. A friction ridge is a raised portion of the epidermis on the skin of palmar: palm and fingers or plantar: sole and toes, consisting of one or more connected ridge units on skin. These ridges are also known as dermal ridges or dermal papillae. [2]

Fingerprints may be deposited in natural secretions from the eccrine glands present in friction ridge skin (secretions consisting primarily of water) or they may be made by ink or other contaminants transferred from the peaks of friction skin ridges to a relatively smooth surface such as a fingerprint card. The term fingerprint normally refers to impressions transferred from the pad on the last joint of fingers and thumbs, though fingerprint cards also typically record portions of lower joint areas of the fingers, which are also used to make identifications [3]

EMBRYONIC DEVELOPMENT OF FINGERPRINTS

Earlier scientific studies related dermatological marking developments to the first four months of gestation, according to Eugene Scheimann [4] or in the second trimester from the report of Berry [5] . Schaumann and Alter [6] described the process more accurately and in detail as taking place early in fetal development and being genetically determined while being modified by environmental forces as exemplified by exposure to Rubella and Thalidomide. The process of dermal ridge formation begins with the formation of fetal volar pads; these are mound-shaped formations of mesenchymal tissue elevated over the end of the most distal metacarpal bone on each finger, in the interdigital areas just below the fingers, and on the hypothenar and thenar areas of the palms and soles. Secondary pads are found in other areas such as in the center of the palm and on the proximal phalanges. The fingertip formations of volar pads are first visible in the sixth to seventh week of development. Babler [7] indicates that the epidermal ridges first appear in the form of localized cell proliferations around the 10th to 11th week of gestation. These proliferations form shallow corrugations that project into the superficial layer of the dermis. The number of ridges continue to increase, being formed either between or adjacent to existing ridges. It is during this period of primary ridge formation that the characteristic patterns are formed. At about 14 weeks the primary ridge formation ceases and secondary ridges begin to form as sweat gland anlagen begin to develop along the apices of the primary ridges at uniform intervals. At this time the epidermal ridges first begin to appear on the volar surfaces. The dermal papillae are reported to develop in the valleys between the ridges on the deep surface of the epidermis around the 24th week. Until then the morphology of primary and secondary ridges appears as a smooth ridge of tissue and thereafter peg like structures, the dermal papillae, characteristic of the definitive dermal ridges are progressively formed. [8]

Unusual dermatoglyphic patterns often relate to genetic disorders. One study of foetuses with chromosomal abnormalities showed that the dermatoglyphic patterns were delayed by more than two weeks. [9]

FINGERPRINT TYPES

Depending on the enhancing source of impression, fingerprints could be regarded as: Latent, Patent or Plastic prints, although the word latent means hidden or invisible, in modern usage for forensic science the term latent prints means any chance or accidental impression left by friction ridge skin on a surface, regardless of whether it is visible or invisible at the time of deposition. Electronic, chemical and physical processing techniques permit visualization of invisible latent print residue whether they are from natural secretions of the eccrine glands present on friction ridge skin - which produce palmar sweat, sebum, and various kinds of lipids, or whether the impression is in a contaminant such as motor oil, blood, paint, ink, etc. Latent prints may exhibit only a small portion of the surface of the finger and may be smudged, distorted, or both, depending on how they were deposited. For these reasons, latent prints are an inevitable source of error in making comparisons as they generally contain less clarity, less content, and less undistorted information than a fingerprint taken under controlled conditions, and much less details compared to the actual patterns of ridges and grooves of a finger. Patent prints - these are friction ridge impressions of unknown origin which are obvious to the human eye and are caused by a transfer of foreign material on the finger, onto a surface. Because they are already visible they need no enhancement, and are generally photographed instead of being lifted in the same manner as latent prints. Finger deposits can include materials such as ink, dirt, or blood onto a surface. Plastic prints - a plastic print is a friction ridge impression from a finger, palm, toe or foot deposited in a material that retains the shape of the ridge details. Commonly encountered examples are melted candle wax, putty removed from the perimeter of window panes and thick grease deposits on car parts. Such prints are already visible and need no enhancement, but investigators must not overlook the potential that invisible latent prints deposited by accomplices may also be on such surfaces. After photographically recording such prints, attempts should be made to develop other non-plastic impressions deposited at natural finger/palm secretions (eccrine gland secretions) or contaminates. [10,11,12]

CLASSIFICATION OF FINGERPRINTS

Before computerization replaced manual filing systems in large fingerprint operations, manual fingerprint classification systems were used to categorize fingerprints based on general ridge formations such as the presence or absence of circular patterns in various fingers, thus permitting filing and retrieval of paper records in large collections based on friction ridge patterns independent of name, birth date and other biographic data that persons may misrepresent. The most popular ten-print classification systems include the Roscher system, the Vucetich system, and the Henry classification system. Of these systems, the Roscher system was developed in Germany and implemented in both Germany and Japan, the Vucetich system was developed in Argentina and implemented throughout South America, and the Henry system was developed in India and implemented in most English-speaking countries. In the Henry system of classification, there are three basic fingerprint patterns: Arch, Loop and Whorl. There are also more complex classification systems that further break down patterns to plain arches or tented arches. Loops may be radial or ulnar, depending on the side of the hand the tail points towards. Whorls also have sub-group classifications including plain whorls, accidental whorls, double loop whorls, and central pocket loop whorls. [13]

THE USE OF FINGERPRINTS IN IDENTIFICATION / INDIVIDUALIZATION

Fingerprint or palmprint identification is the process of comparing questioned and known friction skin ridge impressions from fingers or palms to determine if the impressions are from the same finger or palm. The flexibility of friction ridge skin means that no two finger or palm prints are ever exactly alike, that is, never identical in every detail. Identification otherwise referred to as individualization occurs when an expert or an expert computer system operating under threshold scoring rules determines that two friction ridge impressions originated from the same finger, palm, toe or sole to the exclusion of all others [14]

The English first began using fingerprints in July of 1858, when Sir William Herschel, Chief Magistrate of the Hooghly district in Jungipoor, India, first used fingerprints on native contracts. On a whim, and with no thought toward personal identification, Herschel made Rajyadhar Konai, a local businessman, to impress his hand print on a contract. The idea was merely to frighten him out of all thought of repudiating his signature, and Herschel made a habit of requiring palm prints, and later, simply the prints of the right Index and Middle fingers on every contract made with the locals. Personal contact with the document was believed to make the contract more binding than if they simply signed it. Thus, the first wide-scale, modern-day use of fingerprints was predicated, not upon scientific evidence, but upon superstitious beliefs. [15] As his fingerprint collection grew, however, Herschel began to note that the inked impressions could, indeed, prove or disprove identity. While his experience with fingerprinting was admittedly limited, Herschel's private conviction that all fingerprints were unique to the individual, as well as permanent throughout that individual's life, inspired him to expand their use [15]

Juan Vucetich made the first criminal fingerprint identification in 1892. He was able to identify Francis Rojas, a woman who murdered her two sons and cut her own throat in an attempt to place blame on another. Her bloody print was left on a door post, proving her identity as the murderer. More so, a landmark 'science of fingerprints' case in the courts occurred in 1911 in Chicago, U.S.A. It resulted in the conviction of a man named Thomas Jennings for murder. Very little evidence against Jennings existed, the most significant being fingerprints. To ensure that fingerprint evidence would be admitted, the prosecution called several recognized fingerprint experts as witnesses. Edward Foster - the man responsible for the establishment of Canada's national fingerprint bureau - was one of these witnesses. With the help of his testimony, Jennings was convicted and sentenced to hang on December 22, 1911 [15] . The defense lawyers for Jennings's appealed his conviction to the Supreme Court of Illinois, arguing that fingerprint evidence should not be accepted. In this first test of the legality of fingerprints in an American high court, the landmark ruling stated that, there is a scientific basis for the system of fingerprint identification, and the courts are justified in admitting this class of evidence [15]

One could ask, what was the scientific basis for allowing fingerprint evidence for this case? As at that time, it was the research and comprehensive book: Finger Prints by Sir Francis Galton, a well-known scientist that made a significant contribution to the science of fingerprint identification, particularly with his method of distinguishing fingerprints that contained similar patterns. The general fingerprint patterns of twins, for example, often appeared the same; but Galton had noticed that fingerprint ridges did not proceed across the fingertips in unbroken lines. They often stopped abruptly, split, contained enclosures, or connected with other ridges. The arrangement of these ridge details were never repeated in a print from two different fingers, not even in twins. Identification of one fingerprint with another, Galton realized, should always be made by comparing their ridge details or fingerprint minutia - known as points of comparison or identification. He used this comparison of ridge detail to confirm Herschel's observations of fingerprint permanence. As a result of his research Galton confirmed that a person's fingerprints would identify him for life and he became sufficiently confident in the method to say that it would indeed form the basis for a reliable system of identification. [16]

Justification for the use of fingerprints:

- Presently, the science of fingerprint identification stands out among all other forensic sciences for many reasons, including the followings:
- The patterns of ridges on our finger pads are unique: no two individuals—even identical twins—have fingerprints that are exactly alike.
- We leave impressions—or prints—of these patterns on everything we touch with any pressure.
- The prints can be visible, as when our fingers are dirty or oily, or they can be latent, as when they are made only by the sweat that is always present on our finger ridges.
- Injuries such as burns or scrapes will not change the ridge structure, that is, when new skin grows in, the same pattern will come back. 16
- Has served all governments worldwide during the past 100 years to provide accurate identification of criminals. No two fingerprints have ever been

found alike in many billions of human and automated computer comparisons. Fingerprints are the very basis for criminal history foundation at every police agency.

- Established the first forensic professional organization, the International Association for Identification (IAI), in 1915.
- Established the first professional certification program for forensic scientists, the IAI's Certified Latent Print Examiner program, in 1977, issuing certification to those meeting stringent criteria and revoking certification for serious errors such as erroneous identifications.
- Remains the most commonly used forensic evidence worldwide - in most jurisdictions fingerprint examination cases match or outnumber all other forensic examination casework combined.
- Continues to expand as the premier method for identifying persons, with tens of thousands of persons added to fingerprint repositories daily in America alone - far outdistancing similar databases in growth.
- Outperforms DNA and all other human identification systems to identify more murderers, rapists and other serious offenders - fingerprints solve ten times more unknown suspect cases than DNA in most jurisdictions.

Fingerprint identification was the first forensic discipline, in 1977, to formally institute a professional certification program for individual experts, including a procedure for decertifying those making errors. Other forensic disciplines later followed suit in establishing certification programs whereby certification could be revoked for error. [10,15]

Fingerprint identification effects far more positive identifications of persons worldwide daily than any other human identification procedure. Some of the discontent over fingerprint evidence may be due to the desire to push the conclusiveness of fingerprint examinations to the same level of certitude as that of DNA analysis. DNA is probability-based inasmuch as an individual is genetically half from the mother's contribution and half from the father's contribution. These genetic contributions are passed down from generation to generation. While pattern type - arch, loops, and whorls - may be inherited, the details of the friction ridges are not. For example, it cannot be concluded that a person inherited a certain bifurcation from their mother and an ending ridge from their father as the development of these features are completely random. Further, fingerprints as an analogy of uniqueness has been widely scientifically accepted. For example, chemists often use the term ‘fingerprint region' to describe an area of a chemical that can be used to identify it. Other criticism sometimes leveled at fingerprint practice is that it is a ‘closed discipline'. However, practitioners in the scientific community are generally specialized and may not extend to other areas of science; in this respect, fingerprint scientists are no different from the rest of the scientific community. The fingerprint community asserts that it maintains the need for objectivity and continued research in the area of friction ridge analysis. [15,16]

ERRORS IN THE USE OF FINGERPRINTS

However, while forensic scientists have long claimed fingerprint evidence is infallible, the widely publicized error that landed an innocent American behind bars as a suspect in the Madrid train bombing alerted the nation to the potential flaws in the system. Now, the Irvine criminologist, Simon Cole has shown that not only do errors occur, but as many as a thousand incorrect fingerprints matches could be made each year in the U.S. Cole's study is the first to analyze all publicly known mistaken fingerprint matches. In analyzing these cases of faulty matches dating from 1920, Cole suggests that the 22 exposed incidents, including eight since 1999, are merely the tip of the iceberg. Despite the publicly acknowledged cases of error, fingerprint examiners have long held that fingerprint identification is ‘infallible', and testified in court that their error rate for matching fingerprints is zero. But rather than blindly insisting there is zero error in fingerprint matching, we should acknowledge the obvious, study the errors openly and find constructive ways to prevent faulty evidence from being used to convict innocent people. Cole's data set represents a small portion of actual fingerprint errors because it includes only those publicly exposed cases of mistaken matches. The majority of the cases discussed in this study were discovered only through extremely fortuitous circumstances, such as a post-conviction DNA test, the intervention of foreign police and even a deadly laboratory accident that led to the re-evaluation of evidence [17] . One highly publicized example is that of Brandon Mayfield, the Portland lawyer who was arrested and held for two weeks as a suspect in the Madrid train bombings in 2004. FBI investigators matched prints at the scene to Mayfield, and an independent examiner verified the match. But Spanish National Police examiners insisted the prints did not match Mayfield and eventually identified another man who matched the prints. The FBI acknowledged the error and Mayfield was released. Wrongful convictions on the basis of faulty evidence are supposed to be prevented by four safeguards: having print identifications verified by additional examiners; ensuring the examiners are competent; requiring a high number of matching points in the ridges before declaring the print a match; and having independent experts examine the prints on behalf of the defendant. However, each of these safeguards failed in cases Cole studied. In fact, in four of the cases, independent experts verified the faulty matches. Despite print examiners' zero-mistake claim, Cole points out that proficiency tests conducted since 1983 show an aggregate error rate of 0.8 percent. Though that may seem small, when multiplied by the large number of cases U.S. crime laboratories processed in 2002, it suggests there could be as many as 1,900 mistaken fingerprint matches made that year alone. While we don't know how many fingerprint errors are caught in the lab and then swept under the rug – or, worse, how many have still not been caught and may have resulted in a wrongful conviction – there's clearly a need for full evaluation of the errors, according to Cole, 'the argument that fingerprints are infallible evidence is simply unacceptable' [18]

Moreover, in spite of the absence of objective standards, scientific validation, and adequate statistical studies, a natural question to ask is how well fingerprint examiners actually perform. Proficiency tests do not validate a procedure per se, but they can provide some insight into error rates. In 1995, the Collaborative Testing Service (CTS) administered a proficiency test that, for the first time, was designed, assembled, and reviewed by the International Association for Identification (IAI). The results were disappointing. Four suspect cards with prints of all ten fingers were provided together with seven latent. Of 156 people taking the test, only 68 (44%) correctly classified all seven latent. Overall, the tests contained a total of 48 incorrect identifications. David Grieve, the editor of the Journal of Forensic Identification, describes the reaction of the forensic community to the results of the CTS test as ranging from 'shock to disbelief,' and added: 'errors of this magnitude within a discipline singularly admired and respected for its touted absolute certainty as an identification process have produced chilling and mind-numbing realities. Thirty-four participants, an incredible 22% of those involved, substituted presumed but false certainty for truth. By any measure, this represents a profile of practice that is unacceptable and thus demands positive action by the entire community. What is striking about these comments is that they do not come from a critic of the fingerprint community, but from the editor of one of its premier publications [16] . However, the reliability of the use of fingerprint in human individualization is not 100% error-free. For instance, Shirley McKie was a police detective in 1997 when she was accused of leaving her thumb print inside a house in Kilmarnock, Scotland where Marion Ross had been murdered. Although detective constable McKie denied having been inside the house, she was arrested in a dawn raid the following year and charged with perjury. The only evidence was the thumb print allegedly found at the murder scene. Two American experts testified on her behalf at her trial in May 1999 and she was found not guilty. The Scottish Criminal Record Office (SCRO) would not admit any error, but Scottish first minister Jack McConnell later said there had been an honest mistake. On February 7, 2006, McKie was awarded £750,000 in compensation from the Scottish Executive and the SCRO. Controversy continues to surround the McKie case with calls for the resignations of Scottish ministers and for either a public or a judicial inquiry into the matter. Also, there was the case of Stephan Cowans, convicted of attempted murder in 1997 after he was accused of the shooting of a police officer while fleeing a robbery in Roxbury, Massachusetts. He was implicated in the crime by the testimony of two witnesses, one of whom was the victim. The other evidence was a fingerprint on a glass mug that the assailant drank water from, and experts testified that the fingerprint belonged to him. He was found guilty and sent to prison with a sentence of 35 years. While in prison he earned money cleaning up biohazards until he could afford to have the evidence tested for DNA. The DNA did not match his, but he had already served six years in prison before he was released [17]

More so, the performance of fingerprint recognition systems is heavily influenced by the quality of fingerprints provided by the user. Image quality analysis is traditionally performed using local and global structures of fingerprint images like ridge flow, analysis of ridge-valley structures, contrast ratios etc. Contact issues can affect the sample provided to the fingerprint sensor when an elderly user presents a fingerprint to the fingerprint device. Due to effect of ageing, the skin becomes drier, the skin sags from loss of collagen, and the skin becomes thinner and loses fat as a direct result of elastin fibers. All of these decrease the firmness of the skin, which affects the ability of the sensor to capture a high quality image. The skin of elderly individuals is likely to have incurred some sort of damage to the skin over life of the individual. Medical conditions like arthritis affect the ability of the user to interact with the fingerprint sensor. All of these factors affect the quality of the sample provided to the fingerprint sensor [19]

RECENT ADVANCEMENTS IN FINGERPRINT DETECTION TECHNOLOGY

As part of the attempts to redeem the taunted image of a discipline hitherto singularly admired and respected for its touted absolute certainty as an identification process, University of California scientists working at Los Alamos National Laboratory have developed a novel method for detecting fingerprints based on the chemical elements present in fingerprint residue [16] . Known as micro-X-ray fluorescence, or MXRF, the technique has the potential to help expand the use of fingerprinting as a forensic investigation tool. [20] In research presented at the 229th national meeting of the American Chemical Society in San Diego, Los Alamos scientist Christopher Worley describes the detection of fingerprints based on elemental composition using micro-X-ray fluorescence showing how the salts, such as sodium chloride and potassium chloride, excreted in sweat are sometimes present in detectable quantities in human fingerprints. MXRF actually detects the sodium, potassium and chlorine elements present in those salts, as well as many other elements, if they are present. The elements are detected as a function of their location on a surface, making it possible to 'see' a fingerprint where the salts have been deposited in the patterns of fingerprints - the lines called friction ridges by forensic scientists [20]

More so, a study by the National Institute of Standards and Technology (NIST) shows that computerized systems that match fingerprints using interoperable minutiae templates, that is, mathematical representations of a fingerprint image can be highly accurate as an alternative to the full fingerprint image. NIST conducted the study, called the Minutiae Interoperability Exchange Test (MINEX), to determine whether fingerprint system vendors could successfully use a recently approved standard for minutiae data rather than images of actual prints as the medium for exchanging data between different fingerprint matching systems. Minutiae templates are a fraction of the size of fingerprint images, require less storage memory and can be transmitted electronically faster than images [21]

For many years, law enforcement agencies have used automated fingerprint matching devices. Increasingly, smart cards, which include biometric information such as fingerprints are being used to improve security. The increased use and the desire to limit storage space needed on these cards had encouraged the use of minutiae rather than full images. Fourteen fingerprint vendors from around the world participated in MINEX. Performance depended largely on how many fingerprints from an individual were being matched. Systems using two index fingers were accurate more than 98 percent of the time. For single-index finger matching, the systems produced more accurate results with images than with standard minutia templates. However, systems using images and two fingers had the highest rates of accuracy, 99.8 percent [21]

In addition to the use of fingerprint for identification, a much broader application of fingerprints now is for personal authentication or verification, which implies a user matching a fingerprint against a single fingerprint associated with the identity that the user claims for instance to access a computer, a network, a bank-machine, a car, or a home [22]

Technology developed for roadside fingerprints using hand-held devices has also been pioneered in identifying the dead. The University of Leicester, working with Leicestershire Constabulary and the Institute of Legal Medicine, University of Hamburg, recorded the first ever use of the technology on the dead over six months ago. The purpose of developing the technique is to enable rapid identification of the deceased and would be of particular benefit in cases of mass fatalities. The researchers made use of a handheld, mobile wireless unit used in conjunction with a Personal Digital Assistant (PDA) device for the capture of fingerprints from the dead. They also used a handheld single digit fingerprint scanner which utilizes a USB laptop connection for the electronic capture of cadaveric fingerprints. According Professor Rutty: 'We believe that, through conversations with our colleagues throughout the fingerprint world and the failure to identify any previous peer reviewed publication, we have demonstrated the first use of a handheld PDA based biometric fingerprinting device for use for fingerprinting the dead' [23]

Moreover, according to a new study by researchers from the University of Michigan in Ann Arbor, new ultrasound fingerprint identification system suggested that diagnostic 3D ultrasound of fingers could be used for biometric identification based on matching paired images using internal fingerprint structures that would be difficult to fake, offering the possibility of a unique automated fingerprint identification system. For the study, 3D images were collected of the fingers of 20 volunteers. A group of four readers, including two musculoskeletal radiologists, then attempted to match the pairs based on anatomic and physiological features of the human finger. Radiologists matching the image pairs were 100% successful, and the average success of all four readers was 96%. The purpose of the study was to evaluate whether the use of internal finger structure as imaged using ultrasound could act as a supplement to standard methods of biometric identification. Also, this study provides a way of assessing physiologic and cardiovascular status, for example, whether the person is alive or not, which is not known from just their external fingerprints [24]

In addition, new 'weapon' in forensics device that detects latent prints on human skin fingerprints that hitherto used to escape detection, could soon be produced. Using a field portable system being developed by Chem Image and Oak Ridge National Laboratory (ORNL), investigators at crime scenes will be able to detect latent prints on human skin. The system takes advantage of surface-enhanced Raman spectroscopy (SERS)-based agents to visualize latent prints. A team led by Linda Lewis of ORNL's Chemical Sciences Division is working with Chem Image to identify fingerprint components that are SERS active, which involves identifying the fingerprint components that give a Raman emission when using a SERS reagent. The ORNL team has identified a novel dielectric nano-wire coated with silver as the SERS agent of choice. [25]

Forensic scientists at the University of Leicester, working with Northamptonshire Police, have announced a major breakthrough in crime detection which could lead to hundreds of cold cases being reopened following the discovery of new technology to identify fingerprints on metal.

The University's Forensic Research Centre has been working with Northamptonshire Police's scientific support unit to develop new ways of taking fingerprints from a crime scene. Researchers in the University Department of Chemistry and the Police's scientific support unit have developed the method that enables scientists to 'visualize fingerprints' even after the print itself has been removed. They conducted a study into the way fingerprints can corrode metal surfaces. The technique can enhance, after firing, a fingerprint that has been deposited on a small calibre metal cartridge case before it is fired. Wiping it down, washing it in hot soapy water makes no difference - and the heat of the shot helps the process. The procedure works by applying an electric charge to a metal - say a gun or bullet - which has been coated in a fine conducting powder, similar to that used in photocopiers. Even if the fingerprint has been washed off, it leaves a slight corrosion on the metal and this attracts the powder when the charge is applied, so showing up a residual fingerprint. The technique works on everything from bullet casings to machine guns. Even if heat vaporizes normal clues, police will still be able to prove who handled a particular gun [26]

Fingerprints can reveal critical evidence, as well as an identity, with the use of a new technology developed at Purdue University that detects trace amounts of explosives, drugs or other materials left behind in the prints. The new technology also can distinguish between overlapping fingerprints left by different individuals - a difficult task for current optical forensic methods.

Some of the residues left behind are from naturally occurring compounds in the skin and some are from other surfaces or materials a person has touched. Because the distribution of compounds found in each fingerprint can be unique, this technology can be used to pull one fingerprint out from beneath layers of other fingerprints. By looking for compounds known to be present in a certain fingerprint, it is possible to separate it from the others and obtain a crystal clear image of that fingerprint. The image could then be used with fingerprint recognition software to identify an individual [26]

Fingerprinting has long been used as a method for identifying bodies and, since first discovered, many advances have been made in both fingerprint acquisition and interpretation. However, in the field of forensic pathology, the attainment of fingerprints from mummified bodies has remained difficult. The most common technique historically used to obtain fingerprints in these cases usually employs the amputation of the fingers combined with soaking and/or injecting the fingers with various solutions in order to enhance the fingerprints. A novel approach to fingerprinting mummified fingers involves removal and rehydration of the fingerpads (including the epidermal, dermal, and adipose tissues) followed by inking and rolling, using a gloved finger for support. The technique produces a superior quality of print without amputation of the finger, yielding excellent results and assisting in obtaining positive identification [27]

During its 18-year history, the original intent of the

Automated Fingerprint Identification System (AFIS) Program was to provide a database of fingerprints to solve crimes. AFIS employees learned early on that the capture of quality fingerprints is integral to a successful database. As such, the AFIS Program has grown to prioritize the collection of quality fingerprints. Paramount to the mission is the rapid identification of persons arrested, booked or adjudicated for adult and juvenile offenses. With advances in technology, the future holds great promise for more sophisticated integration of this technique and its applications to other local, state and national criminal justice systems [28]

In conclusion, with such series of new scientific and technological breakthroughs in the evaluation of fingerprint, it would soon be possible to regain and retain its prime ranking as the only yet available and most reliable natural mark of identification.

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