

NEW TECHNIQUES FOR RAISING AND IDENTIFICATION OF FINGERPRINTS

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Abstract

Forensic experts have discovered recently new techniques for identifying fingerprints. New methods may now be used to identify hidden fingerprints, digital impressions found on metals. Now fingerprints can be mathematically described by a new model. Sexual offenders can be easier identified. Analyzing fingerprints drugs and diseases antibodies could be detected. By using light sources a better fingerprinting could be obtained. Analyzing fingerprints it can be established if a suspect has been in contact with chemicals such as drugs and explosives.

Keywords: *New forensic techniques; fingerprints; drugs; diseases; criminality; researchers; trace; fingerprinting; fingerprints mathematically model; explosives; desorption by electrospray ionisation*

Introduction

„There can be no crime without a trace. Homicide is based on the fact that an offender, most often without his knowledge, leaves always traces at the scene”¹⁾.

Edmond Locard formulated the basic principle of forensic science: “Every individual who moves into an environment leaves traces”²⁾.

Broadly, crime trace means „the most varied changes that may occur in the environment as a result of criminal actions”³⁾.

In a narrow sense, crime trace means „traces formed by reproducing the exterior construction of an object on another object”⁴⁾.

In a comprehensive definition, crime trace means „any material changes occurred because of the interaction between offender, the means used by the parts of an environment where their criminal activity took place, changes which, individually or fully examined, may lead to: scene setting, identification of the perpetrator, the means used to clarify the circumstances of the case”⁵⁾.

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¹⁾ P. F. Ceccaldi, *Forensics*, Press Universitaires de France Publishing House, Paris, 1962, p. 6.

²⁾ http://en.wikipedia.org/wiki/Edmond_Locard.

³⁾ S. A. Golunski, *Forensics*, Științifică Publishing House, Bucharest, 1961, p.82.

⁴⁾ C. Suciu, *Forensics*, Didactică și Pedagogică Publishing House, Bucharest, 1972, p.200.

⁵⁾ Gh. Pășescu, *Treaty of Forensic Practice*, Ministry of Interior Publishing House, Bucharest, vol. I, 1976, p.117-118.

Crime trace means any material change occurred in terms of committing a criminal act between the deed and the change produced being a causal link”⁶⁾.

Regarding traces classification, Edmond Locard distinguished „prints (digital, tangible, clothing, animals, etc.) and traces (objects left by the offender, burglary tools, hair etc.)”⁷⁾.

French forensics offers a modern classification of traces, respectively indeterminate traces (which may have chemical nature, biological or non-biological but do not indicate the author) and determined traces which have physical nature, produced by pressing, rubbing or pulling, allowing the identification”.

The forensic chapter dealing with the forensic examination and classification of papillary relief, and after that the identification of its details is called dactiloscopia⁸⁾.

Finger traces found at the scene are called fingerprints, those taken are called experimental digital impressions and photos papillary relief obtained by photographing the traces and impressions are called dactilogramme⁹⁾, which otherwise are the object of study in forensic identification process¹⁰⁾.

Human traces refer to: „the changes created by hands, feet, forehead, nose, lips, ears, and biological traces of human blood, saliva, hair, semen”¹¹⁾.

Fingerprints have a crucial role in criminal investigations. They are most commonly used as forensic evidence worldwide because a person's fingerprints are unique. Even for identical twins, who share the same DNA, no fingerprints were identical and they do not change throughout the whole life. Papillary traces can be collected on the spot or on different objects - sample spot and identify potential suspects, victims and others who have reached the area concerned, to make the connection between certain crimes or to place the suspect at the crime scene.

Papillary drawings are distinguished by shape and characteristic details, whose number and variety are not to be possible meeting of two identical digital impressions¹²⁾.

Francis Galton concluded that only a total of 64 billion digital impressions might meet two perfectly identical ones¹³⁾.

⁶⁾ E. Stancu, *Forensic Treaty*, Actami Publishing House, Bucharest, 2001, p.114-115.

⁷⁾ E. Locard, *Forensic Treaty. Fingerprints and traces in investigations inquiries*, Desvigne Publishing House, Lyon, 1931, vol. I, p. 9.

⁸⁾ M. Minovici, *Full Forensics Treaty*, vol. II, Bucharest, 1930, p.1039-1041.

⁹⁾ V. Sava, *Manual of Dactiloscopia*, Bucharest, 1943, p.35.

¹⁰⁾ I. Mircea, *Forensics*, 2nd edition, Printing House of „Chemarea” Foundation Iași, 1994, p.72.

¹¹⁾ L. Ionescu, *Forensics. Course Notes*, Dimitrie Cantemir Christian University, 2002, Bucharest, p.27-34.

¹²⁾ L. Cârjan, *Forensics*, Pinguin Book Publishing House, Bucharest, 2005, p. 188.

¹³⁾ F. Galton, *Finger-Prints*, McMillan Publishing House, London, 1892, p.109.

Findings confirmed mathematical calculations related to dactiloscopia. Although this method of identification is almost ten decades of police enforcement in all civilized countries, so far there have not been reported any likeness between two digital impressions¹⁴⁾.

Digital design remain immutable from birth until the time when, by putrefaction skin decays. If the overall dimensions of the body and its parts and declines over time according to different influences, while skin and hair color, facial expressions, features, gestures and even writing change with age, just digital impressions remain constant and identical to themselves.

This property should not be considered in a fixist way because it cannot be exceeded the probability of changes that are not able to cause a qualitative difference between papillary drawings of the same person¹⁵⁾.

There are three general groups of methods used to make visible traces of latent papillary respectively: physical methods, chemical methods and instrumental methods.

Digital footprints can be of surface and deep. Trail surface may be, in turn, visible and invisible (latent).

Traces, which are also called colored, are left by fingers contaminated with colored substances such as blood, paint, ink, mud, dust, cement, soot, chalk, ink, etc.

In some cases, colorful digital traces left on objects not in perfect conditions retained design features papillary stain is simple, because of the substance soaking ditches separating the papillary ridges.

Papillary invisible traces (also called latent) are those ones obtained by filling remain human sweat and grease from the skin, the effect of touching with hand or plant, voluntarily or involuntarily, of certain objects.

The means and invisible traces are as well the ones that are visible to some extent, but to be properly considered to be revealed.

Traces remain in print papillary depth profile of papillary ridges in various plastics.

Digital footprints are searched very carefully because they are small, sometimes reproducing only fragments of the drawings papillary which could be barely seen. When searching for traces extreme caution is needed in order not to leave their traces or inadvertently, to remove those that are delinquent¹⁶⁾.

In recent years, scientists have discovered a number of new techniques for raising and then identifying fingerprints.

¹⁴⁾ L. Cârjan, Cited Book, p. 189.

¹⁵⁾ J. I. Thornton, *The doctrine of dissimilation of the unique identification dactiloscopique*, R.I.P.C., nr. 306, martie, 1977, p. 89.

¹⁶⁾ Gh. Pășescu, Ion. R. Constantin, *Fingerprints secrets*, Național Publishing House, Bucharest, 1996, p.139-142.

A. New fingerprint breakthrough by forensic scientists

University of Leicester and Northamptonshire Police research reveals new techniques for identifying prints on metals¹⁷⁾.

The new method will allow forensic specialists to visualize fingerprints even after they have been raised on the spot.

Even more interesting is that this new technique using a fingerprint that was stored on a small metal tube before firing cartridge may even increase after the drawdown¹⁸⁾.

The research group leader, dr. John Bond, said: „For the first time there can be obtained fingerprints from people who have manipulated the cartridge before it is fired”¹⁹⁾.

This discovery allows specialists to reopen old criminal cases even decades.

The researchers have also found that fingerprints can corrode metal surfaces.

Delete, washing with warm soapy water makes no difference to the heat and percussion cartridge facilitates this new forensic identification process.

The new technique discovered works by applying an electrical charge on a metal, such as a gun or cartridge case which has been in contact with a powder similar to that used photo copiers²⁰⁾.

Even if the fingerprint has been washed, it leaves a slight corrosion metal and powder draws the load is applied, thus removing a fingerprint record that this new method can be raised in good conditions.

The technique described can be used on any metal pipe from a box of cartridges to guns.

The heat evaporates normal clues, but police will be able to prove who handled a particular gun.

Experts say that using this method, even after decades, old criminal cases can be reopened, because fingerprints do not disappear again. The new technique also works in cases where traces could be left on other types of metals²¹⁾.

According to dr. Bond, the only way to avoid being identified as a result of digital traces to be cleaned with an abrasive object, causing the removal of a layer of that metal²²⁾.

This research has demonstrated the ease with which created the possibility that the eccrine rich fingerprints to corrode over a wide range of metal surfaces, including alloys. Corrosion process depends on the chemical concentration of chloride ions present in eccrine sweat²³⁾.

¹⁷⁾ http://www.eurekalert.org/pub_releases/2008-06/uol-nfb060208.php.

¹⁸⁾ <http://www.northants.police.uk>.

¹⁹⁾ <http://www.thisisleicestershire.co.uk/news/police-plea-Leicester-fingerprint-expert/article-1931650-detail/article.html>.

²⁰⁾ <http://www.le.ac.uk/forensic-research/>.

²¹⁾ <http://www.blackwellpublishing.com/jfo>.

²²⁾ <http://www.le.ac.uk/forensic/research/drjohnbondfellow.html>.

²³⁾ http://crime.about.com/od/forensics/a/metal_prints.htm.

Water makes up over 99% of the digital prints. Water content of the fingerprint residues acts as an electrolyte and allows galvanic corrosion to take place on the outer surface of the metal.

Corrosion of metal surface was analyzed by using these innovative forensic techniques²⁴⁾.

For this reason the metal surface to be loaded with up to 2,500 KV electricity to be used as a granular powder.

Although this new technique is being patented, has already been used to demonstrate that it is one viable solution to the extremely difficult problem of increasing the fingerprint placed in the cartridge shell fire before execution.

This technique was published in the journal Forensic Science, titled „View of latent fingerprints on metallic surfaces”,²⁵⁾.

Experts have studied the chemical reactions produced between fingerprints and a variety of metal surfaces investigated by heating the metals to a temperature of 600° C after the submission of fingerprints. Ionic salts present in fingerprints corrode metal surfaces and provides a fingerprint image that is durable and resistant to cleaning metal²⁶⁾.

Zoom level fingerprint is independent by the time that has elapsed between the fingerprint storage and heating but it depends very much on the metal composition and salt secretion level of the person who left the fingerprint.

The results obtained so far allow practical applications to enhance fingerprints that are spot fires, contaminated by spray paint or deposited on brass cartridge tubes before running fire²⁷⁾.

Corrosion of metal surface is further used to perform fingerprint increase the electrostatic charge on the metal and then metal dust adhesion to the surfaces corroded metal parts.

Due to lack of evidence, crime produced 15 years ago, for example, could not be elucidated.

U.S. Police have called the support team of researchers and positive results did not appear immediately.

Last year, dr. Bond has helped rising and then identifying a fingerprint on a cartridge case which had been lifted from the spot where a murder committed in Texas, U.S.A. The fingerprint is very good and the only remaining issue to be determined is to identify the person to whom it belongs²⁸⁾.

²⁴⁾ <http://www.moreinspiration.com/Innovation.aspx?id=3544>.

²⁵⁾ <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1556-4029.2008.00738.x>.

²⁶⁾ <http://www.mcs.le.ac.uk>.

²⁷⁾ [http://onlinelibrary.wiley.com/journal/10.1111/\(ISSN\)1556-4029](http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1556-4029).

²⁸⁾ <http://www.amw.com/fugitives/brief.cfm?id=59727>.

B. New technique to help catch sexual offenders

Experts from Sheffield Hallam University have discovered a new technique that can be used to identify sexual offenders. Sexual offenders hoping to fool the police using a condom during the commission of crimes can be deprived of the chance to escape unpunished thanks to a new technique performed by specialists from Sheffield Hallam University, who can prove that they have had contact with a condom and it can place it to place where the crime has been committed²⁹⁾.

Due to the risk of transmission of sexually transmitted diseases and to prevent transfer of DNA evidence in recent years an increase in condom use by sexual offenders from the system has been observed.

The method discovered by researchers at the University Center for Biomedical Research referred allow lifting and fingerprint identification of condom lubricant left on the spot by the suspect.

This new technique can make the link between a suspect, identified by fingerprints, and crime. Thus, police may have helped to establish and if the crime occurred. It is hoped that this method can be used to link the fingerprint and grease residues identified from vaginal swabs collected from the victim³⁰⁾.

Researchers have successfully detected for the first time fingerprint oils from two brands of condoms widely available and this innovative method has proven to be successful even for fingerprints that were not collected several weeks before analysis.

Experts hope that this technique can be used to identify certain types of grease, being able to indicate a specific manufacturer or even a particular brand condom. This would allow any forensic case to have a greater role to prove whether the acts were committed or not.

For this study, researchers used MSI MALDI (matrix-assisted laser desorption / ionization mass spectrometry imaging), a powerful technology that can be used to map the ridge patterns of fingerprints³¹⁾.

Dr. Simona Francese, from the same university, said: „Criminals are increasingly aware of the consequences of acts committed, and discovered techniques to prove them. However, the sexual offenders do not take into account the possibility that the condom lubricant can transfer fingerprints left at the scene“³²⁾.



²⁹⁾ Article published on 19.01.2011 in the magazine of Hallam University from Sheffield Great Britain, retrieved electronically on <http://www.shu.ac.uk/news/release.html?ID=765>.

³⁰⁾ <http://www.medical-valley-enn.de/services/news/global?page=142>.

³¹⁾ <http://www.skdb.info/>.

³²⁾ <http://www.sciencedaily.com/releases/2011/01/110119132517.htm>.

Dr. Rosalind Wolstenholme, co-author of the research, said: „If the condom lubricants fingerprints can be identified, it would improve the evidence needed for criminal prosecution as may be established with the author on the spot and very importantly, he had contact with a condom. This would allow specialists to provide additional support for the collection of evidence necessary to solve cases of alleged sexual assault”³³⁾.

C. Identifying hidden fingerprints

Hidden fingerprints can now be revealed quickly and reliably thanks to two new discoveries in nanotechnology³⁴⁾.

Currently, the method used for fingerprint detection coverage area requires an aqueous suspension of gold nanoparticles and citrate ions. In acidic conditions, gold particles positively charge particles placed in print. Then print is developed using a solution of silver ions, which react chemically to give a form of silver along the ridges of the print³⁵⁾.

However, the solution used by this method is unstable, and the results are difficult to be repeated. Therefore, Dr. Daniel Mandler, Ph.D. Joseph Almog and their team at the Hebrew University of Jerusalem, Israel, used a more stable solution by adding hydrocarbon chains of gold nanoparticles, which were suspended in light oil³⁶⁾.

Impressions produced using the new solutions have a very high quality, being obtained after only three minutes of immersion.

The team used this technique on non-porous surfaces, using a petrol ether suspension of cadmium selenide / zinc sulfide. In this case, by the chemical reaction fluorescent impressions have been obtained, so there is still necessary a further step.

Antonio Cantu, an expert in forensic science for the United States Secret Service in Washington, said, „These revolutionary techniques are able to greatly improve their saving and transforming latent impressions in the evidence”³⁷⁾.

Dr. Claude Roux, director of the Center for Forensic Science at the University of Technology Sydney, Australia, said: „This new nanotechnology using method can bring fingerprints to identify practical solutions to develop and enhance latent fingerprints, which would otherwise remain undetected”³⁸⁾.

³³⁾ <http://www.alphagalileo.org/ViewItem.aspx?ItemId=93971&CultureCode=en>.

³⁴⁾ <http://www.sciencedaily.com/releases/2007/03/070315132718.htm>.

³⁵⁾ <http://www.rsc.org/publishing/journals/cc/article.asp>.

³⁶⁾ M. Halon, *Nanotechnology enables to obtain much better fingerprints*, article retrieved electronically on <http://www.gizmag.com/go/6996/>.

³⁷⁾ http://www.nap.edu/openbook.php?record_id=11276&page=6.

³⁸⁾ <http://projects.nfstc.org/trace/index2007.htm>.

D. New techniques for identifying crime discovered by specialists in U.S.A.: Fingerprint analyses using the process of desorption by electrospray ionisation (DESI)³⁹⁾

Current methods allows analysis of forensic analysis to identify the fingerprints only.

A new technique, identified by U.S. experts and completed in August 2008, allows forensic experts to determine, by analyzing fingerprints, the chemical components which make up fingerprints. By analyzing them, it can be determined whether a suspect has been in contact with chemicals such as drugs or explosives⁴⁰⁾.

Fingerprints can now be used to detect traces of drugs or explosives, as it has been proved recently in one of the most important discoveries in recent years of forensics. The new discovery enables American experts to say much more about people: what they have achieved, what they ate, what drugs they were used⁴¹⁾.

Additional information is of great importance in cases where it is necessary to make a connection between a person and certain types of chemicals such as toxins or explosives. Currently, scientists can determine not only who is an individual, but also the substance used.

Police is now able to analyze fingerprint traces of cannabis, cocaine, other drugs or explosives.

The new technique reveals in detail the chemical components that make up the fingerprint. Now small traces of chemical components of different fingerprints types may indicate the presence of diseases or ailments.

This method can be used directly on a fingerprint, even where the mark is found, without the need for lifting and analysis in a laboratory.

Dr. Demian Ifa, Professor Graham Cooks, along with colleagues at Purdue University in West Lafayette, U.S.A. explained how they had discovered a technique, called desorbtion by electrospray ionization (DESI), which involves spraying a solvent onto a surface that is a fingerprint and then analyzing the droplets resulting from the release print with a method called mass spectroscopy.

This method could be used to establish if a person handled cocaine, explosives or other materials which can be identified through a fingerprint analysis.

³⁹⁾ S. Gîfei, *New techniques for identifying crime discovered by specialists in the U.S.A.: fingerprint analysis by using the process of desorbtion by electrospray ionisation (DESI)*, Law Magazine, The Romanian Association of Jurists, nr. 1/2009, C.H. Beck Publishing House, Bucharest, 2009, p. 171-173.

⁴⁰⁾ Press Agency Xinhua, *New techniques of establishing fingerprint chemical components*, article identified electronically on http://www.news.xinhuanet.com/english/2008-08/08/content_9041951.htm.

⁴¹⁾ D. Castelvechi, *Advanced technology for analyzing fingerprints*, article identified electronically on http://www.sciencenews.org/view/generic/id/35012/title/Fingerprints_go_high-tech.

The new technique relies on a device called mass spectrometer, which uses electric and magnetic fields to analyze chemical compounds in order to identify a sample of the material contained in a fingerprint⁴²⁾.

According to dr. Cooks, this technique provides a „picture of the chemical fingerprint”, with a higher resolution than those offered by any other forensic techniques and can analyze a particle size which may be even a nanogram of material.

The classic example of a fingerprint, which is a printing ink, show deltas and loops used for identification, but analyzing fingerprints lifted from the field may show a distribution of molecular components. Fingerprint is made up of natural components of skin, and some of them are taken from other areas or materials that a person has achieved.

Researchers can detect very small traces of chemical compounds marked with dots on the footprint analysis, which represents the type of digital fingerprint left by the person concerned.

This technique can help to raise small amounts of drugs (such as cocaine or THC⁴³⁾, the active ingredient derived from marijuana, and the rise of compounds obtained from explosives).

Researchers have also established that this method is useful for identifying compounds produced by metabolism or components can be identified in the secretions of fingerprints, whose presence may signal other processes that occur inside the human body.

Also, fingerprints can be analyzed using a standard software system to attempt to identify the person and to determine whether fingerprints obtained do not overlap with others.

Due to the fact that the distribution of compounds identified in each fingerprint can be unique, this technique can be used to extract a fingerprint beneath layers of other fingerprints.

Visualizing chemical compounds in this way, scientists can effectively analyze fingerprints, they can separate from each other and can get a clear picture of each fingerprint. Images can then be used on a fingerprint recognition software in identifying the person⁴⁴⁾.

The team of American researchers is now studying whether this technique could be used as an alternative to blood or urine tests performed for athletes⁴⁵⁾.

⁴²⁾ E. K. Gardner, *Fingerprints can provide solutions not only for establishing the identity of persons*, article retrieved electronically on <http://www.purdue.edu/UNS/x/2008/b/080807CooksFingerprints.html>.

⁴³⁾ T.H.C. is a chemical compound, C₂₁H₃₀O₂, obtained from cannabis or made synthetically, which is the basic narcotic in marijuana and hashish.

⁴⁴⁾ R. Highfield, *A new method of analysis helps police D.N.A. investigations*, article identified electronically on <http://www.telegraph.co.uk/earth/main.jhtml?xml=/earth/2008/08/07/sciprints107.xml>.

⁴⁵⁾ *A new method for analysis of fingerprints can identify drugs and explosives*, article identified electronically on <http://www.drugs-forum.co.uk/forum/showthread.php?t=65159>.

Debbie Krantz, a spokesman of Thermo Fisher Scientific Inc. said: „The unit which made these devices, found that a mass spectrometer similar to that used by American researchers will cost about 350,000\$, compared to standard techniques used today, which cost less than 100\$⁴⁶⁾.

New method of testing may be available in a year or two, but the process is more expensive and lasts longer than the current procedure for analyzing fingerprints, so to use the new technique of law enforcement agencies need much greater financial resources.

E. Antibody tests on fingerprints to detect drugs and diseases

Currently, fingerprints are used only when the author has to be taken against a measure or a person must be identified. Scientists in Great Britain have conducted a research aiming at making possible to use fingerprints for drug discovery and disease diagnosis⁴⁷⁾.

The team of researchers from the University of East Norwich and King's College London were able to use specific antibodies to differentiate between the fingerprints of smokers and nonsmokers⁴⁸⁾.

Forensic fingerprints are useful only when included in a database or can be directly compared with those of a suspect.

Because of this new discovery, we now have the opportunity to obtain information about the lifestyle of the person who left fingerprints, which could reduce the circle of suspects.

Therefore, fingerprints are now used to detect drugs, medicines, foods that were consumed and also to diagnose certain diseases.

Researchers want to combine all these secrets to be found in small traces of perspiration that leaves an imprint on a surface. The research team demonstrated the ease of the above, making a distinction between fingerprints made by smokers and nonsmokers. To obtain correct results, researchers have developed a system to detect cotinine, formed in the human body after consumption of nicotine.

The researchers soaked fingerprints with a solution containing gold nanoparticles to which cotinine-specific antibodies were attached. It binds to cotinine. Then a secondary antibody, which was applied a fluorescent dye binds to cotinine antibodies, which are placed on a fingerprint. Since there are many cotinine antibodies attached to each nanosphere, there is a significant leverage.

It was found that the fingerprints of smokers reveal fluorescent ridge patterns, and not those of non-smokers.

⁴⁶⁾ *New combined services*, article identified electronically on <http://www.newsday.com/services/newspaper/printedition/friday/health/ny-hsfore085793112aug08,0,411405.story>.

⁴⁷⁾ <http://www.sciencedaily.com/releases/2007/05/070516123538.htm>.

⁴⁸⁾ <http://www.kcl.ac.uk/index.aspx>.

Fingerprints are easily treated and can be lifted for comparison with known impressions, just as with normal procedures. When this process is amplified, even when sweating highlighted by tiny pores that run along the finger ridges are visible.

In addition to forensic applications, this method is used to detect doping. Changes in the subjects tested samples would be very difficult, because each sample is unique and each person is assigned based on the model examined the ridge.

Another application of this new method could be to identify drugs, without taking blood samples from drivers such suspects.

F. Fingerprinting by using light sources allows a better control of crime

Researchers in Great Britain have discovered a fast way of fingerprinting for improving the collection and analysis of fingerprints found at the scene⁴⁹⁾.

Standard methods used to collect fingerprints found at the scene, such as powders, amend valuable forensic clues, including traces of chemicals which may be digital impressions. In the new study, Sergei G. Kazarian at Imperial College London and colleagues used a special gelatin tape to collect fingerprints from several different areas, including a door handle, handle a cup, a glass surface bent and a computer screen. They exposed the imprinted gels to a highly sensitive instrument using a beam of light in the infrared detector array to obtain digital fingerprint images collected.

This method has revealed valuable information about the chemical composition of impressions, providing information about individuals who have made (for example smoker, vegetarian) and the presence of contaminants in impressions. This may be offered clues about what the suspects were manipulated (for example food, drugs) and therefore could be useful in identifying an offender. In addition, new methods using the original fingerprint can be kept intact and are available for further analysis⁵⁰⁾.

G. Fingerprints, described by a new mathematical model

Vladimir Goudkov, from Chelyabinsk State University, Department of Applied Mathematics and Computer Science, Russia, proposed an innovation that can be applied globally, according to his new mathematical model representation of fingerprints⁵¹⁾.

The discovery is protected by no less than 16 patents, which have received approval from the Russian Federal Institute of Industrial Property and the Russian Federal Department responsible for intellectual property.

⁴⁹⁾ <http://pubs.acs.org/doi/full/10.1021/ac070580j>.

⁵⁰⁾ <http://www2.imperial.ac.uk/imedia/videos/view/186/professor-sergei-kazarian>.

⁵¹⁾ <http://www.ziare.com/magazin/cercetare/amprentele-digitale-descrie-de-un-nou-model-matematic-1052197>.

The paper is in fact the author's doctoral thesis entitled "Mathematical models and methods of typing digital imaging".

The novelty of this work is that the author has built a trace analysis system based on topological vector.

The system automatically reads a fingerprint image, not as a mere image, but as a relief map with a certain orientation.

This method allows identifying and fingerprinting of poor quality, with traces of fat, deformed, or with various defects.

The mathematical model proposed is based on software whose use requires only a computer, a digital fingerprint sensor and a database of fingerprint images. Models, programs and methods developed can be used in the passports and visa systems, where control systems and systems of movement and access.

Conclusions

New methods of identifying and lifting fingerprints can now be used to identify hidden fingerprints, a digital impressions found on metals, to identify the treatment of sexual offenders. Thanks to the new techniques used antibodies can be analyzed to detect fingerprints on drugs and diseases. Fingerprints can now be described by a new mathematical model. If used, light sources can make a better fingerprint impression. Analyzing fingerprints it can be established if a person dealt with chemicals such as drugs and explosives.

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