

Research Peculiarities of Sebaceous Traces of Palms and Fingers Using the Projectina Docustat DS-210 device

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Characteristic features of technological research on palm and finger prints are defined and described in detail. Considerable attention has been paid to methodical approach development that enables forensic research to be carried out without harming integrity of the paper medium on which invisible prints are left. The opinion that use of Projectina Docustat DS-210 and Regula 4305 devices (in the case of applying the principle of gradual combination) provides an opportunity to prepare at least preliminary conclusions regarding identification of belonging (non-belonging) of invisible fat traces to the same person. Attention is focused on the possible solution of forensic tasks (during the next stages of the investigation) regarding identification of the chemical composition of substances in fat traces, that makes possible to determine whether the suspect was in contact with material evidence in the case (for example, with weapons, drugs etc.). The research purpose is to formulate certain preliminary conclusions before further conducting objective fingerprinting examination itself, as well as to ensure the integrity of the source document by applying a methodical approach developed in “National Bureau of Expertises” State Non-Profit Organization of the National Academy of Sciences of the Republic of Armenia that

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will help forensic expert to more accurately identify belonging (non-belonging) of invisible fat traces to the same person.

Keywords: *fingerprinting; invisible imprints; fat traces; instrumental method; person identification ; document integrity; principle of post-reliable combination; analytical devices Projectina Docustat DS-210 and Regula 4305.*

Research Problem Formulation

Modern forensic science is characterized by a high level of theoretical knowledge and progress use for investigation of crimes and justice administration. Among the various branches of forensic technology, fingerprinting occupies the most important place. It makes it possible to reliably establish a person behind the marks of the palms or fingers, that ensures the proper quality of the pre-trial investigation.

Fingerprint identification is the most common type of specific research. Unfortunately (due to the lack of a law on forensic expert activity), it is still premature to discuss creation of state registers of forensic experts and methods in the Republic of Armenia, however, while its formation, we consider it possible to use some of the provisions set forth in Art. 23 "State Register of Forensic Experts" of the Model Law "On Forensic Expert Activity" ¹. According to the Artur Davtyan's statement, Prosecutor General of the Republic of

Armenia dated September 25, 2019 in Yerevan at international conference: *Actual issues of forensic science, modern problems of forensic expertise and criminology, trends and prospects of development*, the improvement of the legislation regulating this field, in particular, through the adoption and application of the law on the activity of forensic examination in the state and relevant by-laws ². For example, in Ukraine, Instruction on appointment and conducting forensic examinations and researches resolves a number of identification (in particular, the issue of identification of a person by fingerprints left at the scene) and non-identification tasks related to the determination of mechanism of trace formation and some other characteristics of trace-forming object ³.

In foreign countries, in addition to the improvement of certain techniques for detecting and extracting fingerprints, specialists are constantly replenishing fingerprint collections and improving automatic fingerprint identification

- 1 Модельный Закон «О судебно-экспертной деятельности» : прил. к постановлен. Межпарламент. Ассамбл. гос-в — участн. СНГ от 19.04.2019 г. № 49-8. URL: <http://www.parliament.am/library/modelayin%20orenqner/377.pdf> (date accessed: 22.02.2022).
- 2 Speech by the RA Prosecutor General Artur Davtyan in Yerevan on 25.09.2019 in the International Conference on «Current Issues of Forensic Expertise and Criminology, Trends and Prospects for Development» / The Prosecutor General's Office the RA : website. URL : <https://www.prosecutor.am/en/mo/7562/> (date accessed: 19.06.2022).
- 3 Про затвердження Інструкції про призначення та проведення судових експертиз та експертних досліджень та Науково-методичних рекомендацій з питань підготовки та призначення судових експертиз та експертних досліджень : наказ Мін'юсту України від 08.01.1998 р. № 53/5 (зі змін. та допов.). URL: <https://zakon.rada.gov.ua/laws/show/z0705-98> (date accessed: 21.02.2022).

systems. For example, in Germany there is an innovative high-tech EVISCAN workstation, with the help of which experts detect and store invisible and barely visible fingerprints in digital format. The device works without contact and without any chemicals. In this case, the fingerprints remain in their original state and, if necessary, they can be re-examined some time later⁴. In the US, there is a new contactless system that allows you to take fingerprints under special SLI (Structured Light Illumination) lighting conditions. Unlike EVISCAN, skin oiliness or air humidity do not affect SLI technology in any way. This system is actively used by the FBI in its activities: when inspecting the scene, agents use a special wireless scanner that immediately sends detected samples to the central laboratory for verification⁵.

Implementation of the latest automated fingerprint record keeping technologies into the activities of law enforcement agencies is one of the most urgent and promising tasks. Recently, there has been active development in the field of automated fingerprint recognition. The use of computer search systems based on accumulated fingerprint databases will significantly increase efficiency of the work of forensic experts. Taking into account foreign experience, automated fingerprint information and search system

should meet the following requirements: first of all, it is the ability to work with significant volumes of information, ability to process traces and fingerprint maps of average quality, the opportunity to freely exchange information in digital form using modem communication, and the simplicity of processing of fingerprint information, ability to obtain statistical information both on the identifying data of persons and traces and on quantity and quality of entered fingerprint information, ability to form search requests according to the proposed parameters (date, place, method of committing the crime)⁶.

Therefore, the problem of collecting, researching and using fingerprint information while investigation of crimes necessitates development of scientific and legal bases for the activities of pre-trial investigation bodies, forensic science institutions, improvement of means and methods of working with such information. In order to achieve the appropriate level of implementation of the latest fingerprint and other identification technologies, law enforcement agencies need to immediately take appropriate measures for material and technical support, monitoring of new scientific developments training and exchange of practical experience with specialists of law enforcement agencies of European Union and the United States⁷.

- 4 Лапта С. П. Перспективні напрями розвитку дактилоскопії в зарубіжних країнах. *Вісник Харківського національного університету внутрішніх справ*. 2017. № 3 (78). С. 59–66. URL: <http://dspace.univd.edu.ua/xmlui/handle/123456789/2532> (date accessed: 27.02.2022).
- 5 Рогатюк І. В. Напрями удосконалення використання дактилоскопічної інформації в діяльності органів досудового розслідування та прокуратури. *Часопис Київського університету права*. 2014. № 1. С. 292–296. URL: http://nbuv.gov.ua/UJRN/Chkup_2014_1_69 (date accessed: 27.02.2022).
- 6 Хахановський В. Г. Автоматизація експертних дактилоскопічних досліджень. *Форум права*. 2011. № 1. С. 1078–1084. URL: http://nbuv.gov.ua/UJRN/FP_index.htm_2011_1_174 (date accessed: 27.02.2022).
- 7 Членов М. В., Журба О. М. Міжнародний досвід та перспективи розвитку дактилоскопічних технік під час розслідування злочинів. *Актуальні питання судової експертизи і криміналістики* : зб. мат-лів міжнарод. наук.-практ. конф., присвяч. 150-річ. з дня народж. Засл. проф. М. С. Бокаріуса (Харків, 18–19.04.2019). Харків, 2019. С. 254–255.

Currently, in the case of development and addition of forensic researches with new methodological tools, there is inevitably a need to solve a whole series of diagnostic tasks and to find new identification signs that is impossible without development of original instrumental solutions, which, preferably, do not have to cause damage or significant changes to physical evidence⁸. In contrast to typical methods designed to solve the same type of forensic expert tasks (for example, fingerprint identification of a person who left traces at the scene), new informative and reliable methods, which were developed using modern instrumental methods of research and which make it possible to expand limits of detection of qualitative and quantitative characteristics of the objects under research, now is an actual and demanded request by forensic expert community, designed to ensure effective practical activity of forensic expert⁹.

Article purpose

For formulating certain preliminary conclusions before next conducting of the subject fingerprint examination itself, to ensure the integrity of the source document by applying the methodological approach developed in the “National Bureau of Expertises” State Non-Profit Organization of the National Academy of Sciences of the Republic of Armenia (NBE — SNPO) (hereinafter referred to as National Bureau of Expertises SNPO NAS RA) that will allow forensic expert to identify with high accuracy belonging / non-conformity of invisible fat traces to the same person.

As part of researches previously started at “National Bureau of Expertises” SNPO NAS RA concerning combined approach to research of invisible traces of a biological nature (sebaceous secretions), as well as pollution combined with palm and finger prints, this article presents the obtained experimental results based on research

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- 8 Фоминых И. С. Судебная дактилоскопия : учеб. пособ. Томск, 2010. 128 с. ; Корноухов В. Е., Ярослав Ю. Ю., Яровенко Т. В. Дактилоскопическая экспертиза: современное состояние и перспективы развития : моногр. Москва, 2011. 320 с. ; Шведова О. В. Дактилоскопічні дослідження : навч. посіб. Київ, 2010. 208 с. ; Щербаковський М. Г. Проведення та використання судових експертиз у кримінальному провадженні : монографія. Харків, 2015. 560 с. та ін.
- 9 The Science of Fingerprints: Classification and Uses / by Federal Bureau of Investigation (Author). Empire Books, 2011. 298 p. ; Barnes J. G., Maceo A. V., Wertheim K., Sr. Cutro B. T., Hutchins L. A., Moses K. R., Yamashita B., French M., Vanderkolk J. R. at all. The Fingerprint Sourcebook ; ed. A. McRoberts / U. S. Department of Justice Office of Justice Programs. CreateSpace Independent Publishing Platform, 2014. 428 p. URL: <https://www.ojp.gov/pdffiles1/nij/225320.pdf> (date accessed: 26.05.2022) ; Advances in Fingerprint Technology / ed. by Lee H. C. and Gaensslen R. E. 2nd ed. CRC Press LLC, 2001. 426 p. (CRC series in forensic and police science). URL: http://www.esalq.usp.br/lepse/imgs/conteudo_thumb/Advances-in-Fingerprint-Technology-2nd-ed.pdf (date accessed: 26.05.2022) ; Мухачев А. А., Шошин С. В. Инновационные технологии в дактилоскопии. Совершенствование следственной и экспертной практики : мат-лы Междунар. науч.-практ. конф. (Омск, 02.06.2010). Омск, 2010. С. 41—43 ; Про затвердження Інструкції про порядок формування, ведення та використання оперативно-довідкового і дактилоскопічного обліку в органах внутрішніх справ та органах (установах) кримінально-виконавчої системи України : наказ МВС України від 23.08.2002 р. № 823/188. URL: <https://zakon.rada.gov.ua/laws/show/z0738-02#Text> (date accessed: 26.05.2022).

that continues to this day, regarding development of the methodology of forensic examination of human fat traces, in particular traces in the form of solid spots, smears, etc., that do not contain a sufficient amount of fingerprint information ¹⁰.

Analysis of Essential Researches and Publications

A sufficient number of publications both in the Republic of Armenia and abroad are devoted to the issues of fingerprint identification, tools, technical support, methods and techniques, procedural design, etc. ¹¹. However, publications about the peculiarities of working with the device

of the previous model *Projectina Docustat DS-210* are not known enough.

Main Content Presentation

It is important to note the proposed technical solution for improving fingerprinting using the *Projectina Docustat DS-210* analytical device helps to obtain additional information while ongoing research that makes possible to determine the locations of invisible traces of palms and fingers without damaging the papillary pattern.

Mentioned approach makes possible to detect not only the location of palm prints and fingerprints, but also to obtain fingerprint information that can be used repeatedly in forensic procedures for

- 10 Method for Fingerprint Identification / Interpol European Expert Group on Fingerprint Identification II. IEEGFI-II. Lyon, France, 2004. 35 p. URL: <http://www.latent-prints.com/images/IEEGF2.pdf> (date accessed: 26.05.2022) ; Ярослав Ю. Ю. О системе методов обнаружения и фиксации потожировых следов папиллярных узоров. *Криминалистика и судебная экспертиза*. 1979. № 18. С. 94—99.
- 11 Barnes J. G., Maceo A. V., Wertheim K., Sr. Cutro B. T., Hutchins L. A., Moses K. R., Yamashita B., French M., Vanderkolk J. R. at all. Op. cit. URL: <https://www.ojp.gov/pdffiles1/nij/225320.pdf> (date accessed: 26.05.2022) ; McMurtrie J., Swirls and Whorls: Litigating Post-Conviction Claims of Fingerprint Misidentification after the NAS Report (March 5, 2010). *Utah Law Review*. 2010. No. 2. Pp. 267—297. URL: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2405096 (date accessed: 26.05.2022) ; Cole. S. A., Scheck B. Fingerprints and Miscarriages of Justice: 'Other' Types of Error and a Post-Conviction Right to Database Searching (July 5, 2018). *Albany Law Review*. 2017/18. Vol. 81. No. 3. *UC Irvine School of Law. University of California. Research Paper*. Ser. No. 2018-52. *Cardozo Legal Studies Research Paper*. No. 546. Pp. 807—850. URL: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3208975 (date accessed: 26.05.2022) ; A Review of the FBI's Progress in Responding to the Recommendations in the Office of the Inspector General Report on the Fingerprint Misidentification in the Brandon Mayfield Case / Office of the Inspector General Oversight and Review Division. June 2011. 53 p. URL: https://forensicresources.org/wp-content/uploads/2019/05/2019-05-28_OIG-Mayfield-Case-Review.pdf (date accessed: 26.05.2022) ; Strengthening Forensics Science in the United States. A Path Forward. Washington, D. C. : National Academies Press, 2009. DOI: [10.17226/12589](https://doi.org/10.17226/12589) (date accessed: 26.05.2022) ; Wanxiang L. U. O., Xiaoling C. I. A. A study of the principle of the electrostatic imaging technique. *Journal of the Forensic Science Society*. July, 1988. Vol. 28. Is. 4. Pp. 237—242. DOI: [10.1016/S0015-7368\(88\)72841-8](https://doi.org/10.1016/S0015-7368(88)72841-8) (date accessed: 26.05.2022) ; Yaraskavitch L., Graydon M., Tanaka T., Ng L.-K. Controlled electrostatic methodology for imaging indentations in documents. *Forensic Science International*. 20 May, 2008. Vol. 177. Is. 2—3. Pp. 97—104. DOI: [10.1016/j.forsciint.2007.11.004](https://doi.org/10.1016/j.forsciint.2007.11.004) (date accessed: 26.05.2022) ; Стандарт ASTM E 2291-03. Electrostatic detection device / ASTM International. West Conshohocken, PA, 2003. URL: <https://www.astm.org> (date accessed: 26.05.2022) ; Foster D. J., Morantz D. J. An electrostatic imaging technique for the detection of indented impressions in documents. *Forensic Science International*. 1979. Vol. 13. Pp. 51—54. DOI: [10.1016/0379-0738\(79\)90262-7](https://doi.org/10.1016/0379-0738(79)90262-7) (date accessed: 26.05.2022) etc.

identification of a person, without use of traditional solutions in similar situations.

Taking into account the need to detect general and separate signs of identification, first of all, in order to significantly narrow down the likely circle of persons suspected of a specific crime, optimization of fingerprint identification with visualization help of palm and finger prints is an important place in the developed technical approach, thus it is guaranteed to obtain reliable results and the possibility of human error is reduced¹².

Within the scope of the performed work, professionals of the department of documentation examinations “National Bureau of Expertises” SNPO NAS RA examined more than 500 experimental samples. The samples were made both with invisible man-made grease marks (fingerprints, palm prints or traces of individual parts of the palm) and with invisible marks left on the paper by various topics.

Methodological research feature was that invisible traces on the surfaces of the analyzed paper media were treated by experts with an electrostatic charge, without damaging or contaminating the researched document, that is, during the study of the sample, the latter did not lose its intended purpose and, as mentioned above, could be used repeatedly to obtain the same test image. In laboratory conditions, experts placed samples of documents with fingerprints on the vacuum surface of the *Projectina Docustat DS-210* device.

Then these samples with fingerprints and palm prints were covered with a hydrogel polymer film of the IW type. By connecting an electrostatic system, which contains a device for transferring an electrostatic charge, the film was

charged that made possible to take prints of invisible traces — both fingerprints and sweaty palms; further, with the help of covering developing powder (toner), such prints were visualized.

We fixed the detected prints on special paper using a self-adhesive film designed for this research that ensured integrity (preservation) of the document with palm or finger prints (see Figs. 1 and 2).



Fig. 1. Paper medium with an invisible palm print



Fig. 2. Paper medium with visualized palm print

12 Бондаренко Р. В. Автоматизация в дактилоскопии. Москва, 2013 ; Zahid H., Khan U. Comparative Study of Authentication Techniques. *International Journal of Video & Image Processing and Network Security (IJVIPNS-IJENS)*. 2010. Vol. 10. No 04. Pp. 9–13. URL: <https://cite-seerx.ist.psu.edu/viewdoc/download;jsessionid=DF1F2BFF7C60DEF304224039CAE42ACC?doi=10.1.1.657.1219&rep=rep1&type=pdf> (date accessed: 26.05.2022).

It should be noted that while conducting research traces of sebaceous secretions on the surface of the human skin, left on various paper media, experts noted that in some cases — thanks to visualization of high-quality traces (see Fig. 3); it is possible to exclude while investigation under case circumstances, unidentified person from among the potential suspects/accused who left this fingerprint, moreover, with a significant probability degree. For the case under consideration, if there are two different images of the same fingerprints or palms (combining two different images with the help of various modern graphic programs or using the publicly available *Regula 4305* device), there is a high probability of obtaining all the necessary grounds that will allow us to prepare in a categorical form expert opinion on their identification.

In availability of low quality fingerprint images of palms or fingers of, in particular with weakly pronounced or partially blurred structures of papillary patterns (see Fig. 4), combination results of images of fingerprints of palms or fingers left by different persons, in certain cases make possible to exclude a person from among potential suspects/accused persons who left these prints, but a similar case of forensic examination will require a more complex registration procedure, namely: aggregate analysis, while which it is necessary to pay attention to characteristic features of the palm, general structure of fingerprints, their geometric dimensional features: width, length, location of papillary patterns, peculiarities of their construction, etc.



Fig. 3. Visualized fingerprint with the clearest possible image

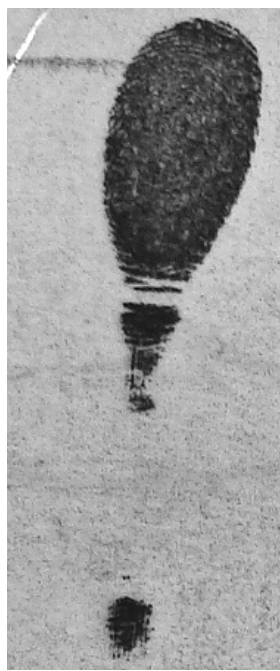


Fig. 4. Visually blurred (weak expressed) fingerprint image

For example, after matching the fingerprints shown in the left and middle pictures (see Fig. 5) of two different people using the *Regula 4305* device, forensic experts found that the prints did not match in structure, size, width, curvature of edges, size of the individual images and their location. The differences in the visualized samples of fingerprints separately and after combining are shown in fig. 5 (circled with ovals).

We will consider the features of forensic research of high-quality palm prints with the most clear image, left on different paper documents at different times by the same person (see Fig. 6).

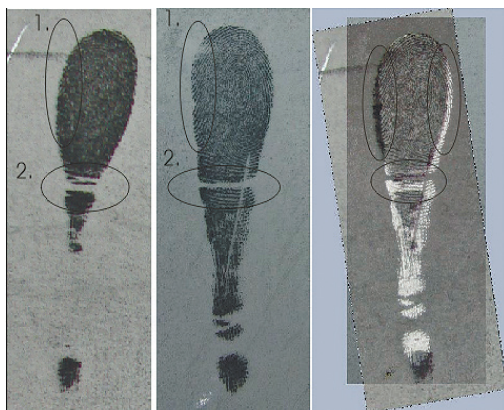


Fig. 5. Difference in results combination of fingerprints, demonstrated in fig. 3 and 4

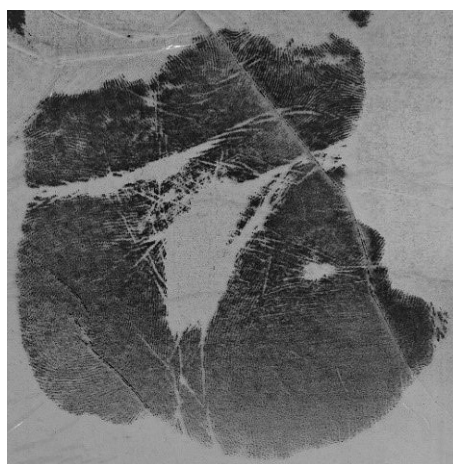
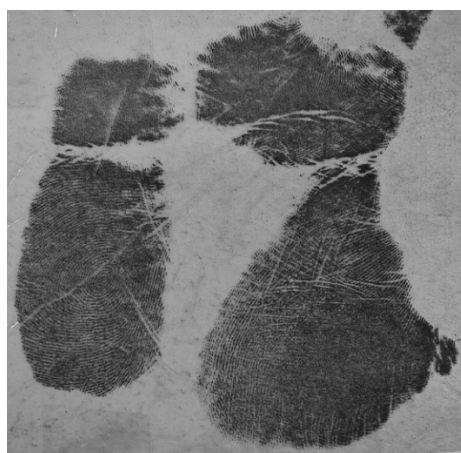


Fig. 6. Visualized palm prints, left by the same person at different times

While research with implementation of step-by-step combination of general images of palm prints, as well as structure of patterns of palm surface, it was established that (in the case of applying the previously described methodical approach) it is possible to identify the person who left this palm print, since the diagnostic nature

of solving the question is differentiated due to superimposition of the structure of overlapping papillary patterns and palmar flexion creases, their location in relation to each other, dimensional features, etc., and also, last but not least, the coincidence of traces of scars in impressions of papillary patterns of palms or fingers (see Fig. 7).

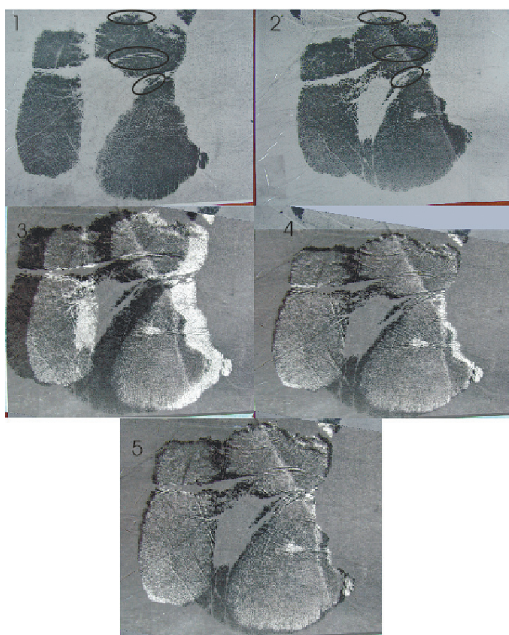


Fig. 7. Schematic algorithm gradual combination of images of palm prints

In particular, considering evaluation results of combining the first and second photographs in Fig. 7, in photos 3—5, you can notice coincidences; both general and individual signs, which, ultimately, allows you to formulate certain preliminary conclusions before the next conduct of the actual fingerprint identification itself.

Based on the results of performed researches, the following can be summarized: thanks to application of proposed methodical approach to the research on invisible prints of greasy traces of palms and fingers (in particular, on paper media), it is quite easy and simple to conduct a research on prints and obtain at least preliminary conclusions regarding their identification.

Conclusions

Thus, it can be concluded that while fingerprint identifications for cases, which

research requires preservation of integrity of the original document, methodical technological approach developed at the “National Bureau of Expertises” SNPO NAS RA allows forensic expert to identify with high accuracy belonging/non-belonging of invisible fat traces to the same person.

The specified method helps to determine the ownership of fingerprints by combining and identifying the features of the structure of papillary patterns (already at the preliminary stage of expert research), having several palm prints or fingers in the case under consideration. A positive factor of the considered method is also the fact that the expert can conduct fingerprint document examinations of (in particular, a paper medium) multiple times without damaging its integrity and without leaving traces of various solutions on the document in contrast to well-known and actively used in expert practice fingerprint research methods fingers.

Особливості дослідження потожирових слідів долонь і пальців рук за допомогою пристрою *Projectina Docustat DS-210* Арсен Багдасарян

Детально визначено й докладно описано характерні особливості технологічного дослідження відбитків долонь і пальців рук. Значну увагу приділено розробленню методичного підходу, що дає змогу виконувати експертні дослідження без шкоди цілісності паперового носія, на якому залишено невидимі відбитки. Обґрунтовано думку про те, що використання пристроїв *Projectina Docustat DS-210* і *Regula 4305* (у разі застосування принципу поетапного суміщення) сприяє підготовці щонайменше попередніх висновків щодо ідентифікації належності (неналежності) невидимих потожирових слідів тій самій особі. Акцентовано увагу на можливому

розв'язанні криміналістичних завдань (під час проведення наступних етапів дослідження) щодо ідентифікації хімічного складу речовин потожирових слідів, що, зі свого боку, дає змогу визначити, чи контактував підозрюваний із речовими доказами за справою (наприклад, зі зброєю, наркотиками тощо). Мета дослідження — сформулювати певні попередні висновки перед подальшим проведенням уже самої предметної дактилоскопічної експертизи, а також забезпечити цілісність вихідного документа шляхом застосування методичного підходу, розробленого в Національному бюро експертиз Національної академії наук Республіки Вірменія, що допоможе експертові з більш високою точністю ідентифікувати належність (неналежність) невидимих потожирових слідів тій самій особі.

Ключові слова: дактилоскопія; невидимі відбитки; потожирові сліди; інструментальний метод; ідентифікація особи; цілісність документа; принцип поетапного поєднання; аналітичні пристрої Projectina Docustat DS-210 і Regula 4305.

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Contributors

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Declaration of Competing Interest

The author declares that he has no conflict of interest.

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