

Contactless forensic imaging systems in crime scene documentation. Applications of 8k technology and the contactless lite system in homicide investigations

Abstract

Technical documentation of crime scenes constitutes an essential stage for the accurate reconstruction of event dynamics and for the production of reliable forensic evidence. Advances in imaging technologies have enabled the development of high-resolution optical capture systems capable of recording forensic traces without physical contact with the evidence. This article presents a technical and operational analysis of two contactless forensic imaging systems: an 8K ultra-high-resolution camera used in homicide scene documentation and the Contactless LITE Evidence Imaging System applied in the detection of latent fingerprints. The experience reported is based on the use of these devices in forensic activities carried out within the Civil Police of the State of Rio de Janeiro.

This innovation was implemented by Mr. Alexandre Trece Motta, Director of the Félix Pacheco Identification Institute of the Civil Police of the State of Rio de Janeiro and fingerprint expert. The results demonstrate that the use of multispectral optical technologies combined with ultra-high-resolution image capture allows forensic traces to be documented with a high level of detail, reduces the risk of scene contamination, and preserves evidence integrity for subsequent analyses. It is concluded that contactless imaging systems represent an important advancement for modern criminalistics, improving the precision of forensic documentation, strengthening the chain of custody, and contributing to greater technical robustness of forensic reports submitted to the justice system.

Keywords: forensic science, forensic imaging, fingerprint analysis, crime scene investigation, contactless technology

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Introduction

Modern forensic investigation is based on the accurate identification, preservation, and documentation of traces present at crime scenes. The quality of this documentation directly influences the ability to reconstruct the dynamics of events and the reliability of evidence presented in judicial proceedings. Historically, forensic documentation relied on methods such as conventional photography, sketches, technical notes, and physical evidence collection. Although these methods remain fundamental, they present limitations related to image resolution, the possibility of later reanalysis, and the risk of scene contamination during evidence manipulation.

With the advancement of digital technologies, new resources have been incorporated into forensic science, including high-resolution digital photography, three-dimensional scanning, computational modeling, and multispectral lighting systems. Among these innovations are contactless imaging systems, which allow the detection and recording of forensic traces without physical contact with the evidence. This approach aligns with fundamental principles of modern criminalistics, particularly regarding scene preservation and maintenance of the chain of custody.

In this context, the present study describes the application of two contactless forensic imaging technologies used in the General Department of Homicides and Protection of Persons (DGHP) of the Civil Police of the State of Rio de Janeiro:

- I. An 8K image capture system applied to homicide scene documentation – currently in the implementation phase

- II. The Contactless LITE system used for optical detection of latent fingerprints

Objectives

To present and analyze the practical application of contactless forensic imaging systems in criminal investigations, highlighting:

- I. The use of an 8K-resolution camera in homicide scene documentation (currently under implementation);
- II. The application of the Contactless LITE system in the detection of latent fingerprints;
- III. The technical advantages of these technologies in evidence preservation and analysis.

Material and methods

The analysis presented is based on the practical use of two forensic documentation systems.

8K imaging system for homicide scenes

(Currently in implementation phase)

Contactless LITE System

The Contactless LITE Evidence Imaging System was used in fingerprint analysis of surfaces potentially containing latent fingerprints.

The equipment uses multispectral illumination and high-resolution image capture to reveal fingerprints without physical contact with the examined surface.

Main technical characteristics

- I. Multispectral illumination • vertical optical reflection • Canon EOS R7 camera (32.5 megapixels)
- II. 18–150 mm lens • image capture in RAW, JPEG, and HEIF formats • ISO range from 100 to 32,000
- III. 3,500 mAh lithium-ion battery
- IV. Average autonomy of 6–8 hours

Results and practical applications

The use of the analyzed systems demonstrated important benefits in forensic practice.

Among the main results observed were:

- I. High image magnification capacity without significant loss of resolution;
- II. Possibility of identifying micro-details invisible to the naked eye;
- III. Optical detection of latent fingerprints on different surfaces;
- IV. Significant reduction in physical contact with forensic traces.

In fingerprint analysis, green illumination was frequently observed to provide better performance in revealing latent prints, whereas white light demonstrated good versatility across different surfaces (Figures 1–5).



Figure 1 8K image acquisition system employed at a homicide scene.



Figure 2 Comparison between conventional forensic photography and a magnified image in 8K resolution.



Figure 3 Latent fingerprint detection using multispectral illumination.

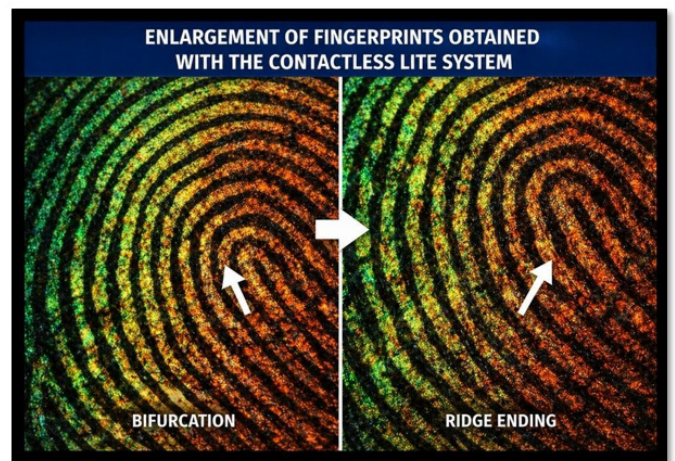


Figure 4 Magnified friction ridge minutiae acquired using the Contactless LITE system.



Figure 5 Non-contact documentation of biological evidence.

Discussion

The evolution of forensic documentation closely follows the development of digital imaging and applied spectroscopy technologies. Over the past decades, methods based on multispectral and hyper spectral illumination combined with high-resolution digital capture have been gradually incorporated into criminal investigations,

particularly in areas such as latent fingerprint analysis, detection of biological traces, and documentation of complex crime scenes. The main advantage of these technologies lies in the possibility of obtaining visual and spectral information from traces without physical contact with the evidence, representing an important advance compared with traditional methods based on chemical reagents or direct surface manipulation.

Hyper spectral analysis, for example, allows recording the spectral response of each pixel in an image, making it possible to identify materials present in the trace or substrate analyzed. In the context of forensic fingerprint examination, several studies demonstrate that the combination of multispectral illumination and high resolution digital sensors significantly increases the detection capacity of latent fingerprints, including on complex or contaminated surfaces.

The interaction between different wavelengths and the organic residues present in fingerprints—such as lipids, amino acids, and sweat secretions— produces optical contrasts capable of revealing papillary ridge details invisible to the naked eye.

This physical principle is similar to that used in forensic illumination systems known as Alternate Light Sources (ALS), widely used for detecting biological fluids, fibers, and fingerprints. Contactless equipment based on these principles represents an operational evolution of such systems by integrating illumination sources, image capture, and digital processing into a single portable device. Another relevant aspect concerns the increase in spatial resolution of forensic images. Modern sensors capable of producing images with tens of megapixels or resolutions equivalent to 8K allow digital enlargement of specific areas of the scene without significant loss of definition.

This is particularly relevant in situations such as:

I. Identification of fingerprint minutiae.

In fingerprint science, individual identification is based on the comparison of minutiae such as ridge endings, bifurcations, and islands. Image quality is a determining factor for the correct identification of these morphological structures. Recent studies indicate that improvements in image quality and digital enhancement techniques can significantly increase the efficiency of Automated Fingerprint Identification Systems (AFIS).

Beyond fingerprint analysis, spectral technologies are also being used in the examination of bloodstains and firearm discharge residues, allowing materials to be distinguished based on their spectral signatures. This approach opens new perspectives for forensic science, especially in the identification of invisible or degraded traces.

Another important point concerns the preservation of the chain of custody. Contactless methods allow traces to be documented in their original state before any forensic intervention. This initial documentation may be crucial in judicial proceedings, as it provides a faithful record of the evidence at the moment of discovery. High-resolution digital documentation also allows later reanalysis of the crime scene, including by external specialists or during judicial phases.

The integration of these technologies with three-dimensional reconstruction and computational modeling tools represents a promising direction for contemporary criminalistics. Three-dimensional scanning systems are already being used to reconstruct complex crime scenes, enabling ballistic simulations, trajectory analysis, and spatial reconstruction of events. Within this context, the

contactless imaging technologies analyzed in this study represent an additional step in the evolution of forensic documentation, combining high spatial resolution, spectral analysis, and preservation of evidence.

Despite these advantages, the adoption of these technologies still faces some challenges, including:

- I. Acquisition and maintenance costs of equipment;
- II. Need for specialized training;
- III. Integration with existing institutional protocols;
- IV. Standardization of image capture and analysis procedures.

Nevertheless, scientific literature indicates that spectral imaging systems and ultra-high-resolution technologies are likely to become increasingly present in forensic practice, contributing to more objective, documented, and technically robust criminal investigations.¹⁻²⁰

Limitations

Among the observed limitations are:

- I. High acquisition and storage costs.
- II. Large file sizes requiring robust hardware.
- III. Need for operator training.
- IV. Limited standardization across agencies.

It should be emphasized that these technologies do not replace traditional forensic analysis, but rather function as complementary tools for documentation and analysis.

Conclusion

The contactless forensic imaging systems analyzed in this study demonstrate high potential for application in contemporary criminal investigations, particularly in the fields of forensic fingerprint analysis and documentation of traces during crime scene examination.

The integration of multispectral illumination, high-resolution sensors, and image capture without physical contact with the evidence establishes a new methodological paradigm for the detection and documentation of latent traces.

From a technical and scientific perspective, the possibility of recording traces in their original state, before any physical or chemical intervention, represents a significant advantage for preserving the material integrity of the evidence. This approach reduces the risk of degradation of biological and fingerprint residues and minimizes interference with complementary examinations such as genetic or chemical analyses.

Furthermore, the high resolution of the images obtained, combined with the possibility of high-fidelity digital magnification, enables detailed visualization of fine morphological structures such as fingerprint minutiae and micro characteristics of surfaces, contributing to more precise and technically supported forensic analyses.

In the context of forensic practice, the adoption of these technologies directly contributes to:

- I. Greater preservation of material traces present at the crime scene;
 - more detailed and technically consistent forensic photographic documentation;
- II. Strengthening of the chain of custody through early and non-invasive recording of evidence;
 - Increased scientific

robustness of forensic reports, enhancing the reliability of conclusions presented in judicial contexts.

Therefore, the incorporation of contactless forensic imaging systems represents a significant advancement for modern criminalistics, particularly in the investigation of violent crimes, reconstruction of criminal events, and processes of human identification. The observed trend points toward the progressive integration of these technologies into forensic routines, consolidating analytical methods that are increasingly precise, preservative, and scientifically grounded.

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None.

Conflicts of interest

The author declare that there is no conflict of interest.

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