New Technical Devices and Methods in Crime Scene Investigation

***Dr. Füszter Erzsébet*[1]**

Abstract

The aim of this article is to draw attention to the importance of crime scene investigation, because the thorough detection of traces, physical evidence, crime related facts and other phenomena indicating the circumstances of the crime are of decisive significance. Recording the state of the scene of crime can provide the investigator with data, points of reference and evidence. Recently developed professional scene processing equipment and imaging tools greatly help the work of the authorities.

Keywords: *special imaging tools and techniques, infrared photography, thermography, 3-dimensional laser scanning, optical crime scene processing equipment, ALS/FLS-light sources*

I. Introduction

Examining the domestic and international professional literature, it can be concluded that the investigation of the crime scene and the detection of traces, physical evidence, crime-related facts and other phenomena indicating the circumstances of the crime are of decisive importance. Recording the state of the scene can provide the investigator with data, points of reference and evidence. The use of data originated from the crime scene can be very widespread during investigations, as evaluating the photos taken at the crime scene and examining other crime scene related data can help the profiling work, even during specific profiling[2].

During the crime scene investigation, we should, without question, search for and collect all the material evidence and we have to ensure that they will be properly preserved. As there is rarely more than one opportunity to obtain evidence from a crime scene, the investigation by the CSI team must be methodical and complete.

The success of the crime scene investigation depends not only on the necessary professionalism and essential legality, but also on the effectiveness of the tools and methods used. Today, we are experiencing a revolution in the field of crime scene processig devices. In addition to the decades-old trace-search techniques, photography, and what are now referred to as traditional trace-recording techniques, we are witnessing the emergence and rapid expansion of new tools and procedures that may change our outlook on crime scene investigation.

---

[1] Prof. dr., National University of Public Service, Faculty of Law Enforcement.

[2] Nyitrai Endre: Bűnelemzés a nyomozásban (Crime analysis in investigation), In: Gaál, Gyula; Hautzinger, Zoltán (szerk.) Modernkori veszélyek rendészeti aspektusai, Pécs, Magyarország: Magyar Hadtudományi Társaság Határőr Szakosztály Pécsi Szakcsoport, 2015. p. 145.

Recently developed professional scene processing equipment and imaging tools greatly help the work of the authorities.

II. New Imaging Features and Techniques

During the last decade, modern imaging techniques have become more and more important in crime scene investigation. Digital technology replacing traditional analog photography provided powerful new tools for capturing, analyzing and storing records of the crime scene and its physical evidence.

On many occasions, the CSI team has to work under conditions that are far from optimal. In poor lighting conditions, however, like at night, where the illumination of the area or object being photographed cannot be achieved properly in the conventional way, the infrared range of the light spectrum is also capable of recording. Two fundamentally different methods are known today for this purpose.

Beyond the visible light range, the so-called Near InfraRed (NIR) (760-1600 nm) image capture is called infrared photography as the camera's optical system captures infrared light reflected from objects. Special infrared projectors are used to "illuminate" the area to be photographed with infrared radiation, with either infra LEDs integrated into the digital camera itself with special optics or with independent lasers or LED light sources, so called infrared reflectors. The illumination distance of infrared radiators can vary from a few meters to hundreds of meters, depending on the light source.

The infrared camera captures what you see in black and white, but imaging is different than usual. Subjects that are bright in visible light are generally dark in the IR image, while those that should be dark are bright in the IR image. Whether a part of the image is white, black, or gray is basically determined by the infrared absorption or reflection property of the object or part of the object. The unusual appearance of photos taken with infrared filters is due to the natural light absorption phenomenon. A feature of an image taken with an infrared camera is that the green vegetation looks white, as if covered by thick snow. The explanation of the white foliage is that the plant chlorophyll absorbs the waves at the beginning and at end of the light spectrum, i.e. the blue and red rays, while reflecting the green and yellow color ranges. That is why plants look green in normal light. However, chlorophyll does not absorb infrared radiation at all, but completely reflects it, and since landmarks usually reflect less infrared light than chlorophyll, plants appear to be the brightest, that is, blinding white. However, e.g. water and sky absorb infrared rays, making them look dark in IR photos.

Infrared, or "IR" photography, offers photographers of all abilities and all budgets the opportunity to explore a new world – the world of the unseen. Why "unseen"? Because our eyes literally cannot see IR light, as it lies just beyond what is classified as the "visible" spectrum – which human eyesight can detect[3].

Infrared photography plays an increasingly important role in many disciplines as well as in forensics. In fact, infrared photos can reveal details that are hidden from the naked eye. Forensic writing and document examination are impossible to imagine without the use of infrared imaging technology. Among the security features of security documents is the so-called security system of IR absorbent and IR

---

[3] Bob Vishenski: Introduction to Infrared Photography, Photographylife, Available at: https://photographylife.com/introduction-to-infrared-photography, Accessed: 02.09.2020.

transparent inks. Printed elements printed with an IR absorbent ink are not visible under normal lighting conditions. These elements are optically imaged in the infrared light range. Shapes printed with IR transparent inks are visible under natural light, but not observed when viewed through an infra-converter.

In addition to infrared photography, another method that can be used in low vision conditions is thermal imaging or thermography.

Thermal imaging is simply the process of converting infrared (IR) radiation (heat) into visible images that depict the spatial distribution of temperature differences in a scene viewed by a thermal camera. Thermal imaging technology developed by the military has recently found its way not only into the commercial market but into forensic use as well because it is a very powerful sensing technique.

Infrared photography and thermal imaging both operate in the range of infrared light. However, infrared illuminators are not required for thermal imaging, because thermal cameras detect the thermal radiation emitted by objects. Thus, a thermal camera detects a thermal image, that is, it is capable of detecting the heat emitted by the area it is observing, the temperature of people and objects outside it, and displaying it in an image transformed into visible light. Therefore, thermal cameras do not detect the radiation reflected from the bodies, but the heat emitted by them.

The operation of thermal cameras is based on the principle that all objects with a temperature above the absolute zero degree generate heat, due to the constant vibration of the atoms and molecules that they are consisted of, thus all things in the infrared range emit infrared rays i.e. heat. Even cold objects like an ice block emit infrared rays. The intensity of radiation depends on the temperature of the object. The warmer an object, the more heat it discharges. The thermal contrast detection method provides the basis for the functioning of thermal cameras.

During thermal imaging, the optical system (usually made of germanium) of a thermal imaging camera collects electromagnetic waves in the range of its sensitivity and converts them into electrical signals using its infrared detector, which is used by specialized imaging software to produce images that are valuable to us. Most thermal cameras create black-and-white images, with the warmer parts appearing white, and the cooler parts appearing black. There are camera types that artificially color the image for easy recognition. Some mark red for warm areas, others mark yellow for warm areas and blue for cold areas. Because objects have constant heat radiation, thermal imaging cameras are capable of imaging even under the most extreme environmental conditions (night, day, mist, fog, rain, snow, smoke etc.).

In general, all forms of photography and video recording are characterized by the fact that analog and digital cameras, but also thermal and video cameras, direct light/electromagnetic rays reflected from or emitted by the object through various lenses (lens systems) into the photosensitive part of the device, which then creates the visual form of the object. In contrast, 3D scanning is a professional imaging technique that is completely different.

3D laser scanning is a state-of-the-art data acquisition method that began to be utilized in the second half of the 1990s and was initially used for surveying. Today, three-dimensional technologies, such as 3D imaging and printing, can be considered as revolutionary innovations of the 21th century.

3D scanning is considered as one of the most efficient and state-of-the-art methods of spatial data acquisition. 3D scanners are devices that "digitalize" objects and spatial objects, capturing their geometry in a 3D data file without being physically in contact with them.

The laser scanner emits millions of laser beams within seconds to measure the distance between the instrument and the spatial object. The data set/spatial point cloud created this way can be used to extract geometric data of the surveyed objects with a software.

Thanks to 3D point cloud technology, the result of scanning is a three-dimensional snapshot of objects and spaces, the detailedness of which depends on the resolution of the instrument used. The resulting point cloud can be used to retrieve the geometry of scanned objects. These can be viewed in three dimensions, and the data for each point can be compared to each other.

The 3D scanners consist of a high-power laser diode, high-speed rotating mirrors, a high-sensitivity laser detector and a control computer.

Several types are known for their efficiency, performance and mode of operation, depending on the size of their surface, the accuracy of their measurements, their resolution and the distance from which they can scan.

Handheld scanners are used primarily to record the morphological and geometric features of small objects and spatial details.

Depending on the complexity of the site, “tripod” space scanners are capable of perfectly reproducing the spaces and objects being examined as a result of multiple measurement scans. With the help of scanned point clouds and spherical panorama photos, all objects of the virtual space can later be observed and accurately measured. The duration and quality of the 3D laser scanner survey depends on the parameters of the 3D laser scanner.

Using a space scanner, you can create a 3D model that is dimensionally accurate and, depending on the resolution you set, is characterized by the accuracy of a fraction of a millimeter. As 3D data acquisition technology is also capable of providing a true virtual representation of the subject being scanned, and since 3D scanning produces high-resolution, detailed virtual replica, it may be ideally suited for capturing a variety of traces, including volume traces in the future. Using appropriate software and 3D printing technology, you can make an exact copy of any object that is relevant to your case.

The use of the 3D technique has many advantages over manual photography, because the images of the 3D laser scanner are always scalable, undistorted, and due to their positioning, every single detail is captured, even in a situation when the crime technician or the CSI team may not consider something to be relevant information, so it would probably not be recorded in the first place[4].

III. Optical Crime Scene Processing Equipment

A new development on the market has been the discovery of optical tracking devices that help detect traces and material remains of less prominent appearance by emitting light at different frequencies. The light emitted by conventional bulbs has different intensities but produces light at all wavelengths. Such lamps are called continuous spectrum light sources.

[4] Rucska András: A helyszín képi rögzítése hagyományos és háromdimenziós eljárással a kriminalisztikai szabályok szerint (Visualization of the scene by conventional and three-dimensional procedures according to forensic rules), Ügyészek lapja, 24(5), 2017.

The visible light ranges from violet to red, complemented by infrared and ultraviolet regions that are no longer visible to the naked eye[5].

Optical trace detection, that is, exposure to traces and physical evidence by using different optical scene processing equipment, is based on four basic photometric phenomena: light absorption, light reflectance, light scattering and fluorescence.

The color we see in an object depends on the wavelength range and the rate at which it is absorbed and reflected by incident light. Unabsorbed rays determine the color of the body.

The color of opaque objects is represented by a mixture of reflected colors. While black "colored" objects absorb all the light falling on them, white "colored" objects reflect all light. Different shades of gray are created by surfaces that absorb and reflect every color range of white light.

The color of a "colored" object can be resulted from two different mechanisms: first, by reflecting only one color range from the white light on its surface and absorbing the rest, and secondly, by absorbing only the complementary color of the specified color from the entire spectrum of incident light and reflecting all the rest[6].

The color of transparent materials is also determined by the range of light transmitted through them. If an object is not completely transparent, it transmits a certain part of the light and reflects the other.

Since the color of an object is the result of a mixture of reflected (or transmitted) colors, it always depends on the composition of the illuminating light[7].

The phenomenon of light scattering can be truly observed when the light rays are projected at a low angle, not perpendicularly on an object. By illuminating the surface of the object with “oblique light”, small surface protrusions and depressions as well as small objects, which are otherwise barely perceivable due to the scattering phenomenon, become visible with contrast.

Fluorescence is a physical process in which a substance absorbs electromagnetic radiation of a given wavelength, in this case light, and as a result, the molecules of the substance enter a higher energy state. When the illumination ceases, they return to their original resting position while giving off some of the energy they have absorbed in the form of light. The light emitted will always be of less energy, that is, of a longer wavelength than the excitation light. If, for example, fluorescence was caused by blue light, the fluorescent object will emit a light in the yellow wavelength range. In such cases, the crime scene technicians should wear orange goggles. In order to detect a faint light phenomenon, it is important that the strong blue light used for illumination

---

[5] The so-called “white light” is a mixture of different wavelengths in the range of visible light in the same proportion as the light of the sun. White light is thus a complex (polychromatic) light, which is a mixture of several lights of different wavelengths and colors (violet, blue, green, yellow, orange and red). The color of the light is determined by the wavelength of the electromagnetic radiation.

[6] For example, an object looks yellow when it reflects only the yellow wavelength of white light and absorbs the rest, so only the yellow light reaches our eyes. But even if it only absorbs violet, the complementary color of yellow, the object is yellow, as all the rest is reflected. By the same logic, an object is green when it reflects only green, and when the complementary color of green, red, is absorbed by the object and all other wavelengths are reflected.

[7] A white object looks green when illuminated by green light, and red when illuminated by red light. A green object is green in both white and green light because it absorbs red (green is the complementary color of red), but when illuminated by red light, it becomes black because it completely absorbs the red.

does not obscure the emitted light, which is always much dimmer than the illuminating light. The orange glasses filter out all the blue light and let only the rays in the yellow range through.

After illumination by the correctly chosen wavelength (color), most organic material demonstrates fluorescence, which can be seen with suitable goggles or a color filter. For example, bone and tooth residues, when illuminated with blue light at 455 nm, exhibit a faint fluorescence phenomenon, which is perceptible through orange goggles and can be captured by photographs using an orange filter.

Forensic tracing was the first field to use illumination with ultraviolet rays in every single ranges of light in the 1970s. The use of various UV light tracing lamps has become widespread both in the field and in laboratory work, as the biological residues of semen, saliva, vaginal secretions, sweat and urine spots are clearly visible to the naked eye when exposed to UV light. However, UV-illumination can also help detect untreated blood spots, because they are completely absorbed by UV, so they look completely black when exposed to UV light.

In forensic practice, UV lamps operating in the 254 nm (UV-C) and the 365 nm (UV-A) ranges are the most commonly used.

A special form of optical crime scene processing in the ultraviolet region is the so-called RUVIS (Reflected Ultra-Violet Imaging System), which is suitable for the optical detection of latent or otherwise untreated fingerprints and certain residues of material on both porous, greasy, sticky surfaces where conventional fingerprinting is very difficult and not very efficient.

RUVIS consists of an ultraviolet illumination unit operating in the 254 nm range and a digital camera with appropriate color filters for photographic documentation based on the detection of reflected beams.

The RUVIS test is based on the principle that some substances absorb light when exposed to ultraviolet light, while others reflect light beams projected onto them. As most materials, and thus the vast majority of trace surfaces, are characterized by UV absorption, the method is capable of detecting/visualizing any trace and material residue that does not absorb, but reflect, ultraviolet rays.

In the international literature and police jargon, special lamps that are specifically designed for crime scene processing are called ALS (Alternate Light Source) or FLS (Forensic Light Force) illuminators. In each case, these lamps consist of a strong light source and a system of special color filters associated, which produce monochromatic light rays of the required wavelength, from UV to IR, for the particular test.

IV. Conclusion

Optical crime scene processing is of outstanding forensic importance. Simple, fast, repeatable, without damaging the evidence. The digital recording of the test result is also suitable for documentation and expert examination.

References

1. Fish J. T., Miller L. S., Braswell M. C., Crime scene investigation, Elsevier, 2011.
2. Gárdonyi Gergely: Kógencia a bűnügyi helyszínelésben (Cogency in criminal investigation), Magyar Bűnüldöző, 2011.
3. Lloyd J. M., Thermal Imaging Systems, Springer Science-Business Media, 1975.

4. Lovas Tamás, Berényi Attila, Barsi Árpád: Lézerszkennelés (Laser Scanning), TERC Kft., Budapest, 2012.

5. Nyitrai Endre, Bűnelemzés a nyomozásban (Crime analysis in investigation), In: Gaál, Gyula; Hautzinger, Zoltán (szerk.) Modernkori veszélyek rendészeti aspektusai, Pécs, Magyarország: Magyar Hadtudományi Társaság Határőr Szakosztály Pécsi Szakcsoport, 2015.

6. Petraco N., Sherman H., Illustrated guide to crime scene investigation, Taylor and Francis Group, 2006.

7. Rahne Eric, TERMOGRÁFIA – elmélet és gyakorlati méréstechnika (TERMOGRAPHY – theory and practical measurement technology), Budapest, Invest-Marketing Bt., 2018.

8. Rucska András, A helyszín képi rögzítése hagyományos és háromdimenziós eljárással a kriminalisztikai szabályok szerint (Visualization of the scene by conventional and three-dimensional procedures according to forensic rules), Ügyészek lapja, 24(5), 2017.

9. Tomcsányi Péter, Demeter Lászlo, Fizika Optika Hőtan (Physics Optics Thermology), Műszaki Könyvkiadó, Budapest, 2000.

10. Vishenski B., Introduction to Infrared Photography, Photographylife, Available at: https://photographylife.com/introduction-to-infrared-photography, Accessed: 02.09.2020.

11. Vollmer M., Möllmann, K.-P., Infrared Thermal Imaging, John Wiley & Sons, 2011.