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Artificial Intelligence in Forensic Science: Can It Be a Revolution or Else?

Neelam Saba[1], Wahied Khawar Balwan[2*]

[1]Assistant Professor, Department of Zoology, Govt. Postgraduate College Bhaderwah, Jammu & Kashmir, India
[2]Associate Professor, Department of Zoology, Govt. Degree College Doda, Jammu & Kashmir, India

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***Corresponding author:** Wahied Khawar Balwan
Associate Professor, Department of Zoology, Govt. Degree College Doda, Jammu & Kashmir, India

Abstract **Review Article**

The study is on the emerging role of artificial intelligence in the forensic sciences. Forensic science is a multidisciplinary science used for the purpose of the law where scientific procedures are applied to solve legal problems of theft, assault, rape, accident, poisoning, medical/surgical negligence, suicide attempt, suicide or murder, animal abuse and cruelty etc. Many potential applications of forensic science exist. They key principle is to identify traces of substances transferred through every contact. It provides impartial scientific evidence that establishes links between crime scenes and suspects. As technology infiltrates every aspect of our lives, solving crimes has become almost futuristic in its advances. From retinal scanning to traces evidence chemistry, actual forensic technologies are very advanced at helping to solve crimes. It is also used for humanitarian purposes to clarify the fate of missing persons. Although forensic science has greatly enhanced the investigator's ability to solve crimes, it has limitations and must be scrutinized in and out of the courtroom to avoid the occurrence of wrongful convictions. Lawyers, judges, officials and the public need to know what forensic science can/ cannot do. The net of law, however, is spread so wide that no sinner from its sweep may hide. The penetration of the application of artificial intelligence into some fields of science is undoubtedly an ongoing process. Most of the varied forensic fields also cannot avoid this development. Analyzing large databases unmanageable with traditional methods, pattern recognition, and machine learning can all be important tools for forensic science. However, an important conclusion is that AI is a supporter of human expert work, not a substitute.

Keywords: Artificial Intelligence, Forensic Science, Multidisciplinary and Machine Learning.

INTRODUCTION

Artificial intelligence (AI) stands at the forefront of modern scientific innovation. Artificial intelligence has emerged in all fields of science, including investigation and forensic science [9, 10]. The word forensic means a form of legal evidence 'of or before the forum' and it is a synonym for legal/ related to courts. The ancient world lacked standardized forensic practices, which aided criminals in escaping punishment [1]. The use of torture to force confession had to be curtailed with a simultaneous increase in the use of logic and procedures in criminal investigations. Forensic science developed for the purpose of the law where scientific procedures are applied to solve legal problems. It is a multidisciplinary subject, involving chemistry, biology, physics, geology, psychology, social science and virtually all fields of science and technology. It involves the collection of information about the physical characteristics, chemical composition and occurrence of materials of forensic interest. It looks at the scientific association between such samples, based on their origins, manufacture, packaging and distribution characteristics [1, 2].

It provides impartial scientific evidence for use in the courts of law, e.g., in a criminal investigation and trial. Proof of criminal charges initially depended mainly on eyewitnesses and other subjective means. With scientific advances, objective evidence has taken on a greater role in criminal trials. Governments rely increasingly on science to help enforce a growing number of regulations to resolve disputes, to assess blame and establish responsibility, and to enhance public safety. Lawyers, judges, officials, and the public need to know what forensic science can/ cannot do [1-3].

Forensic science has a promising future, as new methods, technologies and scientific advances are creating opportunities that were previously undreamed of. The discovery and use of DNA has undoubtedly transformed current forensic science and will continue to

do so, but as detection technologies evolve, we need to better understand the transfer of DNA trace, its persistence on a substrate, and its collection potential. New discoveries can bring about incremental or revolutionary changes (evolution or revolution) that together reshape the face of forensic science. We cannot predict what innovations and new technologies will emerge, but we can certainly expect them to materialize, and that AI will create new opportunities for forensic sciences [10].

Forensic science is often driven by specific problems and scandals, such as miscarriages of justice, and resources are devoted specifically to addressing them [11]. This means that forensic science is often simply reactive to emerging symptoms [12, 13], rather than a routine practice of ongoing and systematic proactive investigation, research and self-reflection. Moreover, the fundamental paradigm of forensic science is that 'every case is different', which creates a deep-rooted tension between scientific research that, seeks to develop generalizable theories and approaches and professional practices that aim to reconstruct the individual crime. Therefore, the longer-term review of the possibilities, potential and desirable outcomes is an important undertaking for the future of forensic science. AI enabled forensics will not only focus on reconstruction and interpreting crime evidence from the crime scene but will also be able to create a more proactive 'think about crime' type of policing.

Principle

One of the key principles of forensic science is to identify traces of substances transferred through every contact. In a typical criminal investigation, the crime scene investigators will gather material evidence from the crime scene, victim and/ or suspect. Forensic scientists will examine these materials to provide scientific evidence to assist in the investigation and court proceedings, and thus work closely with the police. Senior forensic scientists, who usually specialize in one or more of the key forensic disciplines, may be required to attend crime scenes or give evidence in court as impartial expert witnesses on many occasions [1-5].

1. In a case where half of all currency notes were estimated to be contaminated with detectable traces of cocaine it was established that minutes traces of cocaine were transferred from hand-banknote and from banknote-to-banknote and so on. This principle enables forensic scientists to establish links between crime scenes and suspects.
2. Gas Chromatography combined with Mass Spectroscopy (GM-MS) to identify seized drugs (as little as million-millionth of a gram).
3. DNA profiling to help identify a murder suspect from bloodstain found at the crime scene/ useful in resolving paternity and immigration disputes.
4. Cells from the saliva extracted from a cigarette butt or a piece of chewing gum left near the crime scene by criminals can provide enough DNA to obtain a DNA profile of the individual, thereby linking them to the crime scene.
5. Sticky sweet wrappers left near the crime scene by criminals acts as ‘magnets’ to hairs and fibres, and sometimes enable forensic scientists to match those found at the crime scene with those found on the suspect’s person or clothing.
6. Bullet identification and comparison in killings using ballistics by measuring bullet calibers and matching them with a suspected murder weapon.
7. Anthropometry technique as an identification system based on physical measurements assisted with Crime-scene photography.
8. Toxicology examination/arsenic detection (as little as one-fiftieth of a milligram) in suspected poisoning cases.
9. Laser Raman spectroscopy to identify microscopic paint fragments.
10. Bare foot prints and palm prints are unique to the individual in just the same way as fingerprints are. Failure to recognize this simple fact cost a young burglar a two-year prison sentence. Before entering the premises he had removed his shoes and socks, placing the socks over his hands so as not to leave any latent fingerprints at the scene. Instead he left a nice clear set of incriminating latent footprints and he was caught.
11. Trace evidence such as shoe and tyre impressions and handwriting analysis, known as questioned document examination.

Applications

Many potential applications of forensic science exist. Most forensic scientists will examine the evidence objectively and render an opinion based upon the evidence. The expert’s opinion may support the investigator’s case; however, the investigator should also be prepared to hear that the evidence does not support the investigator’s case. In any case the scientific analysis of physical evidence can be helpful to the investigator. It may provide the objective proof needed to support the case or if it disputes the investigator’s case, it might lead the investigator to an alternate solution of the case [1-8].

1. Criminalistics is the application of various sciences to answer questions relating to examination and comparison of biological evidence, trace evidence, impression evidence, controlled substances, ballistics, and firearm and tool mark examination, in criminal investigations.
2. Forensic intelligence process starts with the collection of data and ends with the integration of results within into the analysis of crimes under investigation.
3. Dactyloscopy (study of fingerprints) and Podiatry (study of feet footprint or footwear).

4. Blood Spatter Analysis is the scientific examination of blood spatter patterns found at a crime scene to reconstruct the events of the crime.
5. Digital forensics is the application of proven scientific methods and techniques in order to recover data from electronic/ digital media.
6. Mobile devices forensics is the scientific examination and evaluation of evidence found in mobile phones, e.g. Call History and Deleted SMS, and includes SIM Card Forensics.
7. Forensic interviews are conducted using the science of professionally using expertise to conduct a variety of investigative interviews with victims, witnesses, suspects or other sources to determine the facts regarding suspicions, allegations or specific incidents in either public or private sector settings.
8. Forensic video analysis is the scientific examination, comparison and evaluation of video in legal matters.
9. Animal Crime Scene Analysis with a focus on the recognition, documentation, and prevention of various types of physical evidence involving animal abuse, cruelty, neglect and death.
10. Wildlife Forensic Science applies a range of scientific disciplines to legal cases involving non-human biological evidence, to solve crimes such as poaching, animal abuse, and trade in endangered species.
11. Trace evidence analysis is the analysis and comparison of trace evidence including glass, paint, fibres and hair (e.g., using microspectrophotometry).
12. Computational forensics concerns the development of algorithms and software.
13. Art forensics authentication methods are used to detect and identify forgery, faking and copying of art works, e.g., paintings.
14. Other potential applications of forensic science are document examination, toxicology, psychology, psychiatry, serological investigation, anthropology, archeology, pathology, botany, chemistry, geophysics, entomology, geology, linguistics, engineering, limnology, meteorology, optometry, seismology, accounting, astronomy, aerial photography.

FORENSIC SCIENCE AND HUMANITARIAN WORK

The international Committee of the Red Cross (ICRC) uses forensic science for humanitarian purposes to clarify the fate of missing persons after armed conflict, disasters or migration, and is one of the services related to Restoring Family Links and missing relative can often make it easier to proceed with the grieving process and move on with life for families of missing persons [1-8].

Technologies

Artificial Intelligence (AI) is a rapidly evolving field of technology that has become increasingly popular over the past few years. It's often used to refer to machines and computer systems which are capable of making decisions, solving problems and learning from their environment. AI can be further broken down into two main categories namely machine learning and deep learning. Machine learning involves algorithms being fed data in order to recognize patterns and make predictions about future outcomes. Deep learning requires more complex algorithms which are designed for tasks such as natural language processing or predictive analytics [9]. As technology infiltrates every aspect of our lives, solving crimes has become almost futuristic in its advances. From retinal scanning to trace evidence chemistry, actual forensic technologies are very advanced at helping to solve crimes. Forensic science techniques used today have become common knowledge. In fact, there are a number of incredibly new forensic technologies that we probably never know existed. These "cutting-edge" technologies with more than 80% reliability have become accepted techniques [1-6].

1. Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS):

When broken glass is involved in a crime, outing together even tiny pieces can be a key to finding important clues like the direction of bullets, the force of impact or the type of weapon used in a crime. Through its highly sensitive isotopic recognition ability, the LA-ICP-MS machine breaks glass samples of almost any size down to their atomic structure. Then, forensic scientists are able to match even the smallest shard of glass found on clothing to a glass sample from a crime scene.

2. Alternative Light Photography:

This is one of the coolest tools to help see damage even before it is visible on the skin, although there are many tools to help make these calls quickly and accurately. A camera such as the Omnichrome uses blue light and orange filters to clearly show bruising below the skin's surface. Being able to quickly ascertain how much physical damage a patient has suffered can be the difference between life and death.

3. High-Speed Ballistics Photography:

It uses high-speed cameras in order to understand how bullet holes, gunshot wounds and glass shatters are created. Anyone, from a crime scene investigator to a firearms examiner, can operate a high-speed camera without any additional education or training. Identifying and matching the bullet trajectories, impact marks and exit wounds must be done by an expert.

4. Video Spectral Comparator 2000:

For crime scene investigators and forensic scientists, this is one of the most valuable forensic

technologies available anywhere. With this machine, scientists and investigators can look at a piece of paper and see obscured or hidden writing, determine quality of paper and origin and "lift" indented writing. It is sometimes possible to complete these analyses even after a piece of paper has been so damaged by water of fire that it looks unintelligible to the naked eye.

5. Digital Surveillance Fox Xbox (XFT Device):

Most people don't consider a gaming system a potential place for hiding illicit data, which is why criminals have come to use them so much. In one of the most ground-breaking forensic technologies for digital forensic specialists, the XFT is being developed to allow authorities visual access to hidden files on the Xbox hard drive. The XFT is also set up to record access sessions to be replayed in real time during court hearings.

6. 3D Forensic Facial Reconstruction:

Although this forensic technology is not considered the most reliable, it is definitely one of the most interesting available to forensic pathologists, forensic anthropologists and forensic scientists. In this technique, 3D facial reconstruction software takes real-life human remains and extrapolates a possible physical appearance.

7. DNA Sequencer:

Most people are familiar with the importance of DNA testing in the forensic science lab. Still, most people don't know exactly what DNA sequences are and how they may be used. Most forensic scientists and crime lab technicians use what's called DNA profiling to identify criminals and victims using traces evidence like hair or skin samples. In cases where those samples are highly degraded, however, they often turn to the more powerful DNA sequencer, which allows them to analyze old bones or teeth to determine the specific ordering of a person's DNA nucleobases, and generate a 'read' or a unique DNA pattern that can be help identify that person as a possible suspect or criminal.

8. Forensic Carbon-14 Dating:

Carbon dating has long been used to identify the age of unknown remains for anthropological and archaeological findings. Since the amount of radiocarbon which is calculated in a Carbon-14 dating) has increased and decreased to distinct levels over the past 50 years, it is now possible to use this technique to identify forensic remains using this same tool.

9. Magnetic Fingerprinting and Automated Fingerprint Identification (AFIS):

With these forensic technologies, crime scene investigators, forensic scientists and police officers can quickly and easily compare a fingerprint at a crime scene with an extensive virtual database. In addition, the incorporation of magnetic fingerprinting dust and no-touch wending allows investigators to get a perfect impression of fingerprints at a crime scene without contamination.

10. Link Analysis Software for Forensic Accountants:

This software combines observations of unusual digital financial transactions, customer profiling and statistics to generate probabilities of illegal behavior. When a forensic accountant is trying to track illicit funds through a sea of paperwork, link analysis software is an invaluable tool to help highlight strange financial activity.

Future of AI in Forensic Sciences

AI is rapidly becoming the most important applied science in all walks of life. Likewise, the forensic sector will benefit until our system becomes totally de-Pendent on IT. More and more people are recognizing the importance of AI in their lives and are working to better understand it. Forensic science is the do-main of professionals and AI will never reach that level, it will only serve as a complementary tool, we hope. Technology can facilitate expert work, but it will never be able to replace it. Despite the overwhelming success of machine learning, the hardware that runs the system bears little resemblance to the human brain it imitates. The hu-man brain weighs roughly a kilo and a half, and can tell you 'what, where, how many metres' with enough energy to power a light bulb. Today's AIs require weeks of training, several megawatt-hours of power and special processors to achieve anything approaching this level of detail.

In order to bring AI a little closer to the extreme size and energy efficiency of the human brain, 'neuromorphic chips' that mimic the structure of the brain are already being developed. Researchers at the Massachusetts Institute of Technology (MIT) have taken a step in this direction by producing an artificial synapse that can withstand strong electricity and thus outperform biological synapses in terms of speed. Electric fields in the brain are relatively weak, otherwise above 1.23 V the water in the cells would start to break down into hydrogen and oxy-Gen. The speed of the human nervous system is therefore measured in milliseconds. The device developed at MIT operates at 10 volts with pulses of 5 nanoseconds, 10,000 times faster than its biological counterpart. However, its size is very small, a few nanometers - synapses in the human brain are thousands of times larger [13, 14]. But the tool currently faces several limitations. One is that the artificial synapse has three connectors: an output, an input and a regulator that determines the position of the proton, but this makes it difficult to build certain neural nets. More-over, the incorporation of a hydrogen ion moving in the nanochannel makes mass production very difficult. The point is, however, that with further development, components can be produced that can easily be used to build hardware that matches or exceeds the capabilities of the human brain [13, 14]. But let's hope that because the artificial brain is developed by the biological brain, it

will never be like the human brain. Let's hope that machine learning in AI will eliminate cognitive bias but will never replace the role of the thinking human. What will happen to humanity if the singularity of AI occurs, i.e. the artificial mind is brought to the level of the human mind?

CONCLUSION

Forensic science applies medical knowledge in judicial proceedings to authenticate or disprove a criminal charge of theft, assault, rape, accident, poisoning, medical/surgical negligence, suicide attempt, suicide or murder brought against an individual and helps to prove the innocence or guilt of an accused. An inquest by a forensic scientist using medical, scientific and legal knowledge into the circumstances and cause of death, in cases of sudden, suspicious or unnatural deaths with/ without injuries in police custody/ police firing/ jail hearsay/ circumstantial evidence helps in crime detection. It relies upon chemical and physical methods of analysis to create 'fingerprints' or 'signatures' of people. Chemical fingerprinting techniques and sample association methods are generally far more effective in excluding and association than establishing a connection between samples. To confirm an association, all points of comparison must be identical, which usually requires exhaustive analysis and a thorough understanding of the sample. To show that samples are different, it's enough to establish a single point of dissimilarity. Forensic evidence provides impartial scientific evidence that establishes links between crime scenes and suspects. As technology infiltrates every aspect of our lives, solving crimes has become almost futuristic in its advances. From retinal forensic technologies are very advanced at helping to solve crimes. However, it is not uniquely immune from the risk of manipulation. Although forensic science has greatly enhanced the investigator's ability to solve crimes, it has limitations and must be scrutinized in and out of the courtroom to avoid the occurrence of wrongful convictions. The net of law, however, is spread so wide that no sinner from its sweep may hide. The term 'forensic medicine' was used to encompass all aspects of forensic work of a medical nature. In the past, this term was often used interchangeably with 'forensic pathology'. Forensic pathology, however, refers to the branch of forensic medicine which deals with death investigations. Nowadays, the term 'clinical forensic medicine' is applied to the branch of forensic medicine involving the living. Veterinary forensics is an emerging branch of veterinary medicine to prevent animal abuse and cruelty. Veterinary have an array of duties within veterinary forensic science, as animal law is a quickly growing field and is essential to a social policy around the world with legal themes that occur throughout the unique relationship between humans and animals.

Nevertheless, the future is likely to be AI assisted (but not triggered!) forensic expert work in fact-finding for law enforcement purposes. Thus, not only for forensic scientists, but also practicing forensic experts, and indeed law enforcement and all actors in the justice system, need to acquire some basic literacy in AI, machine learning and neural networks.

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