REVIEW ARTICLE

IJETV Vol. 11, Issue 1, 2025 Print ISSN: 2394–6822 Online ISSN: 2395–4272

Identification of Unknown Dead Bodies: Integrating AI and Forensic Biometrics in Facial Recognition, Fingerprint Databases, Forensic Odontology, and DNA Profiling

Shilekh Mittal[1*], Ishwer Tayal[2]

[1]Professor, Department of Forensic Medicine, GGS Medical College, Faridkot, Punjab, India.
[2]Associate Professor, Department of Forensic Medicine, GGS Medical College, Faridkot, Punjab, India.

Abstract

The identification of unknown dead bodies is a pivotal process in forensic medicine, with implications for law enforcement, public health, disaster victim management, and human rights. Conventionally, biometric techniques such as facial recognition, fingerprinting, Forensic odontology, and DNA profiling have been used to establish identity. However, these methods can face significant limitations, especially in cases involving decomposition, mutilation, or a lack of comparative data. The recent integration of artificial intelligence (AI) with forensic biometrics has dramatically enhanced the accuracy, efficiency, and scalability of identification processes. AI algorithms can analyse massive datasets, learn from patterns, and assist in automated decision-making, offering superior performance over traditional manual techniques. This review explores the synergy between AI and key forensic modalities, examines their real-world applications, highlights the challenges in implementation, and considers future directions for a comprehensive and ethically sound Forensic identification framework.

Keywords: Unknown dead bodies, Artificial intelligence, Postmortem identification, Automated identification systems, Disaster victim identification.

Int J Eth Trauma Victimology (2025). DOI: 10.18099/ijetv.v11i01.07

Introduction

The process of identifying unknown deceased individuals is central to both legal and humanitarian obligations. Whether due to accidents, homicides, suicides, or mass disasters, unidentified bodies pose serious social and investigative challenges. Traditional methods often require ante-mortem records, which may not always be available or accessible. Moreover, manual analysis is time-consuming and prone to human error.[1]

Technological advances—particularly in artificial intelligence and machine learning—are revolutionising the field of Forensic.[2] By incorporating AI into biometric systems, Forensic experts can now handle large-scale identification efforts with unprecedented accuracy and speed. AI's ability to recognise patterns, optimise comparisons, and learn from incomplete datasets makes it an ideal companion in Forensic applications.[3]

Facial Recognition and Artificial Intelligence

Facial recognition is commonly used in the early stages of identification when the deceased's face is still relatively intact. Traditional facial comparison involves visual inspection or morphometric analysis, but these are hindered when facial features are distorted due to trauma or decomposition.[4]

AI enhances facial recognition through convolutional neural networks (CNNs) and deep learning algorithms, which are capable of extracting facial features even from low-quality or altered images. Software like FaceNet and Amazon Rekognition can detect and match facial landmarks with databases containing millions of images. [5] These tools are useful in matching images from missing person databases, passports, surveillance footage, or even social media.[5]

Moreover, AI can assist in facial reconstruction. In cases where only the skull is recovered, algorithms can generate probable facial appearances using predictive modelling. While still developing, these techniques are being tested for use in archaeological and Forensic anthropology contexts.[3]

Nevertheless, challenges remain, especially regarding algorithm bias, the need for high-quality data, and privacy issues related to image scraping and surveillance.[2]

Fingerprint Identification Enhanced by AI

Fingerprints have been used in forensics for over a century due to their uniqueness and permanence.[1] The evolution from manual comparison to automated fingerprint identification systems (AFIS) marked a turning point in Forensic identification.

Corresponding Author: Shilekh Mittal, Professor, Department of Forensic Medicine, GGS Medical College, Faridkot, Punjab, India, e-mail: shilekh@gmail.com

How to cite this article: Mittal S, Tayal I. Identification of Unknown Dead Bodies: Integrating AI and Forensic Biometrics in Facial Recognition, Fingerprint Databases, Forensic Odontology, and DNA Profiling. Int J Eth Trauma Victimology. 2025;11(1):30-32.

Source of support: Nil

Conflict of interest: None

Received: 16/06/2025; **Received in revised form:** 22/07/2025; **Accepted:** 25/07/2025; **Published:** 07/08/2025;

Today, AI further advances this capability by enhancing degraded prints and improving matching accuracy[3].

Deep learning models can identify ridge patterns and minutiae even in partial, smudged, or decomposed fingerprints[3]. These systems are especially useful in postmortem situations where conventional ridge analysis may fail due to tissue degradation[3]. Machine learning is also being used to improve the speed of searching vast fingerprint databases like the FBI's IAFIS or India's NAFIS.[7,9]

An additional development is the use of AI in ridge pattern classification. By learning from thousands of known prints, AI can classify and match latent prints with minimal human input, thereby reducing workload and increasing objectivity[3].

However, limitations still include variability in print quality, missing fingerprints due to decomposition or trauma, and the need for integration across law enforcement agencies.[7]

Forensic Odontology and AI-based Analysis

Dental identification is a robust method used particularly in mass disasters, as teeth and restorations are resilient to decomposition and fire. Traditional dental identification involves manual comparison of dental records and X-rays with postmortem findings, which can be time-consuming and subjective.[4]

AI significantly optimises this process by using radiograph matching algorithms[3]. These algorithms compare postmortem dental X-rays with large databases of ante-mortem records using pattern recognition and shape-matching techniques. AI also aids in identifying unique dental characteristics like crowns, root patterns, and fillings.[3]

Furthermore, AI-driven 3D modelling helps in reconstructing dentition from skeletal remains, especially when soft tissues are absent. These reconstructions are often used in combination with facial reconstructions to improve identification confidence.[4]

Despite these advances, challenges persist—particularly in populations lacking consistent dental records or in under-resourced regions where digital dental records are not routinely maintained[2].

DNA Profiling and Machine Learning

DNA profiling is the gold standard for human identification. Short tandem repeat (STR) analysis is the most widely used method, offering high discriminatory power. However, DNA analysis can be time-intensive and complex, particularly in cases involving degraded samples or DNA mixtures[8].

AI has been increasingly employed to enhance DNA analysis. Machine learning models assist in mixture interpretation, anomaly detection, and rapid database matching.[3] AI also facilitates predictive DNA phenotyping, a technique that predicts physical characteristics—such as eye colour, hair type, and ancestry—from genetic material[8]. Tools like the Parabon Snapshot use such models to generate facial sketches based on DNA extracted from remains.[9]

Another significant contribution is kinship analysis. AI can rapidly match unknown DNA profiles with those of relatives in missing person databases, thereby streamlining investigations and reducing reliance on direct comparisons.[3]

Yet, AI applications in genomics are data-intensive and require significant computational infrastructure, posing challenges in resource-limited settings.[2]

Multimodal Biometric Integration

One of the most promising applications of AI in forensic identification lies in the integration of multiple biometric systems.[3] A single modality may be inconclusive or unavailable; hence, combining fingerprints, facial recognition, dental data, and DNA enhances reliability and redundancy.[1]

AI platforms can process and cross-verify data from various sources to build a comprehensive identity profile.[3] In mass disasters, for instance, AI-assisted systems can simultaneously evaluate facial images, dental charts, and genetic information to expedite victim identification.[10] Such integrated systems also support probabilistic reasoning, offering statistical confidence in identification outcomes[3].

Multimodal systems can be particularly useful in combating identity fraud, cross-border crimes, and undocumented deaths, where conventional methods often fall short.[3]

Ethical, Legal, and Implementation Challenges

While AI enhances forensic identification, it also raises significant ethical and legal questions. Consent, data security, algorithmic bias, and surveillance concerns are at the forefront of debates. Unregulated use of facial recognition or DNA databases may violate individual rights and lead to wrongful identification or discrimination.[2]

Moreover, the implementation of AI tools requires standardisation across agencies and countries.[7] Many Forensic labs lack the digital infrastructure or trained personnel to operate such systems effectively. Inconsistencies in data collection formats, privacy legislation, and database accessibility further hinder seamless integration.[2]

To address these challenges, a comprehensive framework involving policy-makers, technologists, Forensic experts, and legal professionals is required. International collaboration and open-source platforms may also help democratize access to Forensic AI tools.[6]

Future Directions

The future of forensic identification lies in real-time, AI-driven analysis integrated with national and international biometric databases. Initiatives like India's crime and criminal tracking network system (CCTNS), INTERPOL's Biometric Hub, and the FBI's NGI (Next Generation Identification) system are moving in this direction.[6,7]

Wearable devices, smart sensors, and mobile forensics are also likely to converge with AI-based biometric tools. Moreover, advances in explainable AI (XAI) will ensure greater transparency and accountability in automated decision-making.[2]

Continued investment in research, capacity-building, and cross-sector collaboration will be key to fully realising the potential of AI in Forensic identification.[2]

Conclusion

The integration of artificial intelligence with traditional forensic biometric techniques marks a new era in the identification of unknown deceased individuals. Whether through AI-enhanced facial recognition[5], fingerprint analysis[3], dental imaging[4], or DNA interpretation[8], these technologies collectively offer unparalleled efficiency and accuracy. While significant ethical, legal, and infrastructural challenges remain, the potential benefits of AI-driven Forensic identification are transformative.[2] As technology advances, the Forensic community must adopt a balanced, responsible, and inclusive approach to ensure that the identification of the dead upholds both scientific integrity and human dignity.

References

1. Jain AK, Ross A, Nandakumar K. *Introduction to Biometrics*. New York: Springer; 2011.
2. Parmar P, The Integration of Artificial Intelligence in the Forensic Medicine and its Applications in Medico-Legal Autopsy, Forensic Toxicology, and Disaster Victim Identification. Int J Forens Sci 2023; 8(4): 331.
3. Wankhade TD, Ingale SW, Mohite PM, Bankar NJ. Artificial intelligence in Forensic Medicine and Toxicology: The Future of Forensic Medicine. *Cureus*. 2022;14(8):e28376.
4. De Angelis D, Cattaneo C, Grandi M. Dental superimposition for identification. *Forensic Sci Int*. 2007;168(2–3):212–8.
5. Schroff F, Kalenichenko D, Philbin J. FaceNet: A unified embedding for face recognition and clustering. In: *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*; 2015. p. 815–23.
6. INTERPOL. Biometric identification systems [Internet]. Lyon: INTERPOL; 2022 [cited 2025 Aug 1]. Available from: https://www.interpol.int
7. National Crime Records Bureau. *CCTNS and Fingerprint Bureau Report*. New Delhi: Government of India; 2023.
8. Kayser M. Forensic DNA phenotyping: Predicting appearance from DNA. *Forensic Sci Int Genet*. 2015;18:33–48.
9. Parabon NanoLabs. Snapshot DNA phenotyping [Internet]. 2023 [cited 2025 Aug 1]. Available from: https://snapshot.parabon-nanolabs.com/
10. Das S, Pandey SK, Chakraborty P. An approach for identification of individuals in a mass disaster in Indian setup. *J Indian Acad Forensic Med*. 2022;33(2):67–9.