Forensic Gait Analysis and AI Enhanced CCTV Evidence in Indian Criminal Trials

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ABSTRACT

While CCTV footage has long been part of a traditional investigation process in India, forensic gait analysis, the technique of recognising a person by the way they walk or move, is a newer method that is gaining popularity in the courtroom. This paper will discuss what gait analysis is and how it uses artificial intelligence to enhance movement profiling, as well as the implications of using these types of evidence when determining someone's guilt or innocence. The purpose of this paper is to explain the scientific foundation behind gait analysis, discuss why it is scientifically weak and context-dependent, and provide sound reasoning for why artificial intelligence tools that provide probabilistic evidence can potentially mislead a court.

Using this scientific context, the article places gait and movement identification in the context of expert witness statutes and electronic evidence under the Indian Evidence Act and Bharatiya Sakshya Adhiniyam (BSA). In addition, it discusses recent court rulings regarding the use of video camera footage for identification purposes. Furthermore, it discusses current issues around the use of AI-generated forensic evidence and links these developments to constitutional rights such as the right to privacy, protection against self-incrimination, and the right to a fair trial. Finally, the article suggests a series of recommendations to Indian courts on how to use gait and movement identification in a scientifically sound manner while preserving individual rights, including: minimum standards for video recordings; evidence must be corroborated with other physical evidence; evidence must be accepted by experts trained specifically in the area of gait and movement identification; evidence must include clearly documented methods and error rates; and evidence must be corroborative in nature rather than conclusive in nature.

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1. INTRODUCTION

CCTV cameras are everywhere you go in India (in fact, they are the only form of surveillance, ever, to exist anywhere). They have become part of many criminal investigations using artificial intelligence to enhance blurry video (or still) images, detect "suspicious activities" based on motion patterns (the way something moves over time) and perform facial and/or pattern recognition, utilising vast databases and applying some of the same methods as a detective does when looking for a suspect. As the use of technology continues to grow and expand through various cities, through the recent growth of "smart policing", courts are routinely asked to accept information generated by these systems as unbiased and not as subjective evidence, but as reliable evidence using the scientific method[1].

Examples of how unique developing uses of AI, such as gait-based identification and AI-assisted digital foot printing/motion evidence, represent contemporary advancements within the broader scope of criminal and civil justice include forensic gait analysis and electronic aerial surveillance systems. Additionally, several law enforcement agencies are not only using the footage from their respective closed-circuit television cameras to identify an individual, but sometimes may be using software capable of analysing an individual's mannerisms or physical activity from the frame in which they appeared. This article will argue that gait-based identification systems, as well as AI-assisted digital identification systems, provide an opportunity for reliable and valid identification of individuals for trial, but trials must implement stricter standards for reliability and transparency before relying on these type systems when evaluating guilt or innocence.

Hidden in plain sight at the scene of most major crimes is a witness; the overwhelming presence of closed-circuit video cameras has created pools of visual evidence available to average citizens. Through these vast collections of video data, a new forensic capability has developed; evidence that a person can be identified through the distinctive characteristics of their walk (or

[1] *Arjun Panditrao Khotkar v Kailash Kushanrao Gorantyal*, (2020) 7 SCC 1

gait). Gait pattern analysis presents a unique opportunity for the legal system to both provide a valid and reliable means of identification and raise concerns regarding the introduction of this new forensic capability into our legal system.

In the past, the ways to establish a person's identity in a medico-legal environment have focused on things that have a scientific basis and are backed by scientific procedures, such as fingerprints, scars, tattoos, teeth and DNA. Whereas gait changes with the type of shoe you are wearing, your mood at the time of an incident, any injury that you may have, whether you have consumed alcohol, your age, and the environment that you are in, therefore, gait as a form of personal identification has many more variables and is also considered to be a more dynamic characteristic. In fact, police forces and other experts in various jurisdictions have begun offering opinions to Courts regarding whether or not an accused person 'matches' the gait of a person who was recorded on CCTV in another location. With the development of new artificial intelligence tools to help extract movement markers from video and to compare those movement markers to other movement markers that are stored in other databases, gait will be part of a much larger database of algorithmic forensic evidence.

Indian law has just begun to catch up with this trend. While both the Evidence Act and the new Bharatiya Sakshya Adhiniyam mention expert opinions and electronic evidence in a general manner, neither applies to either gait-based identification or AI-generated forensic outputs. Consequently, trial courts have no clear guidance on how best to use gait as an aid to identification, although they often choose to attribute varying importance to it - in fact, many courts have not applied anything close to the rigorous reliability standards that apply, for example, in DNA cases. Thus, this creates a complex problem with respect to the criminal justice system, which is already dealing with wrongful identifications, issues of discriminatory policing, and a lack of transparency regarding the use of technology.

The purpose of this article is to demonstrate that forensic gait analysis, particularly when used with artificial intelligence video analysis, should always be considered as a form of evidence that has a high level of risk associated with its use and is determined exclusively through probabilities. The evidence should not be used alone to convict someone, and it must only be admitted when there are adequate methodological, procedural and constitutional protections in place. The article will use forensic science literature, Indian evidence law and comparative studies from other jurisdictions that have experimented with gait evidence, to develop the admissibility and weight guidelines specific to the Indian situation and rights-based.

2. Scientific and Medico-Legal Basics of Gait

Forensic gait analysis connects biomechanics with identification. In basic terms, this is the systematic analysis of a person's walking or running movements and then comparing this movement pattern to images or footprints that are associated with the crime. It utilises a significant body of clinical gait-analysis and podiatry in developing these answers, but uses these insights to answer the legal question of whether the person seen on the CCTV or presumed from footprints is the same person standing in the dock.

3. Methods and Features Examined

In casework, four broad approaches tend to overlap rather than exist in isolation:

3.1. Visual comparison from video

The examiner uses CCTV footage of the unidentified individual and the suspect from different recording devices, generally with similar conditions (recording angle, speed of movement, and clothing worn). The examiner looks for visual characteristics, for example, overall posture of body (e.g., upright or bent-forward), arms swinging when moving, length of stride, whether head positioned forward, whether a limp or whether they display asymmetry when walking; other specific behaviours (e.g., foot position or how outwardly the right foot turned compared to the left foot).[2]

3.2. Video-based measurement and annotation

Here, the same footage is slowed down, stabilised or enhanced using video software so that joint angles, timing between steps, path of movement and other kinematic features can be observed more systematically. The examiner may mark key frames, trace limb positions, or overlay comparison grids to highlight similarities and differences between the questioned and reference recordings.[3]

[2] Ashish Badiye, Prachi Kathane and Kewal Krishan, 'Forensic Gait Analysis' in *StatPearls* (StatPearls Publishing 2025) <https://www.ncbi.nlm.nih.gov/books/> accessed 20 December 2025.
[3] *Id*

3.3. Forensic podiatry and footprint evidence

When footprints or footwear impressions are recovered at the scene, a forensic podiatrist examines foot shape, arch type, deformities, pressure patterns and wear marks, and relates them to clinical findings in the suspect. Gait enters the picture because many of these features, such as uneven shoe wear, callosities or altered toe-off, are the physical imprint of how a person habitually walks.[4]

4. AUTOMATED AND AI-BASED RECOGNITION

Computer-vision systems convert video into a sequence of silhouettes or skeletal key-points and use machine-learning models to compare this pattern across a database of known individuals. These systems typically generate a similarity score or rank-ordering of candidates, rather than a simple yes/no answer, and still require human interpretation.[5]

Across these methods, certain typical gait features keep appearing in reports and codes of practice:

- **Spatial measures**: step length, stride length, step width, foot angle, lateral sway.
- **Temporal measures**: cadence (steps per minute), stance and swing times, symmetry between left and right sides.
- **Kinematic features:** degree of knee flexion, hip rotation, ankle dorsiflexion, trunk tilt, arm swing and head movements.
- **Qualitative markers:** obvious limps, use of a walking aid, habitually flexed or stiff joints, or distinctive bouncing or shuffling styles.[6]

For instance, imagine a robbery captured on slightly elevated CCTV. Although the perpetrator's face is concealed by a cap and a mask, the narrow gait, little-to-no arm swing on the right side, and a very distinct outward turned left foot can be observed in the footage. The police subsequently acquire video of a suspect walking down a similar corridor a number of months later. An expert in podiatry may note that the suspect has a similarly narrow step width,

[4] 'Gait, Footprints, and Footwear: How Forensic Podiatry Can Identify Criminals', *Police Chief* (30 April 2025) <https://www.policechiefmagazine.org/gait-footprints-and-footwear-how-forensic-podiatry-can-identify-criminals/> accessed 20 December 2025

[5] F Naemi *et al*, 'A Comprehensive Review of Gait Analysis Using Deep Learning Approaches in Criminal Investigation' (2024) *PeerJ Computer Science* <https://pmc.ncbi.nlm.nih.gov/articles/PMC11622936/> accessed 20 December 2025

[6] Note 1

restricted right arm swing due to an old injury, and marked abducted left foot. Accordingly, the legal question is: to what extent do these common traits indicate that the subjects of both images are in fact the same individual?

5. KEY SCIENTIFIC CRITIQUES AND MEDICO-LEGAL CAUTIONS

Despite its intuitive appeal, the scientific foundation of forensic gait analysis remains relatively modest compared to older identification tools like fingerprints or DNA. Critical reviews emphasise several problems that directly affect how courts should treat such evidence.

- **Limited validation and small datasets:** Many published studies use small, homogeneous samples, often healthy volunteers walking in controlled laboratory settings rather than large, diverse populations in real-world conditions. As a result, there is still insufficient data on how rare particular gait combinations truly are across populations, and on how often different people might coincidentally share similar visible features.[7]
- **Difficulty of true individualisation:** Scientific reviews stress that, with current knowledge, gait should be treated as a contributor to identification, not a stand-alone identifier equivalent to DNA. Gait features vary within the same individual over time and context, and many distinctive-looking patterns are simply not unique enough to support absolute conclusions about identity.[8]
- **High variability due to environment and health:** Speed, surface, footwear, carried loads and camera angle all alter how a person appears on video; fatigue or intoxication may temporarily exaggerate or mask features such as limping or sway. A person's gait can be affected by all sorts of illnesses, including arthritis, neurological conditions and recent injuries, so simply because a person was observed walking (in the footage from an offence) several weeks later, the person may not have the same gait as shown in that video.[9]
- **Observer bias and methodological inconsistency:** When experts rely on visual scoring, bias and inconsistency in methodology can result from expert's knowledge of suspect's identity or any other evidence about the case; therefore, the similarities and differences that experts attribute to a suspect's gait can potentially be altered by such knowledge. Additionally, there are minor differences between evaluating checklists, descriptors and

[7] Michael P Birch *et al*, 'Critical Review of the Use and Scientific Basis of Forensic Gait Analysis' (2018) 3 *Forensic Science Review* 183 <https://pmc.ncbi.nlm.nih.gov/articles/PMC6201773/> accessed 20 December 2025
[8] *Id*
[9] Note 1

scales used among practitioners and laboratories, making it difficult to compare or replicate findings across cases.[10]

6. International Calls for Caution in Courts

Numerous academic articles and professional draft code reviews say that courts should only consider gait evidence if there are clear guidelines, documentation, and limitations spelt out. Further, these documents stress that judges and juries must be made aware of the limited validation of gait analysis, potential error rates, etc., and that they need to see gait as peripheral, or supportive, evidence.[11]

From a medico-legal perspective, these criticisms point in one direction: gait analysis may be an appropriate investigative tool and an additional line of evidence in a mosaic of evidence; however, currently there is neither the empirical base nor the standardisation that would permit gait to support a finding of identification independently. Courts that treat gait evidence as conclusive could cross over from being methodical, principled sciences to making speculative decisions based on the appearance of scientific justification.

7. Indian Statutory Framework: Expert and Electronic Evidence

Indian law deals with forensic gait evidence at two levels: as expert opinion and as electronic records. Sections 45–51 of the Indian Evidence Act[12] create the basic gateway for opinions of specialists, while Sections 65A - 65B[13] lay down a special code for admitting information contained in electronic records, such as CCTV footage. The newer Bharatiya Sakshya Adhiniyam (BSA) retains this dual structure, but updates the language and explicitly highlights expert opinion on digital material in Section 39 and linked provisions on electronic records.

7.1. Sections 45–51: expert opinion and identity

Sections 45 to 51 of the Evidence Act fall under the heading "opinions of third persons, when relevant"[14]. Section 45 makes the opinion of a person "specially skilled"[15] in foreign law, science, art, handwriting or finger impressions a relevant fact when the court has to form an

[10] Note 6
[11] *Id*; Forensic Science Regulator, *Forensic Gait Analysis: Draft Code of Practice* (2018) <https://assets.publishing.service.gov.uk/media/5b3500d140f0b60b48621ced/2018_Forensic_Gait_Analysis_Consultation_Draft.pdf> accessed 20 December 2025
[12] Indian Evidence Act, 1872, s 45–51
[13] ibid s 65A–65B
[14] ibid s 45–51
[15] *Id*

opinion on such matters.[16] Over time, courts and commentators have treated forensic medicine, ballistics, DNA profiling, handwriting comparison, fingerprint analysis and similar disciplines as falling comfortably within this clause.[17] The Law Commission, in its 185th Report,[18] examined these provisions and recommended that the section be read widely enough to include other forms of scientific identification, such as footprints, voice samples and other biometric traits, rather than being confined to the examples listed in the text.

Sections 45A to 51 then provide further scaffolding. Section 45A (inserted later) recognises the opinion of an "Examiner of Electronic Evidence" under the Information Technology Act as relevant when the court must form an opinion on information stored or transmitted in electronic form. Sections 46 to 51 deal with related issues: how facts supporting or inconsistent with expert opinion can be proved, how a person's handwriting or signature may be proved by opinion, and when the opinion of non-experts (for example, persons acquainted with someone's handwriting) becomes relevant.[19] For forensic gait analysis, these provisions together suggest that a suitably qualified forensic podiatrist or gait specialist can testify as an expert under Section 45, while an Examiner of Electronic Evidence can assist on the technical quality, extraction and processing of the CCTV material on which the gait opinion is based.

For example, in a street-robbery case, the main link to the accused is a CCTV clip showing a masked person with a distinctive limp. A forensic podiatrist compares the gait in that clip with controlled recordings of the accused and offers an opinion on similarities and differences. At the same time, a government examiner certifies that the CCTV file is genuine, unaltered and meets basic technical standards. Legally, the court is receiving two layers of expert help under Sections 45 and 45A: one on biomechanics and one on electronic authenticity.

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[16] *State of H.P. v Jai Lal* AIR 1999 SC 3318

[17] 'Opinion of Third Persons When Relevant', *Drishti Judiciary* (31 October 2024) <https://www.drishtijudiciary.com/to-the-point/bharatiya-sakshya-adhiniyam-&-indian-evidence-act/opinion-of-third-persons-when-relevant> accessed 20 December 2025

[18] Law Commission of India, *185th Report on Review of the Indian Evidence Act, 1872* (March 2003) <https://cdnbbsr.s3waas.gov.in/s3ca0daec69b5adc880fb464895726dbdf/uploads/2022/08/2022081047.pdf> accessed 20 December 2025

[19] 'Opinion of the Examiner of Electronic Evidence under Indian Evidence Act, 1872', *iPleaders* (21 August 2020) <https://blog.ipleaders.in/opinion-examiner-electronic-evidence-indian-evidence-act-1872/> accessed 23 December 2025

7.2. Sections 65A–65B: electronic records as "documents"

Sections 65A and 65B form a special, self-contained code for proving the contents of electronic records. Section 65A states that such contents may be proved only in accordance with Section 65B, while Section 65B deems information contained in an electronic record printed, stored or copied from a computer to be a "document" if certain conditions about regular use and proper functioning of the device are satisfied. Crucially, when secondary evidence of an electronic record is relied on, Section 65B(4) requires a certificate from a responsible person describing the device, how the copy was produced and affirming that the conditions in Section 65B(2) are met.[20] Supreme Court case law has repeatedly held that these provisions are mandatory: Sections 63 and 65 on ordinary secondary evidence do not apply where electronic records are concerned.[21]

For gait evidence based on CCTV, this means the video material itself must first clear the Section 65B hurdle; only then does the expert's analysis of that material become relevant under Section 45. If there is no proper evidence supporting the source as an electronic document, then the gait opinion may be viewed as lacking credibility/merit due to it being based on an electronic document that was not properly introduced into evidence. This added requirement of process enhances the issue of whether the evidence was enhanced or altered using an AI tool, and whether there are additional layers of electronic documentation resulting from each step in the processing of the evidence.

7.3.Bharatiya Sakshya Adhiniyam and AI-Driven Gait Tools

The Bharatiya Sakshya Adhiniyam reorganises evidence law but preserves the core distinction between expert opinion and electronic records. Section 39 of the BSA[22] broadly corresponds to Section 45, recognising opinions of experts on matters of foreign law, science, art and identity, and adding a specific subsection on matters relating to information stored or transmitted in electronic or digital form. Under sub-section (2), when a court has to form an opinion on any issue involving electronic or digital information, the opinion of an Examiner of Electronic Evidence appointed under the Information Technology Act is expressly made a relevant fact, confirming and strengthening the earlier Section 45A route.

[20] *Id*
[21] *Anvar P V v P K Basheer* (2014) 10 SCC 473
[22] Bharatiya Sakshya Adhiniyam, 2023, s 39

Electronic records themselves are dealt with in provisions such as Sections 62 and 63 of the BSA,[23] which carry forward and refine the scheme of Sections 65A and 65B of the Evidence Act. Commentators note that these sections continue to treat electronic evidence as a special category requiring clear conditions of admissibility and, in many situations, certification or technical proof.[24] In combination, Section 39 and the electronic-evidence provisions give a structured path for dealing with AI-driven gait tools:

- The underlying CCTV and processed files must satisfy the BSA's rules on electronic records; and
- The interpretation of movement patterns, algorithm outputs and similarity scores must come from experts who can explain both the biomechanical reasoning and the functioning and limitations of the AI system.

In practical terms, AI-based gait tools would be treated much like other AI-generated forensic outputs: the system's operation, training data and error rates would be matters on which expert opinion is relevant, but the court must still insist on proper authentication and disclosure of how the electronic record was produced. This framework gives Indian courts a statutory basis to demand transparency and reliability from AI-driven gait evidence, rather than accepting algorithmic scores at face value.

Courts in India and abroad have begun to encounter gait evidence mainly through CCTV-based identification, but they treat it cautiously and usually as corroborative rather than decisive proof.[25]

8. Indian Practice: "Gait Test" and CCTV Identification

Indian discussion of the "gait test" largely comes from recent high-profile trials and commentary rather than a long line of appellate precedents. In the Saki Naka rape-murder case in Mumbai, the trial court relied on a forensic report comparing the accused's walking pattern, captured on a sample video, with CCTV footage from the crime scene; the scientific officer explained gait features such as arm and leg movement, stride and body build, and the court

[23] *Id* s 62 & 63
[24] 'Admissibility and Proof of Electronic Records', Tamil Nadu State Judicial Academy <https://www.tnsja.tn.gov.in/article/electronic_records_article.pdf> accessed 23 December 2025
[25] Ioana Macoveciuc, Carolyn J Rando and Hervé Borrion, 'Forensic Gait Analysis and Recognition: Standards of Evidence Admissibility' (2019) 64 *Journal of Forensic Sciences* 1294 <https://discovery.ucl.ac.uk/10073084/> accessed 24 December 2025

treated her evidence as corroboration of identity alongside other material.[26] Commentators analysing this judgment have argued that such expert opinions fall within Section 45 (science) read with Section 45A and Sections 65A–65B, and that gait, as a form of behavioural biometric, should be treated as expert assistance rather than a simple visual impression of the judge.[27]

At the same time, doctrinal writing points out that CCTV-based identification generally has been admitted under Sections 9 (facts establishing identity), 45 (expert opinion) and 65B (electronic records), with courts insisting on proper certification of the footage and often warning that visual identification from grainy video is vulnerable to error.[28] A detailed Indian blog analysis of one murder case describes how a forensic expert compared the accused's walk with the CCTV clip, but, under cross-examination, conceded that the movements were "similar" rather than "same"[29] and that footwear, injury or trauma could alter gait leading the author to argue that such evidence should be presented only as supportive, with its limitations clearly acknowledged under Section 45.[30] Together, these materials show that Indian courts have started accepting gait reports as relevant expert opinion resting on CCTV, but there is as yet no settled appellate standard on how much weight to give them or how rigorously to scrutinise methodology.

9. Foreign Cases: Video Quality, Method and Error-Rate

Foreign courts, especially in the UK and some Commonwealth jurisdictions, provide a richer set of judgments on forensic gait analysis, many of which are surveyed in "Guarding the Gait" and related literature. In Otway v The Queen,[31] an English Court of Appeal case, the prosecution relied on a podiatrist who compared 20 seconds of CCTV footage of an offender walking with police-station footage of the accused; the court accepted that gait analysis was a developing science but allowed the expert to describe similarities in movement, emphasising that it was for the jury to evaluate that evidence after viewing the footage themselves. In Hashi

[26] 'Explained: How a "Gait Test" Helped Establish Identity of Accused in Mumbai Rape-Murder', *Indian Express* (Mumbai, 4 June 2022) <https://indianexpress.com/article/explained/everyday-explainers/gait-analysis-explained-walk-can-point-role-crime-saki-naka-rape-murder-7952768/> accessed 24 December 2025
[27] Pratyush Singh, 'Guest Post — Gait Analysis and the Evidence Act', *The Proof of Guilt* (20 September 2022) <https://theproofofguilt.blogspot.com/2022/09/guest-post-gait-analysis-and-evidence.html> accessed 24 December 2025
[28] Pranav Sethi, 'Admissibility of CCTV Recordings as Evidence in Courts', *iPleaders* (30 May 2021) https://blog.ipleaders.in/admissibility-cctv-recordings-evidence-courts/ accessed 24 December 2025.
[29] Note 23
[30] *Id*
[31] *Otway v R* [2011] EWCA Crim 3

v The Queen,[32] an appeal from the United Kingdom, each side had a different podiatric expert analyze poor quality CCTV footage for distinctive gait features, and both used their respective expert to argue their side of the appeal on whether or not the footage was sufficient to allow for reliable analysis. In addition, the appellate court conducted a close examination of such issues as frame rate, image clarity, the expert's qualifications, and whether population-level claims about rarity were overly inflated.

The "Guarding the Gait"[33] examines cases where courts in Canada and Australia have either partially or completely excluded gait evidence based on insufficient quality of video footage; lack of sufficient explanations provided by the expert regarding factors such as clothing, angle and speed; or lack of support from peer-reviewed literature regarding the expert's claimed level of certainty in the exact error rate. The overwhelming majority of these cases show a consistent pattern of appellate courts admitting gait but treating gait as very weak evidence, subject to additional conditions such as camera angle, amount of footage captured, video resolution, how the methodology is documented, and the expert expressing their opinion with a reasonable degree of certainty. If these conditions are not met, the court has placed greater weight on the sufficiency of the conditions as opposed to the evidence and has devalued gait testimony, highlighting the necessity for clear standards to permit the use of gait testimony where gait is a significant factor in a conviction.

10. AI-ENHANCED GAIT AND FOOTPRINT EVIDENCE

Artificial intelligence is being integrated into the daily operations of law enforcement throughout the country due to its ability to identify people through facial recognition and video analytics. Police forces use large infrastructure projects, such as metropolitan areas' "safe city" projects and city-wide CCTV camera grids, to use the same technological abilities for identifying suspects by their gait (the way a person walks) and by their footprints. A significant number of AI tools have been built into the vast majority of these systems to help locate crimes. For example, in Delhi, thousands of cameras are now equipped with facial recognition technology that allows police to recognise individuals at various locations and compare faces from multiple sites with criminal databases within a split second. According to all case studies,

[32] *Hashi v The Queen* [2013] VSCA 288

[33] Ian Freckelton, 'Guarding the Gait: Evaluating Forensic Gait Analysis Evidence' in *Forensic Analysis: Scientific and Medical Techniques and Evidence under the Microscope* (IntechOpen 2021) <https://www.crime-scene-investigator.net/PDF/guarding-the-gait-evaluating-forensic-gait-analysis-evidence.pdf> accessed 24 December 2025

there have been many instances in which individuals were arrested solely due to matching faces from a facial recognition search, without any supporting evidence verified independently.[34] Similar tools are being deployed elsewhere. Nagpur's SIMBA/CrimeGPT platform combines facial recognition, speaker identification and automated analysis of CCTV, images and audio to pull up dossiers on suspects and generate real-time alerts for officers on the ground.[35] Once a city installs AI that can stabilise, enhance and analyse body movement in videos for facial recognition or crowd analytics, repurposing the same infrastructure to extract and compare gait signatures is a natural technological step.

Indian researchers have expressed concern that the rapid introduction of algorithmic tools has exceeded the ability to develop standards for determining the legitimacy of objects used as evidence, and their reliability, as well as ensuring that constitutional safeguards are satisfied. A detailed analysis of the use of AI as evidence under the Evidence Act states that although the Evidence Act's Section 65B provides a procedural check for the admissibility of electronic documents into evidence, that statute does not set any guidelines or requirements for courts to consider in determining whether or not to admit as evidence the outputs of opaque, proprietary AI systems that have been trained using unknown datasets. This study calls for amendments to the Evidence Act to define "AI evidence," require disclosing the underlying architecture, training data and error rates of AI systems that provide exhibits to courts, and require that courts provide oversight of the use of AI evidence.[36] Other analyses of AI-reviewed digital evidence and facial-recognition systems highlight recurring concerns: biased or skewed datasets, lack of transparency about how similarity scores are generated, difficulties in cross-examining an algorithm, and the risk that judges may treat colourful dashboards and numerical confidence scores as more scientific than they truly are.[37] When mapping criticisms against the body of literature on gait analysis/footprint and gait analysis as a tool for an unbiased form of police

[34] Vidhi Centre for Legal Policy, *The Use of Facial Recognition Technology for Policing in Delhi: An Empirical Study of Potential Religion-Based Discrimination* (2021) <https://vidhilegalpolicy.in/research/the-use-of-facial-recognition-technology-for-policing-in-delhi/> accessed 24 December 2025

[35] 'AI-Powered "SIMBA" to Aid Nagpur Police in Fighting Crime', *IndiaAI* (2024) <https://indiaai.gov.in/article/ai-powered-simba-to-aid-nagpur-police-in-fighting-crime> accessed 24 December 2025

[36] Deepanker Singhal and Pragya Narang, 'AI-Generated Evidence in Indian Courts: Admissibility, Reliability and the Chain of Custody Challenge' (2025) 5(5) *Indian Journal of Integrated Research in Law* 186 <https://ijirl.com/wp-content/uploads/2025/09/AI-GENERATED-EVIDENCE-IN-INDIAN-COURTS-ADMISSIBILITY-RELIABILITY-AND-THE-CHAIN-OF-CUSTODY-CHALLENGE.pdf> accessed 24 December 2025

[37] Trishita Chatterjee, 'Admissibility of AI-Reviewed Digital Evidence in Legal Investigations' (2025) 5(2) *Indian Journal of Integrated Research in Law* 2056 <https://ijirl.com/wp-content/uploads/2025/04/ADMISSIBILITY-OF-AI-REVIEWED-DIGITAL-EVIDENCE-IN-LEGAL-INVESTIGATIONS.pdf> accessed 24 December 2025

study, the problems are evident. If an artificial intelligence system processes, normalizes and compares one person's gait pattern to another's gait patterns in advance of an expert viewing the video, the final expert opinion will be shaped not only by the diversity of human gait but also by the underlying implicit assumptions built into the institution that produced it. Accepting the findings produced by an artificial intelligence "black box" without insisting on full and rigorous rational justification and independent verification will allow institutions to use artificial intelligence to determine issues of identity, and therefore may undermine Evidence's basic principles as well as the constitutional due process and fairness requirements under Article 21.

11. CONSTITUTIONAL AND RIGHTS-BASED ANALYSIS

The uncertainty regarding a probabilistic gait match raises significant issues regarding constitutional protections, such as the right to a fair trial, the presumption of innocence, and the prosecution's burden of proof. When a judge or jury hears that a scientist or AI has provided a 'match' between an accused's gait (using CCTV footage), and the majority of them have been determined to be inaccurate, then there is a significant risk that this will be misinterpreted as virtually indisputable, diminishing the standard of proof being beyond a reasonable doubt. If the courts do not require scientific methods to be clearly explained; error rates to be indicated; etc.; then the courts may in effect, permit a questionable scientific inference to be used to shift the burden of proof in practice such that the accused will be forced to disprove an AI or scientist assertion of an evidence-based or AI-based conclusion of identity and the prosecution must prove identity by using a credible, corroboration and direct evidence only.[38]

Article 21's[39] guarantee of life and personal liberty,[40] as interpreted from Maneka Gandhi[41] onwards, requires that any procedure leading to conviction be fair, just and reasonable; scholars on AI-generated evidence argue that admitting opaque algorithmic outputs without proper scrutiny violates this "due process" dimension, because the accused cannot meaningfully challenge or cross-examine a system whose inner workings, training data or biases are concealed.[42] The presumption of innocence, now widely recognised as a human right grounded

[38] Heemani Amarsingh Rajput, 'AI Evidence in Courtrooms: Challenges to Fair Trial and Due Process', *Lawful Legal* (10 July 2025) <https://lawfullegal.in/ai-evidence-in-courtrooms-challenges-to-fair-trial-and-due-process/> accessed 24 December 2025
[39] Constitution of India 1950, art 21
[40] *Justice K.S. Puttaswamy v Union of India* (2017) 10 SCC 1
[41] *Maneka Gandhi v Union of India* (1978) 1 SCC 248
[42] Note 33

in Article 14[43] and 21, is undermined if courts allow speculative, probability-based gait evidence to compensate for weak investigative work, or to fill gaps where traditional identification evidence is missing. In such situations, the sophisticated appearance of AI-processed videos and numerical similarity scores may mask the fact that the underlying inference is no more reliable than a cautious, non-expert visual comparison.

Although gait analysis does not directly extract verbal statements, the Supreme Court's reasoning in Selvi v. State of Karnataka[44] offers a powerful rights-based lens for evaluating intrusive forensic techniques. In Selvi[45], the Court held that compulsory narco-analysis, polygraph and brain-mapping violated Article 20(3)'s[46] protection against self-incrimination and Article 21's guarantees of dignity, mental privacy and fair trial, emphasising that the State cannot short-circuit constitutional safeguards by using "scientific" shortcuts to obtain evidence from within a person's body or mind. Scholarly discussion of AI-generated evidence extends this logic: if AI-driven behavioural analysis or predictive tools begin classifying individuals as "high-risk" or inferring guilt from patterns of movement, association or past data, such inferences may replicate the coercive and privacy-invasive features condemned in Selvi, only now mediated through algorithms rather than direct interrogation.[47]

From this perspective, compulsory participation in AI-driven gait or movement profiling (for example, being required to walk repeatedly before cameras so that software can learn and compare one's gait) raises at least two constitutional questions. First, whether compelling a person to produce highly individualised behavioural and biometric data for the purpose of establishing guilt edges towards "testimonial compulsion" in a broad sense, when combined with other evidence, thereby engaging Article 20(3)'s rationale that the State must prove its case without forcing the accused to assist. Second, whether deploying opaque, potentially biased AI systems to process such data without clear statutory safeguards, avenues for challenge and independent validation offends Article 21's requirement of a fair, transparent and non-arbitrary trial procedure, and Article 14's demand for equality before the law. Properly understood, constitutional doctrine therefore supports a cautious stance: gait and AI-processed

[43] Constitution of India 1950, art 14
[44] *Selvi v State of Karnataka* (2010) 7 SCC 263
[45] *Id*
[46] Constitution of India 1950, art. 20(3)
[47] Siddharth Peter de Souza, 'AI and the Indian Judiciary: The Need for a Rights-Based Approach', *The Hindu Centre for Politics and Public Policy* (28 November 2024) <https://www.thehinducentre.com/incoming/ai-and-the-indian-judiciary-the-need-for-a-rights-based-approach-html-version/article68917505.ece> accessed 24 December 2025

movement evidence may be used, if at all, only with strict voluntariness, transparency and reliability safeguards, and always as one modest strand in a larger evidentiary web rather than as the silent algorithmic witness that decides the case.

12. Proposed Doctrinal Test and Reforms

A structured doctrinal test would help Indian courts handle gait and AI-processed movement evidence with the same care now expected for DNA or other sophisticated forensics. Drawing on foreign codes of practice and critical reviews, the focus should be on admissibility first, weight later: the court must decide whether the evidence should enter at all, and then how much reliance it deserves.

12.1. Multi-step admissibility and weight test

12.1.1. Electronic authenticity and integrity (gateway step)

The prosecution must first prove the CCTV and all processed versions (stabilised, enhanced, AI-analysed clips) as electronic documents under Section 65B / BSA equivalents, with clear certification identifying the devices, software and processing steps used. Any gaps in the chain, like missing original files, unexplained alterations, or undocumented enhancement should normally be fatal to the admissibility of gait opinions based on that material, or at least significantly reduce their weight.[48]

12.1.2. Minimum video-quality and recording standards

Before permitting expert gait testimony, the court should determine whether the footage meets basic quality thresholds suggested in foreign draft codes: sufficient resolution to see limb movement, adequate frame-rate, stable camera position, reasonably consistent lighting and an uninterrupted sequence of several gait cycles. Where these conditions are not met, for example, a few frames from an erratic, low-light camera, the default position should be exclusion of formal gait analysis, leaving only cautious, non-expert observation of what is visible to any lay viewer.[49]

[48] Akshat Pande *et al*, 'Section 65B of the Indian Evidence Act, 1872 – Requirements for Admissibility of Electronic Evidence Revisited by the Supreme Court', Cyril Amarchand Mangaldas Blog (25 July 2020) <https://corporate.cyrilamarchandblogs.com/2020/07/section-65b-of-the-indian-evidence-act-1872-requirements-for-admissibility-of-electronic-evidence-revisited-by-the-supreme-court/> accessed 24 December 2025

[49] Forensic Science Regulator (n 10); Birch *et al* (n 6)

12.1.3. Expert qualification and independence

Experts should have demonstrable training in gait analysis, biomechanics or forensic podiatry, not merely general police experience with CCTV. Courts should prefer independent experts (forensic institutes, hospital-based gait labs, or neutral government facilities) who are not involved in the initial investigation, to reduce confirmation bias; where only prosecution-linked experts are available, this relationship must be disclosed and factored into weight.[50]

12.1.4. Transparent methodology and limitations

The expert must provide a written report explaining, in plain terms, the features examined (e.g., stride length, limb asymmetry, foot angle), how they were measured or described, and what comparison framework was used. The report should also list limitations: video constraints, possible alternative explanations (injury, footwear, fatigue), and any assumptions made about the suspect's usual gait. Courts should be wary of bare assertions of "match" without this methodological spine.[51]

12.1.5. Known or at least discussed error-rates and research base

Even if the precise numerical error rates might not be known, the expert will be able to provide information from literature, such as the database of studies (including samples/size and validity), about whether there is present science supporting individualisation or only very cautious/ probabilistic conclusions. Judges should treat claims of high certainty with scepticism unless backed by robust empirical work; unsupported assertions should be trimmed at the admissibility stage or treated as carrying very low weight.[52]

12.1.6. Special conditions for AI-assisted analysis

Where AI tools have been used to enhance, track or compare gait, the prosecution should disclose at least: the type of software used, whether it is commercially off-the-shelf or custom, the kind of training data employed (e.g., number and diversity of subjects), and any available evaluations of accuracy or bias. Courts should insist that AI-generated similarity scores are explained in language the defence and judge can understand, and should forbid the presentation

[50] Forensic Science Regulator (n 10)
[51] *Id*
[52] Note 6

of algorithmic output as a binary "identification"; instead, it should be described as one fallible input into the human expert's opinion.[53]

12.1.7. Corroboration requirement and limits on standalone use

As a matter of doctrine, gait and AI-processed movement evidence should be treated as corroborative only: convictions should not rest solely or even primarily on gait matches, especially where identity is contested.[54]

Judges should direct themselves that such evidence can strengthen an existing identification case but cannot create one by itself in the absence of other reliable strands such as eyewitnesses, confessions free from taint, location data or other forensic links.

13. Legislative Tweaks and Practice Directions

13.1. Clarifying the scope of expert opinion

Parliament could amend the illustrative portion of Section 45 / BSA Section 39 to expressly refer to "biometric identifiers such as fingerprints, DNA, footprints, voice, gait and other movement-based characteristics", signalling that behavioural biometrics fall within the expert-opinion framework and should be subject to the same scientific scrutiny.[55]

A new Explanation could require courts, when dealing with novel or emerging sciences, to consider factors like peer-review, known error-rates, existence of professional standards and acceptance in the relevant scientific community, borrowing from foreign admissibility tests.

13.2. Defining AI-generated forensic outputs

The Bharatiya Sakshya Adhiniyam could be supplemented with a definition of "AI-generated forensic output" covering algorithmic analysis of images, audio, video, behavioural patterns and other digital traces, with a provision that such material is admissible only if the party relying on it discloses the system used and provides sufficient technical information for the court to assess reliability.

[53] Note 31
[54] Note 28
[55] Note14; Note 31

A schedule or set of rules, framed under the Act, could lay down minimum documentation requirements for AI tools used in policing, including logs of processing, version history and validation reports.

13.3. Practice directions for trial courts and forensic agencies

High Courts, using their rule-making power, could issue practice notes on gait and CCTV evidence requiring:

i. early disclosure of all original and processed video files to the defence;
ii. joint expert meetings where appropriate to narrow issues; and
iii. model directions cautioning fact-finders about the limitations of probabilistic gait and AI evidence.

Forensic laboratories and government examiners could be required, through executive guidelines, to follow a written code of practice for gait analysis, similar to the draft code circulated in the UK, including protocols for video capture, feature description, report writing and peer review before testimony.

13.4. Right-to-Explanation and Defence Access

The right to an explanation of the AI-assisted evidence must be defined through either legislation or judicial precedent in the context of Article 21 and the right to a fair trial. The prosecution must demonstrate the nature of the AI-processed forensics and provide the accused with sufficient details of their functioning to be effective in opposing such evidence, regardless of whether the source code is confidential. Additionally, Legal Aid programs will need to include ways for forensic and AI evidence to assess how to interpret technical terms associated with this technology to facilitate effective representation by defence lawyers and judges, and to ensure that they will not be intimidated by technological vocabulary or be forced to rely solely on varying forms of gait methods and their underlying data reliability.

In short, these tests and reforms to this doctrine will not prevent the use of gait or AI-enhanced evidence; rather they will place a narrow gate through which all gait and AI-enhanced evidence will enter, allowing the fact-finder to understand all of the scientific weaknesses in the gait and/or AI-enhanced evidence used to reach their conclusions and all potential constitutional implications associated with that evidence.

14. CONCLUSION

Gait analysis and AI- Analysed movement do have the potential to provide a very powerful identification tool through traditional CCTV systems, but the scientific and legal basis for providing this as evidence, through studies conducted for this article, is generally weak. According to the limited number of credible validation studies supporting gait as an individualisation method in the forensic arena, the current body of literature constantly cautions against using gait by itself as an independent method of identification and that it should not be equated to finger/ DNA. The highly variable nature of gait due to both environmental and physiological influences on the individual's ability to walk further diminishes its reliability and therefore does not make it appropriate for identification purposes in the same.

Under current Indian law, the information could be used as an electronic record of an expert opinion; however, courts must insist on strict adherence to the rules surrounding electronic evidence, require experts to provide thorough and transparent methodology, and take into account that the output from the AI may be wrong when rendering their decision.

Case law and foreign codes of practice show the continued use of a conservative model for determining admissibility based on the quality of the video, level of expertise of the expert and concurrent acknowledgement of uncertainty. Thus, the gait analysis should be used as supporting evidence, not as conclusive evidence for establishing guilt or innocence.

The use of probabilistic gait and AI-generated similarity scores as a basis for identity cases violates the presumption of innocence, creates an alternative burden of proof, and undermines the Article 21 demand for fair, transparent, and reasonable procedures in criminal trials. When these technologies are deployed in a coercive manner or without proper disclosure, they mirror the concerns raised in Selvi about intrusive "scientific" shortcuts that bypass dignity, mental privacy and meaningful contestation of the evidence presented during trial. Therefore, the safest and most rights-respecting position is that gait and/or AI-enhanced movement evidence should only be used as corroborative evidence and only in the presence of robust safeguards related to authentication, methodology, error rates and disclosure; gait and/or AI-enhanced movement evidence should never serve as the sole or primary basis for a conviction.

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