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MATHEMATICS AND ITS APPLICATIONS IN FORENSICS: CASE STUDIES AND ANALYTICAL APPROACHES

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ABSTRACT

Aim:

This paper aims to critically review the role of mathematics in forensic science, emphasizing how quantitative methods enhance the analysis, interpretation, and validation of forensic evidence. It explores statistical, geometrical, and computational approaches used across diverse forensic disciplines and illustrates these through landmark case studies.

Methodology: A comprehensive literature review was conducted focusing on forensic applications of mathematical techniques such as statistical modeling, Bayesian inference, geometric morphometrics, and machine learning. Selected case studies— including DNA profiling in the Colin Pitchfork case and bite mark analysis in the Ted Bundy investigation—were analyzed to demonstrate practical applications. Emerging computational methods and their integration into forensic workflows were also examined.

Results:

Mathematical methodologies provide objective frameworks that increase the reliability and reproducibility of forensic analyses. Statistical models quantify evidentiary strength via likelihood ratios and probabilistic reasoning. Geometric and pattern analysis facilitate accurate biometric comparisons, while machine learning enhances automated evidence classification. Case studies confirm that mathematical rigor significantly contributes to successful forensic investigations and judicial outcomes.

Conclusion:

The integration of advanced mathematical tools is indispensable for modern forensic science, improving the precision and transparency of evidence evaluation. Continued interdisciplinary collaboration and methodological innovation are essential to address current challenges and fully leverage mathematical techniques in forensic practice.

***K*eywords** Forensic science · Mathematics · Statistical modeling · Bayesian interference · geometric morphometrics · machine learning · forensic evidence

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