

# FORENSICS

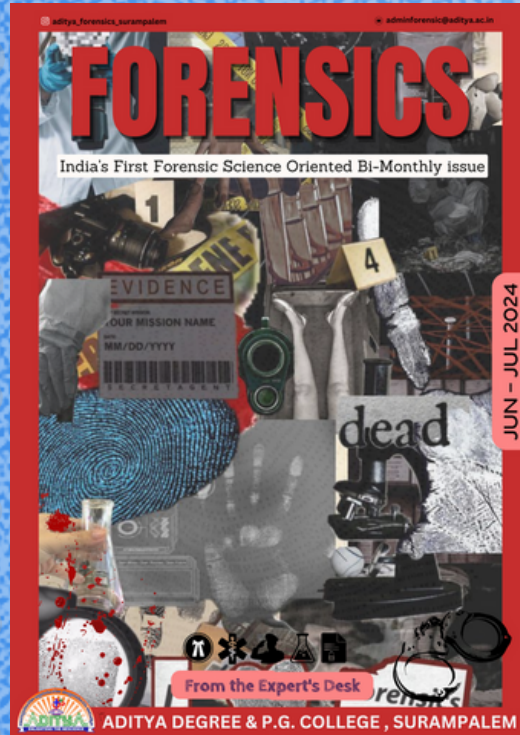
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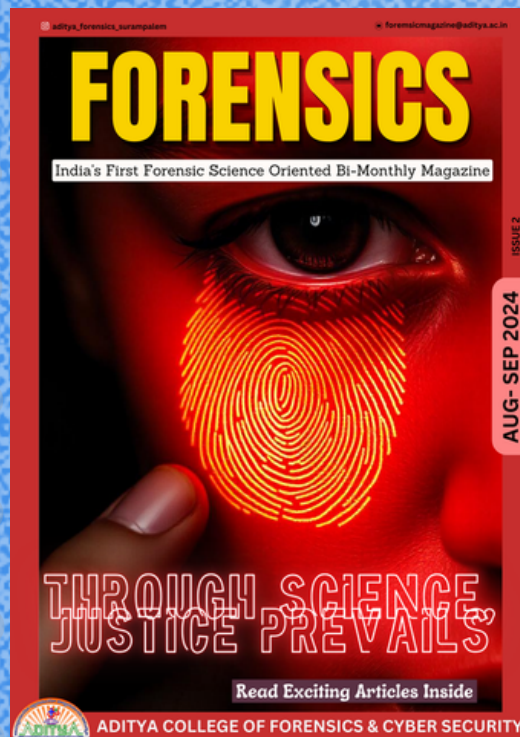
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ISSUE - 3



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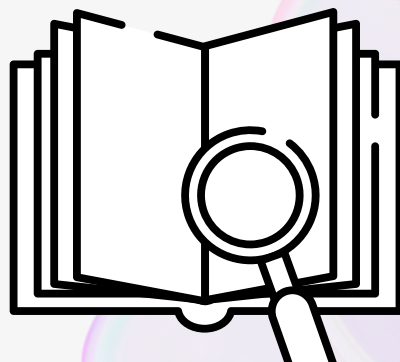
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# From the Management's Desk

I am thrilled to announce the release of the third issue of India's first bimonthly forensic science magazine, following the remarkable response to our previous issues. This publication stands as a cornerstone in advancing forensic science education and practice nationwide.



**Dr. N. SSHA REDDY**  
CHAIRMAN  
ADITYA EDUCATIONAL  
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Packed with insightful articles and contributions from students, faculty, and industry professionals, this issue delves deeper into the multifaceted world of forensic science, fostering collaboration, innovation, and knowledge sharing within the community.

I am confident that this latest issue will continue to showcase cutting-edge developments while inspiring and educating the next generation of forensic scientists. Thank you to everyone who contributed to this pioneering endeavor. We look forward to seeing its lasting impact in the field.



**Dr. N. SATISH REDDY**  
VICE-CHAIRMAN  
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I am thrilled to present the third issue of India's ground breaking bimonthly forensic science magazine, following the outstanding response to our previous editions. The recognition and encouragement from the forensic science community across the country fuel our dedication to advancing knowledge in this vital field.

This issue brings together a broad spectrum of topics, showcasing insightful contributions from students, faculty, and professionals nationwide, each dedicated to pushing the boundaries of forensic science.

My deepest gratitude goes to the Department of Forensic Science for leading this initiative and I am confident that this magazine will continue to inspire learning and innovation, and strengthening forensic science education and practice in India.



# From the Editor's Desk

Welcome to the third issue of India's first bimonthly forensic science magazine! After the great response to our previous editions, we're excited to bring you the latest in forensic research, breakthroughs, and expert insights.

Your support fuels our passion, and we hope this issue inspires and informs you. We look forward to your feedback as we continue shaping the future of forensic science together!



*Vifas Anil Chavan*  
Editor-in-Chief

This issue upholds our dedication to high-quality content, featuring in-depth research, expert insights, and the latest advancements in forensic science. With contributions from leading professionals, we explore new innovations shaping the field.

Thank you for being a part of this transformative journey as we work together to elevate forensic science in India and beyond.



*Darshan Murali*  
Editorial Head

As Managing Editor, I'm thrilled to present this issue, which continues our commitment to delivering top-notch content. Inside, you'll find detailed research, expert perspectives, and the latest breakthroughs in forensic science, all contributed by leaders in the field.

Thank you for your ongoing support as we work together to push the boundaries of forensic science and drive innovation both in India and globally. Let's continue this exciting journey of discovery and progress!



*B V S S Udaynadh*  
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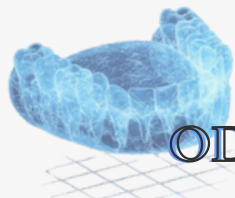


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# CONTROVERSIAL JOURNEY OF FORENSIC ODONTOLOGY IN CRIMINAL INVESTIGATIONS

Author: Mohd Rameez Raza & Dr Anubha Srivastava

Forensics is one of the key supplements to crime investigations, from DNA testing to fingerprint analysis to chemical analysis - it plays a vital role in crime investigation and trial. In contemporary times a new branch of forensics has been used for crime investigations - "forensic odontology". Evaluation of dental injuries and bite marks, identifying deceased people through dental records, or application of any dental knowledge in crime investigations is known as forensic odontology commonly dental forensic. In 1980, Keiser-Nielson coined "forensic odontology" - a branch of forensic medicine, in the interest of justice - that deals with properly handling and examining dental evidence with the proper evaluation and presentation of the dental findings for crime investigations. (Divakar, 2017) Keiser-Nielson believes teeth are ideal for identification in situations where other techniques like fingerprints or DNA are unavailable since, teeth are incredibly resilient and frequently survive harsh environments like fire, decomposition, and trauma. (Pramod, 2012)

## Forensic Odontology and Crime Investigation:

The application of forensic odontology to criminal matters usually involves the analysis of bite marks, examination of dental injuries discovered during criminal investigations, and identification of deceased persons through dental records. Among these two main dental forensics subfields essential to many forensic investigation scenarios are bite mark analysis and dental identification.



Fig 1.1

Analyzing bite marks at a crime scene entails looking for and examining marks made by human teeth on skin or tissue. In serious crimes like homicide, sexual assault, or child abuse, when suspects may bite the victim or engage in physical conflict, this tactic is frequently employed. The presence of bite marks particularly in cases of homicide or other severe crimes, may help identify the nature of the attack (Fig 1.1 and 1.2) and in some cases suspect. (Afsin, 2014).

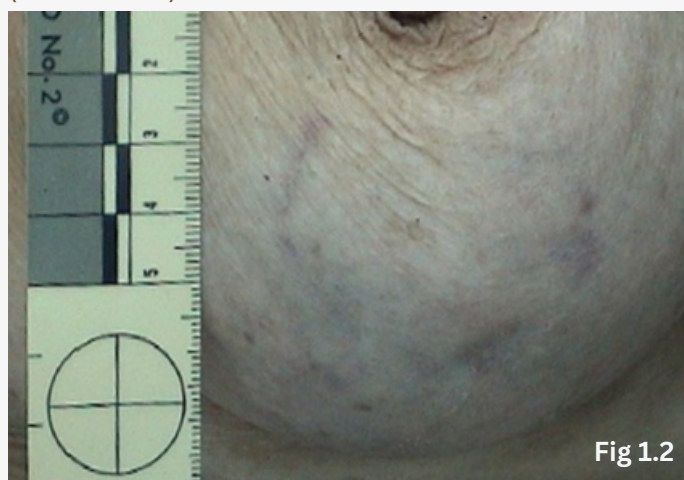


Fig 1.2

Fig 1.1 and 1.2. Bite mark on the face and breast, along with ABFO Scale II. Forensic odontology combined with autopsy helped determine the nature of the case. Picture Credit: Afsin, 2014. CC BY-NC-SA 3.0 Licensed Image.

In several cases saliva is also present with bite marks, which helps to ascertain the suspect who may have created the bite mark (Fig 2), forensic dentists use overlays and models to compare the bite mark to the tooth impressions along with DNA analysis. (Hinchliffe, 2011).

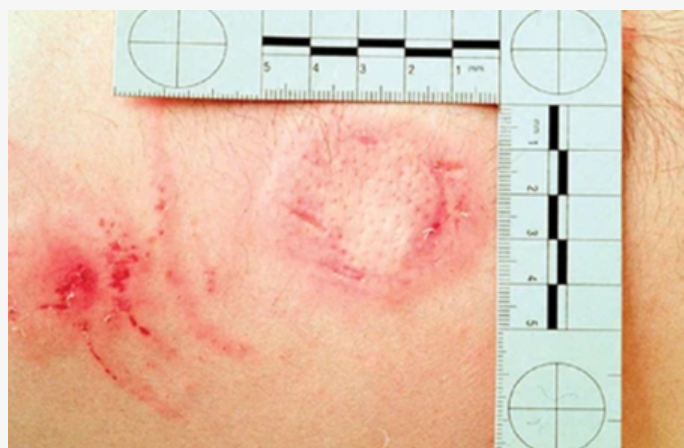


Fig 2. Bite mark injury with ABFO Scale 2, along with the presence of saliva, and injuries caused by fingernails containing DNA. Picture Credit: Hinchliffe, 2011. CC BY-NC-SA 3.0 Licensed Image.

In dental identification establishing an unknown person's identity using dental data is known as dental identity. In circumstances where visual identification is impossible owing to decomposition, trauma, or fire, this procedure is critical for disaster victim identification (DVI), homicide investigations, and other scenarios. Forensic odontologists examine the remains once they have been recovered, noting important details such as tooth structure, and dental treatment such as crowns, fillings, and root canals. Also, wear patterns, and abnormalities, e.g., missing teeth, fractures, or alignment difficulties. (Emam, 2024) Like fingerprints or DNA, each person's dental records are unique, which enables forensic odontologists to produce extremely precise identifications. (Krishan, 2015)

In Indian courts, judges are beginning to acknowledge the value of forensic odontology. When it comes to bite mark analysis and mass catastrophe identification, Indian courts have accepted forensic dental evidence in some cases. However, the absence of codified laws and rules within the legal system concerning the use of forensic odontology results in disparate standards of practice and admissibility across many courts.

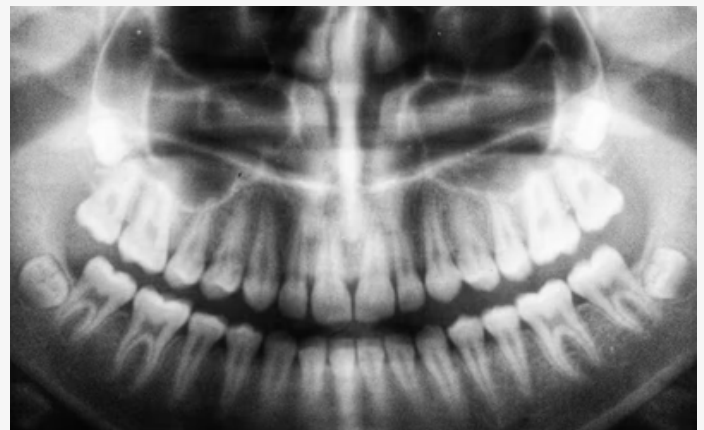
### **Forensic Odontology in Indian Courts**

In India, forensic odontology especially bite mark analysis is contentious, despite its usefulness in solving heinous crimes – the dependability of such evidence in criminal prosecutions has come under scrutiny due to the absence of standardized regulation and specialized trained personnel. (Vij, 2022) Forensic odontologists have tasted some success in India and have proved crucial in identifying victims, establishing age, and connecting suspects to crimes, although it is utilized less frequently than other types of forensic evidence like fingerprints or DNA. Few well-known Indian cases have seen success due to forensic odontology where dental evidence proved crucial.

In the Nirbhaya Case, forensic odontology played a significant role for the very first time in crime investigation, in India.

The victim had bite marks on her body from the assault, and these markings served as important forensic evidence in the prosecution, that provided evidence to convict two accused. The accused's teeth impressions were compared and examined with bite marks found on the victim's body. The bite marks, according to forensic odontologists, matched the accused's dental profile, offering crucial evidence against them. (Balachander, 2015) These bite marks' forensic examination contributed to the proof of the accused's involvement in the crime. In the end, the accused was convicted and received a death sentence.

Nithari Killings, one of the most horrific criminal cases in Indian history – that involved the sexual assault and serial slaughter of several women and children. Numerous human corpses were found in drains, and a large number of the corpses were too decomposed for just traditional identifying techniques, forensic odontology was also used by the investigators. (Raina, 2010) This case set a precedent that forensic odontology can be used to support other types of evidence, in matters of heinous crimes.



In Sheena Bora Case, the identification of the burnt remains of Sheena Bora, after her body had been burned and disposed of in a deserted location in Raigad, Maharashtra, was made possible in large part by forensic evidence, including dental examination. First, it was hard to identify the body because it had burned and decomposed, but the dental characteristics of the remains were compared with Bora's medical records by forensic odontologists, and it was one of the key techniques employed to verify identity. (Deshpande, 2020)



In the Mangalore Plane Crash, forensic odontology played a major role in victim identification following the 2010 Mangalore plane tragedy, in which an Air India flight overshot the runway, killing hundreds of passengers. Conventional methods of identification proved unfeasible for numerous bodies that had sustained severe burns. Using dental data, forensic odontologists were instrumental in identifying the victims. (D'Souza, 2013) Since teeth withstand heat and deterioration, this approach has shown to be among the most successful. This particular instance highlights the significance of forensic odontology in disaster victim identification (DVI) within the Indian context.



analyst's level of experience. Unfortunately, due to doubts over its scientific credibility, bite-mark analysis is rather controversial and mostly not admissible.

During the 2004 Indian Ocean Tsunami, forensic odontology was instrumental in identifying hundreds of victims. Because of the extensive deterioration of the bones, traditional identification techniques were useless - nevertheless, dental data offered trustworthy identification confirmation. This illustrates the critical role forensic dentistry can play in major catastrophes too. (Schuller-Götzburg, 2007).

One of the most well-known applications of forensic odontology - bite mark analysis, has come under fire for lacking scientific validity and consistency. The idea behind bite mark analysis is the conviction that bite marks on victims may be conclusively matched to the distinctive dentition of humans. However, a significant problem for bite mark analysis is the absence of empirical research demonstrating that individual differences in human dentition may be accurately determined, so bite mark analysis is vulnerable to subjective interpretations, resulting in disparate conclusions from different forensic odontologists studying the same bite mark, that could lead to false convictions.

Still, Indian courts do not rely on forensic odontology or the application of dental science to crime investigations. The only exception is determining the age of victims and suspects under the Juvenile Justice (Care and Protection of Children) Act. (Misra, 2022) Else many controversies are obstacles that forensic odontology faces in India, despite its acknowledged efficacy.

Ray Krone Case is a well-known example of a person who was wrongfully convicted of murder, primarily due to bite mark evidence. Before being cleared by DNA evidence, he was imprisoned for ten years. The validity of bite mark analysis was seriously questioned in this case, as was the possibility that it may result in injustices. (Bjerkhoel, 2023)

### **Controversies surrounding Forensic Odontology:**

Numerous criminal investigations and cases, including a few in India, have been solved as forensic odontology has played a larger role, still, the techniques have been controversial, mostly because of questions about scientific validity, the possibility of false convictions, and admissibility in court. Nonetheless, the interpretation is frequently arbitrary and heavily reliant on the forensic

Despite being less contentious than bite mark analysis, the dental identification technique is also not free from controversies. The availability and caliber of personnel for post-mortem and analysis of dental records to determine the accuracy of dental identification can present serious challenges in victim identification in India, where dental records are not regularly maintained.

## **Frye and Daubert Standards on Forensic Odontology:**

In addition to the admissibility of forensic odontology in Indian courts, forensic odontology is controversial due to the Frye and Daubert standards of forensic admissibility that are applied to it in common-law countries. Frye and Daubert's standards also have affected how Indian courts employ forensic odontology. (Selvajothi, 2014)

According to the Frye standard, forensic methods cannot be used in court unless they are widely acknowledged by the scientific community. Further, the Daubert standard mandates that forensic evidence's scientific methodology be verified by testing, peer review, and known error rates in addition to being accepted.

Frye and Daubert's standards have made the application of forensic odontology more challenging to achieve the requirement due to the differing views, especially on bite mark analysis and victim identification among the forensic science community. High rates of error and variability seen in research make forensic odontology difficult to apply the Daubert standards too. Forensic odontology methodologies have been questioned as to whether they satisfy the requirements for Frye standards of acceptable, trustworthy forensic evidence in Indian courts, even though India does not strictly adhere to Daubert when it comes to forensic evidence.

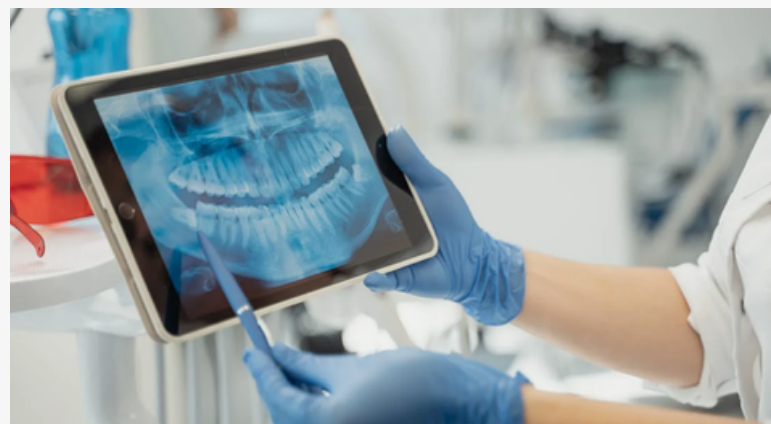


## **CONCLUSION:**

### **Reform and Standardization for Forensic Odontology**

DNA analysis has been the gold standard for forensics in recent years – because DNA analysis yields more conclusive and trustworthy results than forensic odontology, the scientific community has been advocating for its usage more and more, which also satisfies Frye and Daubert's standards. But forensic odontology has the potential, and that has been proved at times, even in the rarest of the matters like Nithari Killings.

Now is the time forensic specialists, academics, and legal professionals demand changes to the way forensic odontology is conducted and presented in court for admissibility. Standardized regulations and techniques are required for forensic odontology, particularly for bite mark analysis, as it would be less confusing if there were clear procedures for gathering, preserving, and analysis, and would satisfy Frye and Daubert's standards too.



Also, a separate cadre of forensic personnel must be trained and certificated in forensic odontology to guarantee that only professionals are permitted to testify in court as experts as required under Indian Evidence laws, to meet the standards of admissibility.

Forensic odontology should only be used in conjunction with other forensic evidence, like DNA or fingerprints, to reduce the possibility of erroneous convictions. In order to evaluate the validity of dental evidence, courts ought to adopt a multidisciplinary strategy consult trained experts from a range of disciplines, and then decide on conviction or acquittal.



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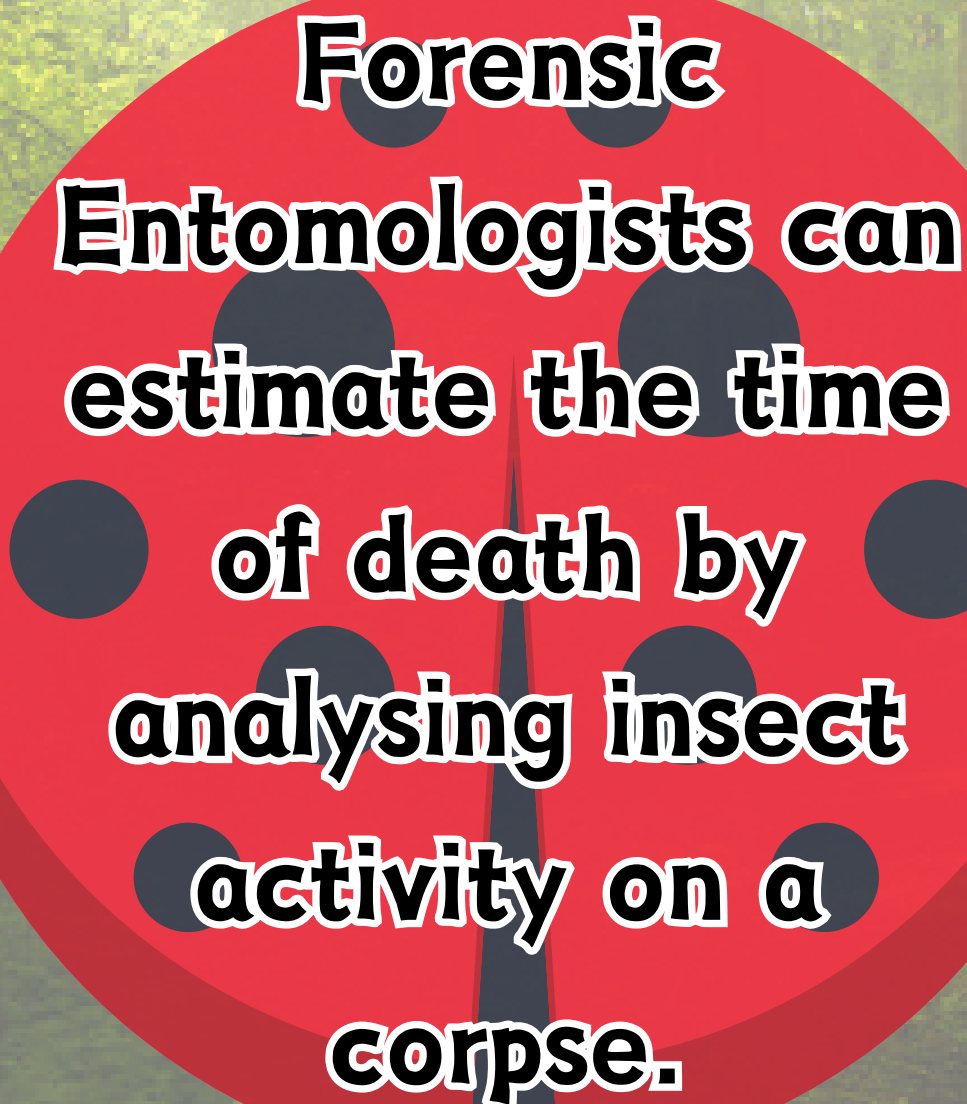
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# DID YOU KNOW?



**Forensic  
Entomologists can  
estimate the time  
of death by  
analysing insect  
activity on a  
corpse.**



# CYBER TERRORISM: THE RISING THREAT IN A DIGITAL WORLD

**Author: Ria Ghosh**

## ABSTRACT

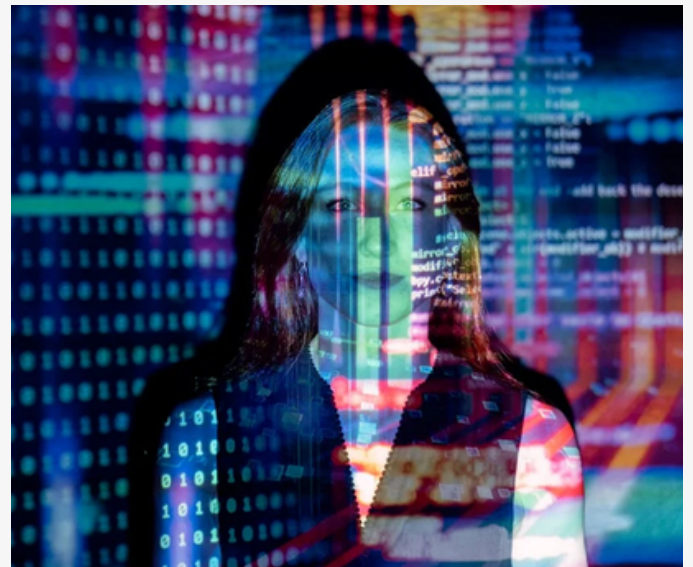
Cyber terrorism represents a growing threat in an increasingly digital world, characterized by the politically motivated use of technology to cause harm and disrupt societies. This article explores the definition of cyber terrorism, its distinguishing features, and the motivations behind it, such as political, ideological, and economic factors. By examining historical incidents, such as the cyberattacks on Estonia and the Colonial Pipeline ransomware attack, the article highlights the significant impact of cyber terrorism on national security, the economy, and societal stability. Furthermore, it discusses the multi-faceted approaches necessary for combating this threat, including strengthening cybersecurity measures, enhancing public awareness, and fostering international collaboration. Ultimately, the article emphasizes the need for proactive strategies to safeguard societies against the evolving landscape of cyber terrorism.

## INTRODUCTION

In the rapidly evolving digital landscape, cyber terrorism has emerged as a significant concern for governments, organizations, and individuals alike. Defined as the politically motivated use of computers and the internet to cause harm or disrupt societies, cyber terrorism presents a unique challenge that transcends traditional notions of warfare and terrorism. This article explores the multifaceted dimensions of cyber terrorism, its implications, the motivations behind it, and the measures taken to combat this growing threat.

## UNDERSTANDING CYBER TERRORISM

Cyber terrorism can be broadly defined as the convergence of cybercrime and terrorism, where malicious actors utilize technology to execute their agendas. The U.S. Department of Defence defines cyber terrorism as “the premeditated, politically motivated attack perpetrated against a computer system, computer program, or data which results in violence against non-combatant targets.” This definition emphasizes the intent to cause harm and disrupt normalcy through digital means.



## CHARACTERISTICS OF CYBER TERRORISM

**1.Motivation:** Unlike traditional cybercrime, which is often motivated by financial gain, cyber terrorism is politically or ideologically driven. Terrorists aim to install fear, cause chaos, or draw attention to their causes.

**2.Targets:** Cyber terrorists may target critical infrastructure (e.g., power grids, transportation systems, and healthcare facilities), governmental institutions, or even private organizations to achieve their objectives.

**3.Methodology:** Cyber terrorists leverage various techniques, including malware, denial-of-service attacks, data breaches, and social engineering tactics. These methods can disrupt services, steal sensitive information, or damage systems.

**4.Anonymity:** The internet provides a veil of anonymity, making it challenging to trace the origins of cyber attacks. This characteristic emboldens terrorists to exploit technology for their purposes.

## HISTORICAL CONTEXT

The roots of cyber terrorism can be traced back to the late 20th century when the internet began to gain traction. One of the earliest examples is the 1999 "New Year's Eve" incident, where hackers disrupted computer systems worldwide in anticipation of the millennium bug. However, it wasn't until the early 2000s that the term "cyber terrorism" gained prominence, particularly after the September 11 attacks in the United States.

The emergence of more sophisticated technology has since enabled various forms of cyber terrorism. High-profile incidents such as the 2007 cyber attacks on Estonia, which targeted government, media, and banking sectors, and the 2010 Stuxnet worm attack on Iran's nuclear facilities showcased the potential of cyber warfare and terrorism. These incidents raised awareness and prompted discussions on the need for robust cyber security measures.

## MOTIVATIONS BEHIND CYBER TERRORISM

Understanding the motivations behind cyber terrorism is crucial in developing effective countermeasures. The motivations can be categorized into several key areas:

**Political Motivations:** Political motivations often drive cyber terrorists to target governmental institutions or infrastructures that represent authority. Groups may seek to challenge or destabilize governments, promote ideologies, or draw attention to specific issues. For example, hacktivist groups like Anonymous have targeted government websites to protest policies they deem unjust.

**Ideological Motivations:** Ideological motivations are prevalent among extremist groups, including religious extremists. Cyber terrorists may use digital platforms to promote their beliefs, recruit members, and incite violence. The Islamic State (ISIS), for instance, has been known to utilize social media for propaganda and to coordinate attacks.

**Economic Motivations:** While traditional cybercrime often revolves around financial gain, cyber terrorism may also intersect with economic motives. Terrorist organizations may seek to disrupt economic activities or extort funds to finance their operations. For instance, ransomware attacks can be seen as a form of cyber terrorism when they target critical infrastructure to maximize disruption.

## THE IMPACT OF CYBER TERRORISM

The impact of cyber terrorism can be profound, affecting individuals, organizations, and nations. The consequences can be classified into several key areas:

**Economic Disruption:** Cyber terrorism can result in significant economic losses, particularly when critical infrastructure is targeted. For instance, a successful attack on a power grid can lead to widespread outages, halting business operations and causing financial strain. The economic ramifications can be felt not only by the immediate targets but also by interconnected industries.





**Psychological Impact:** The psychological impact of cyber terrorism should not be underestimated. The fear and uncertainty generated by cyberattacks can lead to anxiety and panic among the population. For instance, when a major city is targeted, residents may feel vulnerable and insecure, leading to a loss of trust in their government and institutions.

**National Security Concerns:** Cyber terrorism poses a threat to national security, as it can undermine public confidence in government capabilities to protect citizens. The potential for cyber attacks to cause physical harm or loss of life raises alarms among security agencies. Consequently, governments must invest in cybersecurity measures and collaborate with international partners to enhance resilience against cyber threats.

**Societal Fragmentation:** Cyber terrorism can exacerbate societal divisions by promoting fear and distrust among different groups. Targeting specific communities or organizations can lead to increased polarization and conflict, undermining social cohesion.



## CASE STUDIES OF CYBER TERRORISM

Several notable incidents highlight the impact and implications of cyber terrorism. Examining these cases provides insights into the tactics employed by cyber terrorists and the responses from governments and organizations.

### 1. The Estonia Cyber Attacks (2007)

In April 2007, Estonia experienced a series of cyberattacks that targeted government, media, and banking websites. The attacks were triggered by the relocation of a Soviet war memorial, leading to widespread protests.

The attacks were attributed to Russian nationalist hackers, demonstrating how geopolitical tensions can escalate into cyber warfare. The incident underscored the vulnerability of nations to cyber threats and prompted Estonia to enhance its cybersecurity infrastructure.

### 2. The Stuxnet Worm (2010)

Stuxnet is often considered a landmark case of cyber warfare. Developed by the United States and Israel, Stuxnet was a sophisticated worm designed to disrupt Iran's nuclear program. The attack targeted centrifuges at the Natanz facility, causing physical damage and delaying Iran's nuclear ambitions. While Stuxnet is not a traditional example of cyber terrorism, it highlights the potential for cyberattacks to achieve strategic military objectives, blurring the lines between warfare and terrorism.

### 3. The Colonial Pipeline Ransomware Attack (2021)

In May 2021, the Colonial Pipeline, a major fuel supplier in the United States, fell victim to a ransomware attack by the hacker group Dark Side. The attack disrupted fuel supplies along the East Coast, leading to panic buying and fuel shortages. While the incident primarily aimed for financial gain, its impact on critical infrastructure raises questions about the potential for such attacks to be classified as cyber terrorism, given the significant disruption caused to society.



#### **4. Russian Cyber Operations (2023-2024):**

Russian hackers have been actively involved in cyber espionage and politically motivated attacks. In March 2024, they targeted Germany's Christian Democratic Union with a ransomware-laden phishing attack, leaking sensitive communications between German military officials regarding Ukraine. This campaign was part of broader Russian efforts to exploit geopolitical tensions through cyber warfare.

**5. Royal Mail Ransomware Attack (2023):** In January 2023, the UK's Royal Mail was hit by a significant ransomware attack by affiliates of the LockBit Ransomware-as-a-Service group. This attack affected international postal services, highlighting vulnerabilities in critical infrastructure. The attackers encrypted systems and exfiltrated data, using dual extortion tactics to maximize their leverage.

**6. African Union Cyberattack (2024):** In March 2024, the African Union experienced a massive cyberattack, leading to system paralysis for over a week and affecting over 200 devices. The motive behind the attack remains unclear, but the incident demonstrated the potential for cyber terrorists to disrupt intergovernmental organizations on a global scale.

**7. El Salvador's Cryptocurrency Wallet Breach (2024):** In April 2024, hackers breached El Salvador's national cryptocurrency wallet, Chivo, leaking 144 GB of personal information and its source code. This breach, which affected millions of citizens, raised concerns over the security of government-led cryptocurrency initiatives.

### **COMBATING CYBER TERRORISM**

Addressing the threat of cyber terrorism requires a multi-faceted approach involving governments, private sector organizations, and international collaboration. Some key strategies include:

#### **1. Strengthening Cybersecurity Measures:**

Organizations must prioritize cybersecurity by implementing robust measures to protect sensitive information and critical infrastructure. This includes regular security audits, employee training, and adopting best practices for data protection.

#### **2. Enhancing Public Awareness**

Public awareness campaigns can help educate individuals and organizations about cyber threats and the importance of cybersecurity. Increasing awareness can empower citizens to take proactive measures to protect themselves and their information.

#### **3. International Collaboration**

Given the borderless nature of the internet, international cooperation is crucial in combating cyber terrorism. Governments should share intelligence, resources, and best practices to strengthen collective cybersecurity efforts. Organizations like INTERPOL and Europol play vital roles in facilitating cross-border collaboration.

#### **4. Developing Legal Frameworks**

Establishing comprehensive legal frameworks that address cyber terrorism is essential for holding perpetrators accountable. Laws should be updated to reflect the evolving nature of cyber threats, ensuring that law enforcement agencies have the tools necessary to investigate and prosecute cyber criminals.

#### **5. Promoting Research and Innovation**

Investing in research and innovation is crucial for developing advanced cybersecurity technologies. Collaboration between academia, industry, and government can drive innovations that enhance resilience against cyber threats.



## CONCLUSION:

As society becomes increasingly dependent on technology, the threat of cyber terrorism looms large. The convergence of cybercrime and terrorism presents unique challenges that require comprehensive strategies to mitigate risks. By understanding the motivations behind cyber terrorism, the impacts it can have, and the measures needed to combat it, stakeholders can work together to create a more secure digital environment. The battle against cyber terrorism is ongoing, but with vigilance and collaboration, we can strive to safeguard our societies from this evolving threat.

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## ABOUT THE AUTHOR

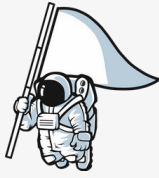


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# SPACE FORENSICS: EXPLORING KEY AREAS AND EMERGING APPLICATIONS



Author: Gaurav Ashok Varade

## Abstract:

Space forensics is an emerging interdisciplinary field at the intersection of aerospace engineering, planetary science, and forensic investigation. As humankind ventures deeper into space exploration and colonization, the need to understand and analyze space-related incidents has grown substantially. This paper explores key areas in space forensics, including satellite failure analysis, extra-terrestrial crime scene investigation, space debris impact assessment, and forensic pathology in space environments. The review of these areas underscores the necessity of developing advanced forensic methodologies tailored to the unique challenges posed by the space environment. Additionally, this article highlights current advancements, limitations, and potential future directions in space forensics research.

## Introduction:

With the increasing reliance on space-based technologies for communication, navigation, defence, and scientific exploration, there is a rising need for specialized forensic techniques that can address incidents and accidents occurring in outer space. The unprecedented scale of space missions, coupled with the rise in private space enterprises and the eventual colonization of extra terrestrial bodies, makes space forensics a critical area of research. Space forensics, defined as the application of forensic science principles to space environments, involves the investigation of accidents, criminal activities, or unexplained events in space or involving spacecraft. i. The extreme conditions of space, including microgravity, vacuum, radiation exposure, and temperature extremes, present unique challenges to forensic investigations.



This paper focuses on several key subtopics within space forensics: satellite failure analysis, crime scene investigation in space, debris impact assessment, and the future of forensic pathology in space environments

## Key Areas of Space Forensics:

### Satellite Failure Analysis:

Satellites are critical infrastructure for modern society, supporting essential functions such as weather forecasting, global positioning systems (GPS), and telecommunications. However, these devices can experience malfunctions or catastrophic failures due to technical defects, space weather, or hostile actions such as cyberattacks or missile strikes. Satellite failure analysis aims to determine the root cause of such failures.

In a space forensics context, satellite failure analysis involves examining telemetry data, analyzing communication logs, and reconstructing failure scenarios. For instance, the failure of the European Space Agency's Ariane 5 rocket in 1996, due to a software error that caused the rocket to veer off course, led to more rigorous standards for satellite software verification and validation [1]. This example highlights the importance of post-failure investigations to improve future mission success rates.

in cases where satellite failures are suspected to result from hostile actions, such as anti-satellite missile tests, forensic investigations can also involve radar tracking data, analysis of debris fields, and detection of unusual energy signatures to distinguish between accidental failures and intentional sabotage .



### **Space Crime Scene Investigation:**

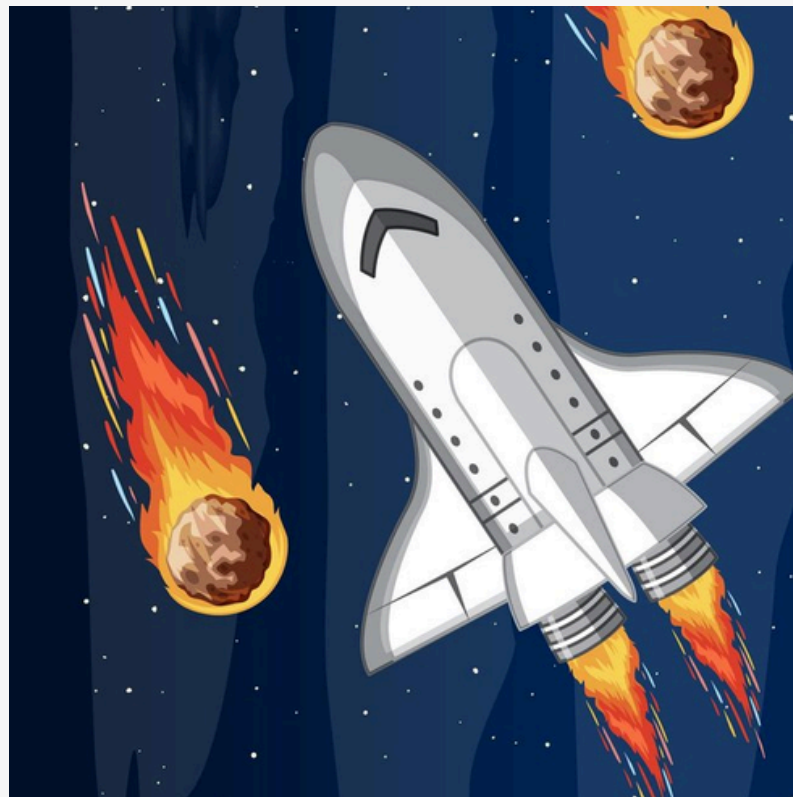
As human activities in space increase, including the presence of astronauts on the International Space Station (ISS) and future missions to the Moon and Mars, the possibility of criminal activities occurring in space becomes a real concern. Space crime scene investigation is a novel subfield of space forensics that could involve the investigation of crimes ranging from theft or sabotage to more serious offenses such as assault or homicide.

One early case in space crime involved astronaut Anne McClain, who was accused of accessing her estranged spouse's bank account from the ISS. This case, although minor, demonstrated the complexities of jurisdiction and legal frameworks when dealing with crimes committed beyond Earth's atmosphere. Space crime investigations may require new forensic techniques adapted to the constraints of microgravity environments, including specialized methods for collecting trace evidence, analyzing fingerprints, and documenting crime scenes without the benefit of gravity.

Forensic experts will also need to consider the unique physiological changes that occur in the human body in space, such as fluid redistribution and altered muscle function, which may affect the interpretation of forensic evidence.

### **Space Debris Impact Assessment:**

Space debris, or orbital debris, refers to the millions of defunct satellites, rocket fragments, and other remnants from past space missions that orbit Earth. Collisions between space debris and active spacecraft pose significant risks to space missions.



### **Forensic Pathology in Space Environments:**

Forensic pathology in space is a relatively unexplored but critical field, particularly as plans for long-duration space missions to Mars and other distant destinations come closer to reality. The human body undergoes several physiological changes in space, including muscle atrophy, bone density loss, and altered cardiovascular function. Understanding how these changes affect forensic pathology is essential for investigating causes of death or injury in space.

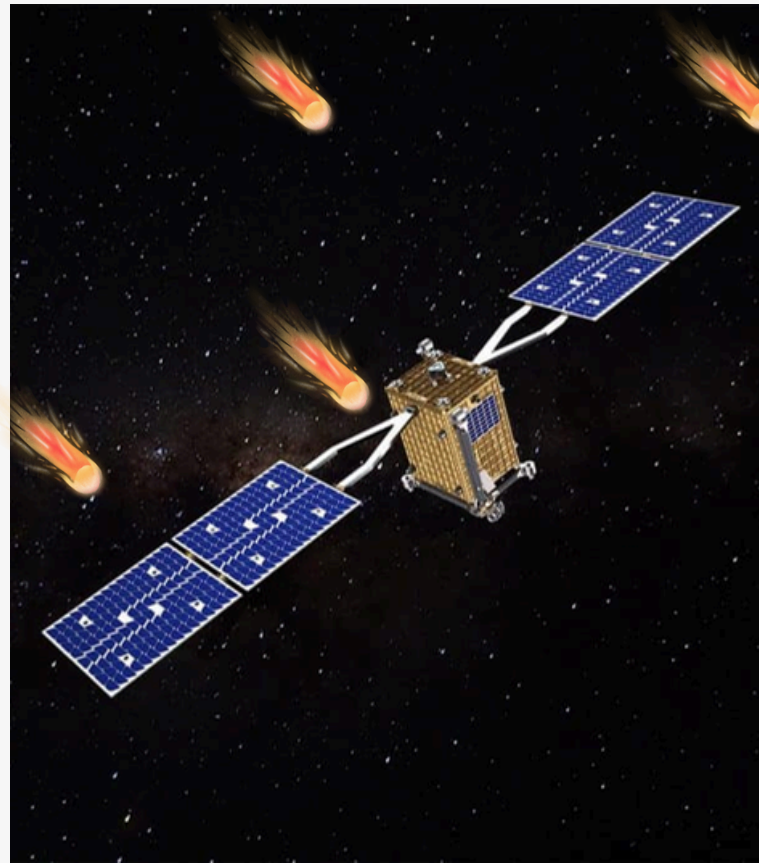
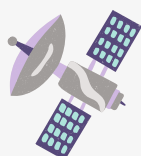
In the event of a fatal incident in space, forensic pathologists will face the challenge of performing autopsies in microgravity, where traditional techniques such as fluid drainage and organ extraction are impractical. Additionally, radiation exposure in space can cause long-term damage to tissues and DNA, complicating forensic analyses. This necessitates the development of novel autopsy tools and methods that can be applied in space habitats or spacecraft. Furthermore, space agencies are currently exploring medical monitoring systems that can record biological data from astronauts in real-time, which may provide valuable forensic evidence in cases of sudden illness or unexplained deaths during space missions.

### Challenges and Future Directions:

The field of space forensics is still in its infancy, and many challenges remain. The primary difficulties include the absence of established forensic protocols for space environments, limited access to space-related forensic data, and the lack of international legal frameworks for addressing crimes in space.

Another challenge lies in the logistics of conducting forensic investigations in space. The vast distances involved, combined with the high cost of space travel, make it difficult to deploy specialized forensic equipment or personnel to space crime scenes. As commercial space travel grows, it is possible that private companies will need to develop their own forensic capabilities to handle accidents or criminal activity on space tourism flights. Emerging technologies such as artificial intelligence (AI) and machine learning could play a significant role in space forensics by automating aspects of failure analysis, crime scene reconstruction, and debris tracking.

Additionally, the use of 3D printing in space environments could allow astronauts to manufacture forensic tools on demand, reducing the need to transport large amounts of specialized equipment from Earth.



### Conclusion

Space forensics is a rapidly evolving field with significant implications for the future of space exploration and colonization. The unique challenges posed by the space environment—ranging from microgravity and radiation exposure to the complexity of international space law—necessitate the development of new forensic methodologies. Key areas of space forensics, including satellite failure analysis, crime scene investigation, space debris impact assessment, and forensic pathology in space, require continued research and innovation to ensure the safety and security of future space missions.

As humanity ventures further into the cosmos, space forensics will play a crucial role in safeguarding space assets, investigating accidents, and addressing legal and ethical issues related to space activities. The field's growth will depend on interdisciplinary collaboration, technological advancements, and the establishment of robust international frameworks for space law and governance.



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**Did You Know?**

**The use of fingerprints for identification dates back to ancient Babylon, where fingerprints were used on clay tablets for business transactions?**

# FORENSIC NURSING: AN INTEGRATED APPROACH TO HEALTHCARE AND THE CRIMINAL JUSTICE SYSTEM

Author: Rekha Basuraj Chavan

## Abstract

Forensic nursing, a rapidly growing speciality in healthcare, integrates clinical practice with law enforcement, bridging the gap between medicine and the legal system. It encompasses the assessment and treatment of victims of trauma, violence, and abuse while ensuring the preservation of forensic evidence. This article explores the key areas of forensic nursing, including sexual assault nurse examination, death investigation, legal nurse consulting, forensic psychiatry, and the care of victims of human trafficking. The article emphasizes the multifaceted role of forensic nurses in both clinical and legal settings and highlights the importance of specialized training to ensure justice for victims and the effective prosecution of perpetrators.

**Keywords:** forensic nursing, sexual assault nurse examiner, death investigation, forensic psychiatry, legal nurse consulting, trauma, human trafficking

## Introduction

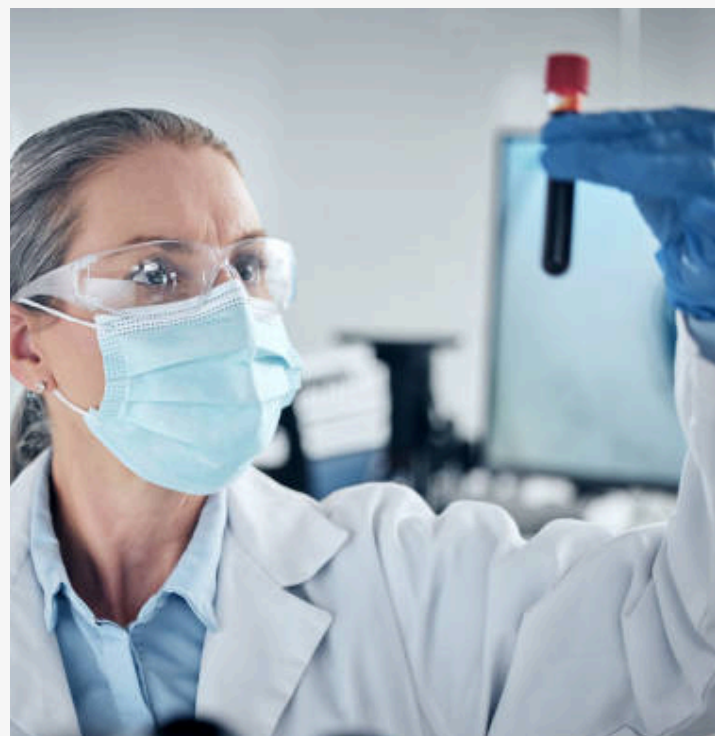
Forensic nursing is a distinct healthcare specialty that emerged in response to the growing need for healthcare professionals who are trained to work at the intersection of medicine and the law. The International Association of Forensic Nurses (IAFN) defines forensic nursing as the application of nursing science to public or legal proceedings and the investigation of trauma-related medical issues that have legal implications. The scope of practice for forensic nurses includes providing care to victims and perpetrators of trauma, collecting forensic evidence, participating in legal proceedings, and contributing to the understanding of forensic pathology and criminal investigations.

Forensic nursing professionals are employed in various settings, including hospitals, correctional facilities, medical examiner offices, and legal consultancies. This article provides a comprehensive overview of the key subfields within forensic nursing, highlighting their unique contributions to both healthcare and the criminal justice system.

## 2. Sexual Assault Nurse Examiners (SANE)

One of the most well-known roles within forensic nursing is that of the Sexual Assault Nurse Examiner (SANE). SANEs are registered nurses who receive specialized training to provide care to victims of sexual assault while collecting and preserving forensic evidence. They are critical in the identification, collection, and documentation of evidence that may later be used in court to prosecute offenders. SANEs also play a vital role in offering emotional support and medical treatment to survivors.

In addition to performing forensic examinations, SANEs often collaborate with law enforcement agencies, attorneys, and victim advocates. Research has shown that SANE programs improve patient outcomes by providing immediate and compassionate care while ensuring the integrity of forensic evidence collection. One study found that the presence of SANE programs increased the rate of successful prosecution in sexual assault cases by approximately 30% compared to regions without such services (1).







### 3. Forensic Death Investigation

Forensic death investigation is another significant area of forensic nursing that involves the investigation of sudden, unexpected, or suspicious deaths. Forensic nurses working in this capacity often collaborate with medical examiners or coroners to assist in determining the cause of death, especially in cases where trauma, violence, or negligence is suspected. These nurses perform postmortem examinations, collect toxicological samples, and review medical records to assist in death determinations.

The application of forensic nursing in death investigations requires specialized knowledge of both anatomy and pathology. Forensic nurses must be well-versed in recognizing signs of trauma, decomposition, and other forensic indicators. Their involvement can be crucial in identifying victims of homicide, overdose, or neglect. Studies indicate that forensic nurses in this role contribute to more accurate and timely cause-of-death determinations, thereby supporting both public health and legal investigations (2).

### 4. Legal Nurse Consulting Legal nurse consultants (LNCs)

It offer a unique service by applying their medical expertise to assist in legal cases. They are responsible for analyzing medical records, identifying standards of care, and providing expert testimony in legal cases related to medical malpractice, personal injury, or criminal acts involving medical issues. LNCs often collaborate with attorneys, insurance companies, and other legal entities to clarify complex medical issues in both civil and criminal cases. The role of LNCs is crucial in bridging the gap between legal and medical professionals. They play a critical part in interpreting medical jargon, procedures, and

standards of care for the legal community, thus ensuring that justice is served through an accurate understanding of medical evidence. An increasing number of malpractice cases and healthcare-related litigation has underscored the demand for forensic nurses in this consulting capacity (3).

### 5. Forensic Psychiatry

Forensic psychiatry is another essential area of forensic nursing that focuses on the intersection of mental health and the law. Forensic psychiatric nurses assess and treat individuals who are involved in the criminal justice system, including those with mental illnesses who have committed crimes or are being evaluated for competency to stand trial. These nurses work closely with psychiatrists, psychologists, and legal professionals to develop treatment plans, provide therapeutic interventions, and offer expert testimony regarding a defendant's mental state.

Forensic psychiatric nurses are particularly involved in the assessment of dangerousness and the risk of recidivism. This role is critical in ensuring that individuals with mental health conditions receive appropriate care while protecting public safety. Forensic psychiatric nurses often work in correctional facilities, psychiatric hospitals, and outpatient forensic clinics, offering a specialized form of care that requires both clinical and legal expertise (4).



## 6. Human Trafficking and Victim Advocacy

Forensic nurses play an important role in identifying and caring for victims of human trafficking, an area that has received increasing attention in recent years. Human trafficking involves the exploitation of individuals for labour or sexual purposes and often goes undetected in healthcare settings due to lack of awareness or inadequate training. Forensic nurses are uniquely positioned to identify the signs of trafficking, which may include physical injuries, psychological trauma, and inconsistent medical histories. By working closely with law enforcement and social services, forensic nurses can help rescue victims and connect them to necessary resources such as housing, legal assistance, and counselling.

A study revealed that healthcare providers, including forensic nurses, are often the first point of contact for trafficking victims, underscoring the need for enhanced training in this area (5).

In addition to direct care, forensic nurses advocate for victims' rights and assist in gathering evidence that can be used in prosecuting traffickers. The healthcare sector's growing recognition of human trafficking has led to more initiatives aimed at educating nurses about the signs of trafficking and the proper protocols for reporting and intervening in these cases.

## 7. Ethical and Legal Considerations

Forensic nurses face complex ethical and legal challenges due to their involvement in both healthcare and criminal investigations. They must navigate the delicate balance between patient confidentiality and the legal obligation to report and testify in criminal cases. For example, forensic nurses often work with vulnerable populations, such as victims of abuse or sexual assault, where issues of consent, autonomy, and confidentiality are paramount.

The collection and handling of forensic evidence also raise important ethical considerations. Ensuring the proper chain of custody and avoiding contamination of evidence are critical to maintaining its admissibility in court. Moreover, forensic nurses must be careful to avoid bias when providing testimony in legal proceedings, as their professional credibility depends on their impartiality.

## 8. Conclusion

Forensic nursing is a critical specialty that operates at the nexus of healthcare and the criminal justice system. By providing medical care to victims and perpetrators of violence, collecting forensic evidence, and contributing to legal proceedings, forensic nurses ensure that both justice and patient care are served. Their roles, ranging from sexual assault nurse examination to forensic psychiatry and death investigation, reflect the breadth of this growing field. As the need for trauma-informed and legally informed care continues to expand, the demand for specialized training in forensic nursing will likely increase, further solidifying its role within both the healthcare and legal landscapes.



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# DID YOU KNOW?

**Lip prints can vary by age, gender, and even mood—women's are more curved, men's are straighter, and emotions can subtly change the pattern!**



# VIRTUAL REALITY FORENSICS: A PARADIGM SHIFT IN CRIME SCENE INVESTIGATION

Author: Vikram K. Hankare

## Abstract

Virtual reality (VR) technology has revolutionized many fields, including medicine, education, and entertainment. Its application in forensics, particularly in crime scene investigation and reconstruction, is an emerging domain that promises to enhance the accuracy, visualization, and accessibility of crime scene data. This paper explores the use of VR in forensics, specifically focusing on its potential to transform crime scene investigations. Key areas discussed include VR-based crime scene reconstruction, virtual autopsies, evidence visualization, and the role of VR in courtrooms. Additionally, this paper highlights the advantages, challenges, and future directions of VR forensic applications. The article underscores VR's potential to improve forensic science through immersive, interactive, and accurate digital simulations, although technical, legal, and ethical issues remain to be addressed.

## Introduction

Virtual reality (VR) technology allows the creation of immersive, three-dimensional environments, enabling users to experience and interact with simulated surroundings. While initially developed for entertainment and training purposes, VR has since expanded into fields such as healthcare, education, military training, and forensics. In forensic science, the integration of VR into crime scene investigation presents a paradigm shift from traditional methods of evidence documentation and analysis. This shift can lead to greater accuracy in reconstructions, enhanced communication of complex data, and more immersive ways to present evidence in courtrooms.

Crime scene investigations traditionally rely on photographs, videos, and physical models to recreate and analyze events. However, such methods have limitations in terms of scale, perspective, and interactivity. VR can overcome these limitations by providing an interactive, fully immersive environment where investigators, experts, and jurors can "enter" the crime scene, gaining a better understanding of spatial relationships and contextual evidence.

This paper explores key subtopics in VR forensics, including VR-based crime scene reconstruction, virtual autopsies, evidence visualization, and courtroom applications. The benefits, limitations, and ethical considerations of VR in forensics are also discussed.

## VR-Based Crime Scene Reconstruction

### 1. Immersive Crime Scene Visualization

One of the primary applications of VR in forensics is crime scene reconstruction. VR allows investigators to recreate crime scenes digitally, preserving the environment and evidence in a format that can be revisited at any time. By creating a three-dimensional replica of a crime scene, VR facilitates a more detailed examination of the spatial relationships between various elements, such as the position of the victim, the location of physical evidence, and the proximity of potential witnesses. This immersive visualization offers advantages over traditional methods, such as photographs and physical models, which often lack depth and perspective.

In a VR-based reconstruction, users can move freely within the environment, view evidence from multiple angles, and simulate the movements of individuals involved in the incident. Studies have shown that VR

reconstructions can enhance memory recall and improve investigators' ability to identify inconsistencies or overlooked details in crime scenes (1). Additionally, VR allows investigators to simulate different lighting conditions or perspectives that may not be possible to capture during initial evidence collection.

## **2. Scene Preservation and Long-Term Analysis**

One of the critical challenges in forensic science is preserving the integrity of crime scenes for long-term analysis. Physical crime scenes deteriorate over time due to environmental factors, human activity, and the decomposition of biological evidence. By digitizing the scene using VR, forensic experts can "freeze" the crime scene, allowing it to be revisited and analyzed indefinitely. This is particularly valuable in cold cases or long investigations, where new evidence or hypotheses may require investigators to revisit the scene years after the event.

Recent advancements in VR scanning technology, such as photogrammetry and LiDAR (Light Detection and Ranging), have enabled highly accurate digital reconstructions of crime scenes, capturing intricate details with millimeter precision. This high level of detail allows forensic experts to perform virtual walkthroughs, aiding in the identification of key evidence or the reconstruction of events leading to the crime (2).

## **Virtual Autopsies**

### **1. Non-Invasive Post-Mortem Analysis**

Another significant development in VR forensics is the virtual autopsy, or "virtopsy," which uses VR technology to conduct non-invasive post-mortem examinations. Unlike traditional autopsies, which require physically dissecting the body, virtual autopsies rely on imaging technologies such as computed tomography (CT) and magnetic resonance imaging (MRI) to create detailed three-dimensional models of the body. These models can be examined in VR environments, allowing pathologists to investigate internal

injuries, determine causes of death, and identify forensic markers without physically altering the body.

Virtual autopsies are particularly beneficial in cases where traditional autopsies are either culturally or religiously prohibited or when bodies are too fragile for physical dissection. Moreover, virtopsy provides a permanent digital record of the body, allowing the autopsy to be revisited and reviewed by multiple experts or during legal proceedings.

## **2. Advantages Over Traditional Autopsies**

Virtual autopsies offer several advantages over traditional methods. First, they are non-invasive, preserving the integrity of the body while still providing detailed information about internal injuries. Second, virtopsy can be used in conjunction with traditional autopsy findings to corroborate evidence or provide additional insights. Third, the digital models created during a virtual autopsy can be presented in courtrooms, offering jurors and legal professionals a clear and immersive visualization of the injuries sustained by the victim (3).

## **Evidence Visualization and Analysis**

### **1. Enhancing Evidence Presentation**

VR offers innovative ways to visualize and analyze forensic evidence. Complex datasets, such as ballistic trajectories, blood spatter patterns, or DNA sequences, can be visualized in three-dimensional, interactive VR environments. This allows forensic experts to analyze the relationships between different pieces of evidence more effectively and to communicate their findings to non-experts, such as jurors, more clearly.

For example, bloodstain pattern analysis (BPA) is a forensic technique used to reconstruct the events of a crime by studying the patterns of blood left at the scene. Traditional BPA requires manual measurement and analysis, but VR can automate and enhance this process by allowing



investigators to simulate blood spatter patterns in three-dimensional space. Investigators can manipulate the environment, change variables (e.g., height, velocity, and angle of impact), and visualize the results in real-time (4). This level of interactivity can lead to more accurate interpretations of the evidence and help jurors understand complex forensic principles during trial presentations.

## 2. Collaborative Investigations

VR can also facilitate collaborative investigations by enabling multiple forensic experts to work together in a shared virtual environment, regardless of their physical location. This can be particularly valuable in cases involving multiple jurisdictions or when expertise is required from specialists in different fields. Investigators can enter the same VR crime scene, share insights, and annotate areas of interest in real-time, streamlining communication and decision-making.

## VR in Courtroom Applications

### Enhancing Juror Understanding

One of the most challenging aspects of presenting forensic evidence in court is effectively communicating complex scientific information to jurors and legal professionals who may not have a technical background. VR can bridge this gap by offering a more intuitive and immersive way to present evidence. For example, jurors can be placed in a virtual reconstruction of the crime scene, allowing them to explore the environment and visualize key pieces of evidence in context.

Studies have demonstrated that jurors who engage with VR evidence presentations show higher levels of comprehension and recall compared to those exposed to traditional methods, such as photographs and diagrams (5). Additionally, VR's ability to simulate various scenarios—such as the movement of suspects, the trajectory of bullets, or the impact of weapons—can help jurors better understand the sequence of events leading to a crime.



### Legal and Ethical Considerations

Despite its advantages, the use of VR in courtrooms raises important legal and ethical considerations. One concern is the potential for VR reconstructions to be perceived as more "real" than they actually are, potentially biasing jurors or giving undue weight to certain interpretations of the evidence. It is essential that VR evidence is presented transparently, with clear explanations of the assumptions and limitations underlying the reconstructions.

Moreover, the admissibility of VR evidence in court is still a developing area of law. While some jurisdictions have embraced the use of VR in legal proceedings, others remain cautious due to concerns about the reliability and fairness of such evidence. As VR technology continues to evolve, it will be crucial for legal frameworks to adapt and establish clear guidelines for its use in the courtroom (6).

## Conclusion:

Virtual reality technology offers transformative potential in the field of forensic science, particularly in crime scene investigation, autopsies, evidence analysis, and courtroom presentations. VR enables immersive, accurate, and interactive representations of crime scenes and evidence, which can enhance both forensic investigations and legal proceedings. However, the integration of VR into forensics also presents challenges, including the need for standardization, legal admissibility, and ethical considerations regarding the interpretation and presentation of digital evidence. As VR technology continues to advance, it is likely to become an indispensable tool in modern forensic science, but further research and legal development are necessary to fully realize its potential.

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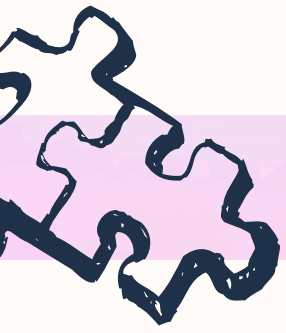
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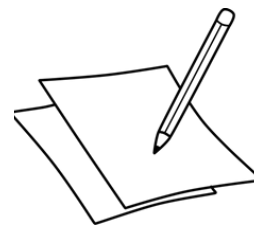
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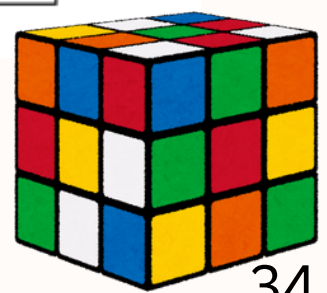


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# THROUGH THE MAGNIFYING LENS OF A PRIVATE DETECTIVE

## An interview with Mr. T. K. Sukumar

*With over 19 years of experience in private investigation, Mr. T. K. Sukumar is a distinguished professional and founder of a renowned detective agency that has resolved approximately 7,000 cases. A Bachelor of Arts graduate with technical expertise in Computer Hardware and Engineering, he previously served as Chief Warden in the Tamil Nadu Police Traffic Department, earning 16 awards. As Vice President of the Tamil Nadu Association of Private Detective Investigators (TAPDI), he has advanced industry standards. Through the SpyShot Forensic Academy, he fosters academic collaborations and mentors aspiring investigators, leaving a lasting impact on the field.*

### **What inspired you to pursue a career as a private detective? Was there a particular moment that sparked your interest?**

During my college days, cinema was my primary source of entertainment since television was quite rare at the time. Alongside cinema, I developed a strong passion for reading books, which quickly became a lifelong habit. Among the various genres I explored, I found myself particularly drawn to novels, especially those written by **Pattukottai Prabhakar**. His crime novels, in particular, had a profound impact on me. I became completely engrossed in his compelling commentaries and intriguing writing, developing a strong attachment to his works.

In many of his novels, the characters Bharat and Sushila run a detective agency and solve a range of crimes. This deeply inspired me and sparked a long-held desire to one day run my own detective agency. The idea became so ingrained in my mind that it stayed with me as I progressed in life.

Looking back, I can confidently say that reading Pattukottai Prabhakar's novels was a significant influence on my decision to pursue this path. His writing not only ignited my passion for detective work but also inspired me to turn that passion into a successful career.

### **Can you walk us through your journey from the beginning of your career to becoming an established private investigator?**

My career began as a computer hardware engineer, and I had the opportunity to work in Singapore as a Senior Hardware Engineer. While I achieved professional success, I realized my true passion lay elsewhere.

Detective work had intrigued me since my youth, inspired by the crime novels of Pattukottai Prabhakar, whose characters ran detective agencies and solved complex cases. Despite a stable career, my desire to pursue this path remained strong. In 2005, I made the bold decision to leave my engineering job and return to India to establish Spy Shot Detective Agency. Though the journey was challenging, my commitment to providing professional investigative services never wavered.

Over the past 19 years, I've proudly built the agency into a respected name in private investigation, helping clients solve complex cases and uncover the truth. Looking back, I'm grateful for following my passion. Turning my lifelong interest into a rewarding career has made every challenge worthwhile.

### **How did you prepare yourself for this line of work? Did you undergo specific training or gain experience in related fields like law enforcement or forensics?**

Before starting my own detective agency, I made it a priority to research and gather as much information as I could about the field of private investigation. To gain practical experience, I joined the Tamil Nadu Police as a Chief Warden, in Tamil Nadu Police Traffic Warden Organization.

During my tenure with the police, I was selected for the Special Wing, where I had the opportunity to hone my skills in law enforcement. I performed well in this role and received numerous accolades and awards

from senior police officers. These experiences were invaluable in shaping my understanding of investigative work.

It was through my interactions with experienced police officers that I developed a deeper insight into the methods and techniques of detective work. Their encouragement and guidance played a crucial role in my growth, and I attribute much of my success in establishing a well-respected detective agency to the foundation I built during my time in law enforcement.

**What types of cases do you usually handle, and which area of investigation do you find the most challenging?**

I have handled a wide variety of cases within the detective field, investigating and resolving over 7,000 cases to date. These cases have included pre/post matrimonial screenings, pre/post employment background checks, missing persons, individual investigations, threatening cases, financial fraud, theft, murder, white-collar crime, and cybercrime, among others. Throughout my career, I've faced many challenging and high-stakes cases.

One notable case involved a faceless gang sabotaging the operations of one of Coimbatore's most renowned companies. Their actions were causing significant disruptions and stifling the company's growth. The management feared that involving the police would damage their reputation, so they sought my help. After three months of intense investigation, I identified the five individuals behind the disruptions. I gathered all the necessary evidence and assisted the management in bringing the offenders to justice through both legal channels and the police.

While I've managed various challenging investigations, I find pre-matrimonial screenings to be the most personally demanding. Clients rely on my findings to make one of the most important decisions of their lives—choosing a life partner. It is crucial that my investigations are thorough and based on solid evidence, as any misjudgment could have serious consequences for the

individuals involved. The responsibility of providing accurate, unbiased assessments in these cases is something I take very seriously.

In today's legal environment, gathering information about individuals is more challenging than ever, especially with concerns over privacy and individual rights. While I provide evidence and support in various cases, it's important to acknowledge that the final decision in legal matters, such as determining guilt or innocence, lies with the courts. However, in pre-matrimonial investigations, the decisions I make directly affect individuals' lives in ways that can last a lifetime. This makes it one of the most delicate and significant areas of my work.

**Have you ever had to deal with a case that affected you emotionally or personally? How do you handle such situations?**

A delicate emotional balance is required in this line of work. Clients often come to me in a vulnerable state, deeply affected emotionally and financially. These clients are dealing with painful issues, ranging from extramarital affairs and divorce to financial fraud, blackmail, and other forms of deception. People approach us when they have been tricked or manipulated, often in cases involving financial fraud or fake investments. In these instances, we begin by identifying the individuals involved and investigating their backgrounds and assets to collect solid evidence.

A profoundly moving story where we helped a man reconnect with a woman he had loved decades earlier. A man approached us with only an old black-and-white photograph of a woman he loved 35 years ago. He was now married and settled but wanted to find her, simply to reconnect after all these years. We searched four districts for over a month and eventually located her. They reconnected briefly over the phone, expressing gratitude for this chance to close a chapter in their lives. It was an experience that showed the emotional impact and sensitivity required in our work.



**Can you tell us about the most interesting or unusual case you've worked on? What made it stand out?**

Our work typically involves pre- and post-matrimonial investigations, employment verifications, divorce cases, and infidelity inquiries, but some cases stand out.

In one, a client sent money online for hospital bills and personal expenses. When the individual avoided in-person meetings, we uncovered that the supposed romantic interest was a woman impersonating an actress to manipulate the client. Our evidence led to legal intervention, preventing further losses.

In another complex case, a man supporting a woman financially discovered she was actually a transgender individual concealing her true identity. Our investigation saved him from further financial and emotional harm.

These cases reflect my agency's commitment to uncovering the truth in high-stakes situations.

**Have you ever encountered a case where the outcome surprised you? How did you navigate the unexpected twists and turns?**

In our line of work, assumptions can be a dangerous detour. I avoid presuppositions and focus strictly on evidence, following it with precision. Evidence guides me to the truth, not preconceived notions or emotions. Over the years, I've learned to leave all assumptions at the door and concentrate solely on facts to catch the culprit.



One particularly memorable case involved a prominent jewellery manufacturing company in Tamil Nadu, employing around 4,000 people. When a 1-kilogram gold bar went missing, the company was reluctant to involve the police, fearing damage to their reputation. Instead, they entrusted my team with a private investigation. We were given a list of 15-20 suspects, all working in departments that regularly handled gold items. Each day, about 10 kilograms of gold was sent to the departments, processed into jewellery, and the remnants stored in a stockroom under camera surveillance.

"Over three days, we monitored the operations and analyzed 10 days of footage from 28 security cameras, focusing on both morning and evening shifts. We discovered that the camera in the stockroom had been repositioned, obscuring the area where the gold was stored. After interviewing the initial 16 suspects, our attention shifted to a security guard who had recently taken 15 days off. When questioned, he claimed it was due to a family issue. However, on social media, we discovered that he had bought a Yamaha R15 motorcycle, claiming it was for his younger brother, a college student. The company verified the loan for the bike, and his story seemed plausible.

Despite his story being credible, I felt there was more to investigate. We visited his hometown and uncovered inconsistencies; the motorcycle was actually for the guard's own use, shared with a friend. When we traced the friend, we found a photo of the missing gold bar on his phone. Both men were questioned, and they confessed: the guard had stolen the gold bar and arranged for his friend to melt it down. The guard was taken into custody.

Initially, the suspect's story seemed credible, even corroborated by the company. Yet, as the investigation unfolded, we uncovered details that surprised even the company itself. This case was a reminder that diligent investigation, based on evidence—not assumptions—is the only way to reveal the truth, no matter how convincing appearances may seem."



## **What's the closest you've come to uncovering a major conspiracy or dealing with organized crime? How did you manage the risks involved?**

We handled a case involving a group of 4-5 young men who filed a complaint against an individual promising them jobs abroad. This person took significant amounts of money, claiming it was for health checks, visas, background verification, and later, tickets. Each victim lost between 2 to 3 lakhs. When I asked why they hadn't approached the police, they explained that it would affect innocent workers and even the building owner who hadn't received rent payments. They feared the issue would become public, and they wouldn't get their full refunds, so they opted to hire us to find the culprit.

We began by collecting details about the company—the name, the owner, and the number of employees. The building owner revealed that the suspect had claimed to be starting an IT business but had vanished after failing to pay the rent. We tracked down the workers and discovered that none had ever met the owner in person, and there were no official bank accounts for the company. Instead, the suspect had the workers deposit money into their own personal accounts to avoid tax issues. They were simply paid a salary and followed instructions.

By this time, the suspect had switched off his phone, but we discovered he was from abroad and had set up about 10 branches. Our investigation led to identifying his Aadhaar details through a hotel, where a call had originated from. This was crucial in tracing the individual and building the case against him.

This case showcases how thorough investigation and attention to detail can reveal the truth behind financial fraud.

## **What has been the most adrenaline-pumping moment of your career? Did it feel like a scene from a crime thriller?**

I handled a high-stakes case that felt like a crime thriller. A client from Malaysia, a trader in sugar, turmeric, and grapes, had fallen victim to fraud. He paid ₹1.3 crore to a supplier who, using forged documents, promised goods but vanished. After nine months of unsuccessful efforts by the Mumbai

Police to locate the suspect, the case was handed to my team.

We started from scratch, combing through the suspect's old phone records, tracking past addresses, and investigating his son's educational connections across cities. The breakthrough came when we found that the suspect's wife and son were actively involved. Surveillance of the wife's phone calls led us to her sister's home in Tamil Nadu, where the suspect's family was hiding. The Mumbai Police were informed, and we set a plan to apprehend them.

The operation turned into a high-speed chase as the family attempted to flee to Coimbatore. My team pursued them at speeds over 140 km/h, eventually apprehending them. However, the drama didn't stop there.

To prevent interference from the suspect's lawyers, we devised a strategy. After informing the local police station of the arrest, we anticipated the lawyers might arrive with bail papers, so we redirected the transfer to a different station. We then decided to fly the suspects to Mumbai to avoid exposure during train or bus travel.

At the airport, the suspect accused the Mumbai Police of impersonation and claimed they were being kidnapped. We had to present our IDs, FIR, and remand copy to security. After several hours of tension and planning, the suspects were finally boarded onto a flight to Mumbai. Once there, the Mumbai Police took them into custody, and they were remanded to judicial custody.

Reflecting on the case, it showed the critical importance of strategy, teamwork, and adaptability under pressure. It was a career-defining moment, emphasizing the relentless efforts needed to ensure justice.



## **How do you measure success in your line of work? What advice would you give to young professionals looking to make a mark in this field of private detective investigation?**

Private investigation is not a profession suited for everyone. It requires talent, a keen grasp of details, strong observational and psychological skills, and an alert mind. Our work often involves navigating delicate situations, where helping one party might inadvertently make us a villain in someone else's eyes. This can sometimes lead to threats, but we handle most cases discreetly to avoid such risks.

For me, it's not about competition or winning and losing. This field isn't about victory or defeat—it's about helping our clients achieve justice. Reflecting on the performance of my agency, I confidently mentioned that we have successfully completed 95% of our cases with positive outcomes. However, we operate strictly within the framework of the law. We don't promise to do whatever the client wants. Instead, we assure them that justice will be served lawfully.

To succeed in private detective investigation, it's important to be patient, observant, and highly ethical. Always base your work on evidence and avoid assumptions. Stay disciplined and persistent, even when the case seems challenging. The ability to think critically, analyze information, and maintain discretion is essential.

For aspiring entrepreneurs, it's crucial to build a strong foundation of knowledge and credibility. Understanding the legalities and ethical considerations in this field is key. Focus on creating trust with clients, as reputation is everything in this business. Start small, ensure quality service, and always be prepared to adapt to new technologies and trends.

### ***About the Interviewee***



*Mr. T. K. Sukumar is the founder and director of Spy Shot Detective Agencies, established in 2005. He has transformed his agency into one of the most renowned private detective organizations in Tamil Nadu, with a strong presence in Coimbatore and an extensive international network. Under Dr. Sukumar's leadership, the agency has built a reputation for providing effective services specializing in a matrimonial screening, background verification, surveillance, fraud investigations, tracing missing persons, family dispute investigations, and more.*

***Interviewed by Ms. Sanjana T Shaju  
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# **DID YOU KNOW?**

**Even burned or  
shredded  
documents can  
sometimes be  
reconstructed  
using advance  
forensic  
technologies**



# TRACING DIGITAL FOOTPRINTS: THE ROLE OF EMAIL FORENSICS IN MODERN INVESTIGATIONS

Author: Gargi Ghosh



## Abstract

Email forensics is a critical branch of digital forensics focused on the investigation, recovery, and analysis of email data to uncover evidence related to cybercrime, fraud, and legal disputes. With the growing reliance on email communication in personal, corporate, and governmental sectors, emails have become a common vector for malicious activities like phishing, spoofing, malware distribution, and fraud. This paper outlines key methodologies in email forensics, including email header analysis, metadata extraction, content and attachment investigation, and the detection of phishing and spoofing attempts. It also highlights the importance of maintaining the chain of custody to ensure the admissibility of digital evidence in court. Advanced forensic tools and techniques like hashing, malware analysis, and domain authentication (SPF, DKIM, DMARC) are explored, offering a comprehensive overview of the process. The paper concludes with real-world applications of email forensics in cybersecurity, corporate investigations, and litigation, emphasizing its importance in maintaining digital security and legal accountability.

## INTRODUCTION

Email forensics is a vital field within digital forensics that involves the investigation and analysis of email communications to uncover evidence of cybercrime, fraud, or policy violations. Given the prevalence of email as a communication tool, it is frequently targeted by cybercriminals through tactics such as phishing, email spoofing, and malware distribution. The primary goal of email forensics is to trace the origin, authenticity, and integrity of emails by examining headers, metadata, and content.

This analysis helps forensic experts identify suspicious activities and determine the legitimacy of emails, providing crucial insights for investigations. Email forensics also plays a key role in ensuring legal compliance and data integrity within organizations. By supporting incident response and regulatory adherence, it provides essential evidence for legal proceedings, helping to protect digital assets and maintain accountability in both personal and professional communications.

## KEY COMPONENTS OF EMAIL FORENSICS

- **Data Acquisition:** Collecting email data from servers, clients, and devices. This may involve extracting emails from applications like Microsoft Outlook, Gmail, or other email services.
- **Email Header Analysis:** Examining the metadata in email headers to trace the origin of an email, identify the sender and recipient, and track the path taken by the email across the internet. Headers contain timestamps, IP addresses, and server information.
- **Content Analysis:** Analyzing the body of the email for relevant information, such as keywords, phrases, attachments, and links. This can help identify intent, motives, or the context of communications.
- **Attachment Analysis:** Investigating attachments for malware, suspicious files, or relevant documents. This may include extracting metadata from files to trace their origins or modifications.
- **Data Recovery:** Recovering deleted emails or lost data using forensic tools that can restore information from storage media or email servers.
- **Legal Considerations:** Understanding the legal implications of email investigations, including privacy laws and regulations, which can vary by jurisdiction.

- **Reporting:** Documenting findings in a clear and concise manner, often for use in court or legal proceedings. Reports typically include methodologies, evidence collected, and conclusions drawn from the analysis.

## TOOLS COMMONLY USED IN EMAIL FORENSICS

### 1. EnCase Forensic

- **Functionality:** EnCase is one of the most widely used forensic tools, allowing investigators to acquire, analyze, and report on digital evidence, including emails.
- **Key Features:** Email data extraction, metadata analysis, full-text search, and report generation.
- **Use Cases:** Often used in large-scale investigations, including criminal cases and corporate fraud detection.



### 2. Forensic Toolkit (FTK) by AccessData

- **Functionality:** FTK is known for its fast indexing and searching capabilities. It helps with the analysis of email files, including recovering deleted emails and examining attachments.
- **Key Features:** Email indexing, header analysis, attachment review, and detailed reporting features.
- **Use Cases:** Used in both civil and criminal investigations, including cybercrime cases.

### 3. X1 Social Discovery

**Functionality:** X1 focuses on social media and email forensics. It enables investigators

- to extract data from cloud-based email services like Gmail and Yahoo.
- **Key Features:** Email and social media data acquisition, preservation, and analysis.
- **Use Cases:** Effective for cases involving cloud-based email services or where cross-platform analysis (email and social media) is required.

### 4. MailXaminer

- **Functionality:** This tool is designed specifically for email forensics, making it easier to examine email formats like PST, OST, MBOX, and EML files.
- **Key Features:** Advanced email search, email header analysis, recovery of deleted emails, and support for multiple email clients.
- **Use Cases:** Often used by law enforcement agencies for email analysis in criminal investigations.

### 5. Paraben's Email Examiner

- **Functionality:** Focused solely on email analysis, this tool allows for detailed examination of email archives, recovery of deleted messages, and identification of hidden data.
- **Key Features:** Header analysis, in-depth keyword searches, and support for various file formats (PST, OST, MBOX).
- **Use Cases:** Ideal for email-related investigations in fraud, intellectual property theft, and insider threats.

### 6. Sleuth Kit and Autopsy

- **Functionality:** An open-source forensic suite that includes tools for email analysis. Autopsy offers a user-friendly interface for performing email forensics.
- **Key Features:** Email artifact recovery, metadata extraction, and analysis of multiple formats.
- **Use Cases:** Used in a wide range of investigations, from small businesses to large-scale criminal cases, especially by organizations looking for cost-effective solutions.

### 7. SysTools Email Forensic Tool

- **Functionality:** This tool is designed to work with various email formats like EDB, OST, PST, and NSF, making it versatile for different types of email investigations.

- Key Features: Recover deleted emails, analyze attachments, and preview email metadata.
- Use Cases: Useful for investigating employee misconduct, fraud cases, and phishing incidents.

### 8. Wireshark

- Functionality: Although primarily a network traffic analysis tool, Wireshark can be used in email forensics to capture and analyze SMTP, IMAP, and POP3 email traffic.
- Key Features: Captures and inspects email communication protocols, enabling email traffic analysis and tracing email origins.
- Use Cases: Used in network forensics for investigating email interception and tracing phishing attacks.

### 9. eM Client

- Functionality: A mail client with capabilities for managing and analyzing email data. Although not a forensic-specific tool, it is used for accessing and managing large volumes of email data.
- Key Features: Full email search, message sorting, and data export in multiple formats.
- Use Cases: Handy for basic email forensics tasks such as reading and exporting data from email accounts.

### 10. Aid4Mail

- Functionality: A tool for extracting and converting emails from various formats and clients like Outlook, Gmail, Yahoo, and Thunderbird.
- Key Features: Supports email migration, format conversion, and forensic preservation of emails.
- Use Cases: Often used when converting email evidence into court-admissible formats or archiving large amounts of email data.

### 11. Belkasoft Evidence Center

- Functionality: A digital forensic tool that includes email analysis capabilities. It can extract and analyze email artifacts from disk images and mobile devices.
- Key Features: Extracts email data from smartphones, computers, and disk images, while also supporting a wide range of email formats.

- Use Cases: Used in both computer and mobile device forensics to extract email communications for analysis.

### 12. Emailchemy

- Functionality: This tool helps convert old or archived email formats into readable and analyzable formats.
- Key Features: Converts proprietary email formats into standard formats (like EML), making it easier for forensic analysis.
- Use Cases: Useful in investigations involving legacy email systems or archival data that need to be converted for analysis.

### 13. P2C Email Investigator (EmailTracer)

- Functionality: Specialized in email tracing and identifying the geographical location of the sender.
- Key Features: Email tracing, header analysis, and determination of the IP address of the sender.
- Use Cases: Used in investigations related to spam, phishing, and email fraud.

### 14. Gargoye Investigator Forensic Pro

- Functionality: Designed to find and analyze emails along with other digital artifacts on seized devices.
- Key Features: Includes email recovery, analysis of email metadata, and support for various formats.
- Use Cases: Commonly used in investigations of corporate espionage, intellectual property theft, and criminal activities.





## ADVANCED TECHNIQUES IN EMAIL FORENSICS

- **Signature and Anomaly Detection:** Forensic analysts may develop signatures (unique identifiers) for known malicious emails, allowing for quick identification of threats. Anomaly Detection involves using machine learning to identify unusual patterns in email communications, which can indicate phishing or insider threats.
- **Timeline Analysis:** Creating timelines of email communications can help investigators understand the sequence of events leading up to an incident. This can be useful in establishing alibis or timelines of fraudulent activities.



- **Link Analysis:** Analyzing relationships between email senders and recipients can uncover hidden networks of communication, such as those used in conspiracy or organized crime cases.
- **Contextual Analysis:** Understanding the context in which emails were sent can help interpret their meaning more accurately. This may involve analyzing prior communications, related documents, or the overall situational context.

## CHALLENGES IN EMAIL FORENSICS

- **Data Volume:** The sheer volume of email data can be overwhelming, requiring efficient data filtering and analysis techniques to isolate relevant information.
- **Encryption:** Many email services now offer encryption, which can make it challenging to access and analyze the contents of emails without proper decryption keys.
- **Cloud Storage:** With many users relying on cloud-based email services, data may be stored across various jurisdictions, complicating legal and forensic access.
- **User Awareness:** Users often delete or manipulate emails before an investigation, potentially hindering the availability of evidence. Forensic tools must account for this by recovering deleted items effectively.
- **Privacy and Legal Issues:** Navigating privacy laws and regulations (like GDPR or HIPAA) can be complex, especially when dealing with personal or sensitive information.

## CONCLUSION:

- Email forensics is an essential field within digital forensics, continuously evolving to address the complexities of modern communication. It plays a pivotal role in uncovering evidence across various domains, from criminal investigations to corporate security. As technology advances, so will the methods and tools used in email forensics, further enhancing its effectiveness in uncovering the truth.



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# DEMONS ON TRIAL: UNRAVELING CRIMES LINKED TO DARK FORCES

**Author: Mr. Aswin M & Ms. Sneha K**

## FORENSIC DEMONOLOGY

A specialized branch of research that straddles the boundaries of demonology and forensic science, forensic demonology investigates crimes or incidents that are thought to have been caused by demonic possession, influence, or occult activity. It combines the investigation of supernatural or preternatural elements in criminal cases with conventional investigative techniques. Regardless of sociocultural beliefs, the concept of demonic possession has always been a hallmark of human civilization throughout history.

The idea that evil forces can affect people's actions has been around for millennia and is ingrained in many different religious and cultural traditions. Nonetheless, the notion that demons are connected to crimes still surfaces occasionally in the current world, when scientific explanations frequently eclipse the paranormal. These links are investigated by the interdisciplinary study of "forensic demonology," which looks at the fine line that separates mental illness, criminal activity, and alleged demonic possession. Demons appear to go on trial alongside the accused in some of the most perplexing instances, opposing detectives, courts, and religious authorities.

## DEMONIC POSSESSIONS AS A DEFENCE

Even though the majority of contemporary court systems depend on psychiatric assessments to ascertain a defendant's mental state, allegations of demonic possession do occasionally appear. Forensic demonologists may be asked to help investigators in these situations by offering their understanding of the religious or cultural meaning of possession claims. These experts try to determine if the person's behaviour was motivated by a real belief in demonic control or if psychiatric conditions like psychosis or dissociative identity disorder provide a more compelling explanation.



Even if hard evidence of demonic control is still hard to come by, some examples offer fascinating hints. Unusual behaviour, such as abrupt personality changes, unexplained physical strength, or a deep-seated hatred for religious symbols, is displayed by some people who are accused of horrible crimes. Witnesses have occasionally claimed to have seen strange things happen during or after these crimes, which has fuelled more conjecture regarding supernatural participation.

Sadly, demonology is a science on the verge of collapse. This basically indicates that any explanation using non-material or spiritual types of evidence will never be accepted by modern science. According to official definitions, any crime involving demonic possession could be considered insane. Psychiatrists are the professionals who diagnose and prognosticate a person's state of sanity or insanity on behalf of the Court. The links between demonic possession and crime are typically explained by modern science in a materialistic and logical manner.







## FORENSIC APPROACH TO THE PARANORMAL

Most of the time, mental health issues rather than paranormal phenomena are the cause of violent or strange behaviour. The idea of demonic possession is refuted by forensic psychology, brain scans, and psychiatric assessments that frequently identify underlying problems like trauma, personality disorders, or schizophrenia. Nevertheless, forensic demonologists ensure that every facet of a case is examined by helping to bridge the gap between cultural beliefs and scientific inquiry.

## FINE LINE: PSYCHOLOGICAL VS. SUPERNATURAL

The main difficulty in assessing crimes associated with dark forces is distinguishing between psychological disorders and sincere belief in the paranormal. Claims of demonic possession, according to a number of forensic psychologists, frequently conceal underlying mental diseases including schizophrenia, dissociative identity disorder, or acute psychosis. Investigators working in forensics have to carefully consider if a defendant's faith in demonic entities is a coping strategy, a hallucination, or an attempt to avoid accountability.

When there is evidence of occult rituals, such as ritualistic killings, the demonic tale could function more as a psychological allegory than as a genuine possession. However, these symbols may have actual ramifications. Experts in forensics need to look into whether the offender was motivated by cult beliefs or terrorized victims by posing as a demonic force.

## FUTURE IN FORENSIC DEMONOLOGY

There is a terrifying chapter in criminal history where the lines between the ordinary and the horrific are blurred. The public has long been fascinated by crimes that appear to have their origins in the supernatural and cases that defy logical explanation. Despite the general tendency towards skepticism, an increasing number of occurrences point to a darker undercurrent that raises the possibility of the involvement of evil forces.

Even though it can be difficult to demonstrate the presence of demonic forces, it is crucial to keep an open mind and look into these cases thoroughly. We might learn a lot about the darker sides of the human mind and the human condition by exploring the psychological, social, and cultural elements that might influence such behaviour.

## CONCLUSION

While the field of forensic demonology remains controversial and largely unexplored, it offers a unique perspective into the complexities of human behavior and criminal acts that appear to defy rational explanation. By approaching such cases with an open yet critical mind, investigators and researchers can bridge the gap between myth and reality, uncovering insights into the psychological and societal influences that may drive individuals toward these darker manifestations. Although evidence of supernatural forces may remain elusive, a thorough examination of these phenomena can deepen our understanding of the human psyche and the factors that contribute to acts of violence and terror. This exploration, while daunting, holds the potential to shed light on the shadows within us all.



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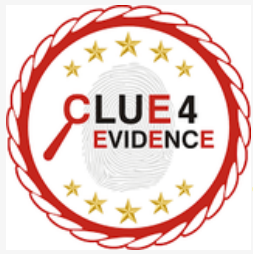
**Assistant Professor,  
Criminology and Forensic Science,  
CMS College of Science and Commerce,  
Coimbatore, Tamil Nadu**

# **DID YOU KNOW?**

**Gunshot  
Residue (GSR)**

**can be  
detected with  
electron  
microscopes,  
revealing  
microscopic  
metal particles  
on a suspect**





# WHAT IT MEANS TO BE A Private Forensic Experts.....?

*An interview with Mr. Phaneender B N*

## **Can you share your journey in forensic science and law? What inspired you to pursue this field?**

I began my career with a strong foundation in physics, which naturally led me to explore analytical and investigative sciences. Forensic science fascinated me because it marries science with justice, two fields that deeply resonate with me. My interest grew further as I recognized the critical role forensic evidence plays in ensuring fairness and accuracy in legal proceedings. The multidisciplinary nature of forensic science, combining law, science, and technology, inspired me to delve deeper into this fascinating domain.

## **What role does interdisciplinary education play in shaping a forensic expert?**

Interdisciplinary education is vital in forensic science. My background in physics, law, and cybersecurity has allowed me to approach cases from multiple perspectives. For example, understanding the legal implications of forensic evidence is as crucial as mastering the technical aspects. This holistic approach not only strengthens your credibility as an expert witness but also enhances your investigative accuracy.

- Roles:
- Integration of Diverse Knowledge Areas
  - Cross-Disciplinary Thinking
  - Problem-Solving Agility
  - Technological Proficiency
  - Ethical and Societal Awareness
  - Effective communication and collaboration
  - Adaptability in a Dynamic Field

After all the above, it is very important to identify the RIGHT EXPERT for any given situation, which is only can be delivered by interdisciplinary approach.

## **What advice would you give to students interested in pursuing forensic science as a career?**

Firstly, the capacity to apply common sense is an essential skill. Focus on developing a strong foundation in science—physics, chemistry, and biology are essential. Alongside technical knowledge, cultivate analytical skills and attention to detail. Keep yourself updated with advancements in forensic technology and certifications in specialized areas like digital forensics or questioned document examination. Lastly, understanding legal frameworks is crucial, so consider pursuing legal studies or training if possible.

## **How would you compare the job opportunities in government sectors versus private organizations in India?**

Government roles, such as those in forensic labs or law enforcement agencies, offer stability and are often the first choice for forensic graduates. However, the private sector, including independent forensic labs like Clue4 Evidence, is growing rapidly and offers opportunities for specialization and innovation. Private practice also provides flexibility and the ability to cater to a diverse clientele.

Govt. Roles:

- Researcher and Academician
- Employment in Govt. agencies - CBI, IB, NCB, NIA, WCCB, etc



## Could you elaborate on the roles of a forensic expert working independently compared to one in a government setup?

Independent forensic experts often handle a variety of cases, including civil disputes, corporate investigations, and private consultations. They must be skilled in managing business operations, client relationships, and legal nuances. On the other hand, government forensic experts typically focus on criminal investigations and follow structured protocols, working within a defined scope of responsibilities.

- Private Investigations
- Consultation Services
- Courtroom Testimony
- Evidence Review
- Resource Management
- Education and Training
- Entrepreneurial Roles.

| Aspect        | Government Setup                   | Independent Practice                 |
|---------------|------------------------------------|--------------------------------------|
| Scope of Work | Broader, mandated by law.          | Focused, based on client needs.      |
| Resources     | Access to advanced tools and labs. | Self-funded or outsourced resources. |

|                  |   |  |
|------------------|---|--|
| <b>Clientele</b> | <b>State or Public Sector, Law enforcement agencies and Court of Law.</b> | <b>Law Enforcement Agencies, Court of Law, Private Clients, Firms, Corporates.</b> |
| <b>Standards</b> | <b>Government Protocols and Legal Standards.</b>                          | <b>Standard Manuals and Legal Standards.</b>                                       |

### What are some emerging job roles in forensic science, particularly in digital forensics and cybersecurity?

Digital forensics and cybersecurity are booming fields. Roles like digital evidence analysts, cybersecurity investigators, and data privacy consultants are in high demand. Specializations such as mobile forensics, blockchain forensics, and AI-based crime analysis are also emerging, driven by the increasing digitization of crime.

- Cybercrime Investigator
- Mobile Device Forensic Expert
- Malware Analyst
- Cloud Forensics Specialist
- Forensic Data Analyst
- Incident Response Analyst

### CYBERSECURITY

- Cyber Threat Intelligence Analyst
- Ethical Hacker (Penetration Tester)
- Cryptographic Analyst
- Blockchain Forensics Specialist
- IoT Forensics Specialist

### What are the key challenges forensic experts face while working on criminal cases in India?

Some key challenges include limited infrastructure in government labs, delays in case processing, and lack of awareness about forensic evidence among law enforcement. Additionally, maintaining the chain of custody and overcoming technological hurdles in cybercrime cases are significant issues. While some of the states have taken initiatives in upgrading their infrastructure and also getting special training to their officers in general.



## How do you maintain objectivity and accuracy when presenting forensic evidence in court?

Firstly, it is very important to understand the purpose. As per our new Bharatiya Sakshya Adhinyam, The EXPERT should be qualified with training, experience, knowledge and skill in the field. EXPERT'S EVIDENCE should be Relevant to the Case, should be Based on Facts, should have Scientific Corroboration.

Objectivity is the cornerstone of forensic science. I ensure accuracy by adhering to standardized protocols and conducting thorough analyses. Detailed documentation, independent peer reviews, and clear communication of findings are critical to maintaining credibility and impartiality.

## With technological advancements, what challenges do forensic experts encounter in adapting to new tools?

The pace of technological advancement can be overwhelming. Staying updated requires continuous learning and investment in training and equipment. Another challenge is ensuring that new tools meet legal admissibility standards, as any lapse can render evidence inadmissible in court.

## Can you walk us through the typical process of investigating a questioned document or a fingerprint examination?

For questioned documents, we analyze handwriting, ink composition, and paper quality, often using advanced tools like spectral imaging. For fingerprint examinations, we first collect and preserve the prints, then compare them using automated systems or manual techniques. Each step is meticulously documented to ensure accuracy and chain-of-custody integrity.



**Questioned Document** – technically has 2 variants

- Forensic Document Examination
- Forensic Handwriting Examination

**It involves -**

- Detection of Forgery
- Detection of fraudulent alterations
- Document Verification
- Handwriting and Signature Analysis

**Fingerprint**

- Fingerprint Development and Lifting
- Classification and Analysis
- Individualization and Identification
- Comparison and Matching

**In General,**

- Must follow - ANALYSIS - COMPARISON - EVALUATION (ACE)
- Reporting and Court presentation

## What role does digital forensics play in modern investigations?

Digital forensics is a game-changer in modern investigations. It helps uncover evidence from devices, track digital footprints, and even recover deleted data. This field is crucial for solving cybercrimes, financial frauds, and cases involving digital communication. Also, involves - Counter-Terrorism and National Security Fraud Detection in E-Commerce and Online Transactions

**Risk Assessment**

Every other branch of forensics deal with ONE on ONE comparison, whereas in DIGITAL FORENSICS, it is not limited to this approach however we look into EVERY PROBABILITY in the electronic evidence.



## How important is collaboration with law enforcement agencies during forensic investigations?

Collaboration with law enforcement is essential for effective investigations. Forensic experts provide the technical insights needed to interpret evidence, while law enforcement ensures legal compliance and case context. A symbiotic relationship ensures justice is served efficiently. Efficient Evidence Collection, Contextual Understanding, Interdisciplinary Expertise, Support for Legal Proceedings, Holistic Case Reconstruction, Cross-Jurisdiction Investigations, and Continuous Feedback Loop

## What inspired you to establish Clue4 Evidence Forensic Lab?

I wanted to create a space where forensic science could thrive beyond traditional boundaries. Clue4 Evidence was established to provide high-quality forensic services, focusing on innovation, training, and comprehensive client support. It all started when I wanted to investigate who was the writer who sent the Death Threat letter to my Father. This motivated me to pursue training in Questioned Document Examination. As I gained expertise in the field, I realized the significant demand for forensic investigation services, which ultimately led to the establishment of CLUE4 EVIDENCE FORENSIC LAB.

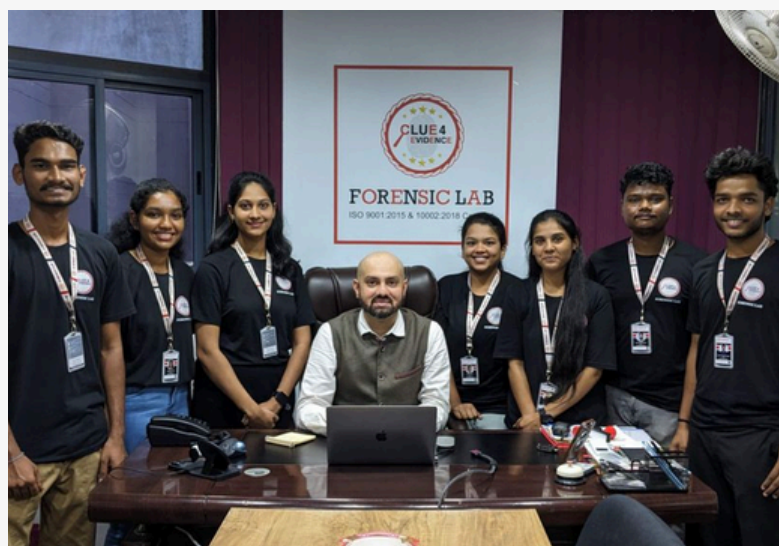


## How do you manage the business aspects of running a forensic lab while maintaining technical precision?

The field of forensic or so called business or profession is a debatable question while I don't consider this as business while offering a best professional services requires certain visibility and reach, which is managed by our dedicated team. Balancing business operations with technical work requires strong time management and delegation. I ensure that we have a skilled team handling business logistics, allowing me to focus on investigations. Regular training and audits help maintain technical excellence.

## In your opinion, how does being a private forensic expert differ from working within institutional frameworks?

Private experts have the freedom to choose cases, innovate, and interact directly with clients. However, this also means taking on additional responsibilities like training, and maintaining the ongoing operational challenges including human resource, logistics and finances, client relationships, which are not a concern in institutional roles.



## What advancements in forensic science are you most excited about?

Technologies like AI in crime scene reconstruction, DNA phenotyping, and advancements in digital forensics excite me. These innovations are redefining how we approach investigations and evidence interpretation.

## **How do you see forensic science evolving in India in the next decade?**

India is gradually embracing forensic science as a critical component of the justice system. With increasing investment in forensic infrastructure, training programs, and public awareness, the field is poised for significant growth.

Particularly since Indian law has been amended to mandate the use of forensics in all criminal cases with punishments of seven years or more.

## **Are there any particular trends in forensic science Indian professionals should focus on?**

Digital forensics, AI, and machine learning are key trends. Professionals should also explore global certifications and training to stay competitive in the international market. Also, Preventive Forensics, and in Involvement in Constant Research and Development.

## **What skills and certifications would you recommend for aspiring forensic experts?**

Focus on analytical skills, technical certifications in digital forensics, questioned documents, and cybersecurity. Hands-on training and internships with forensic labs can provide invaluable experience. Also to FOCUS on enhancement of SOFT-SKILLS, COMMUNICATION SKILLS, BEHAVIOURAL/PERSONALITY DEVELOPMENT SKILLS, etc.

## **How important is networking for career growth in forensic science?**

Networking is critical. Memberships in organizations like the International Association of Identification open doors to knowledge-sharing, mentorship, and global opportunities. ATTEND and CONTRIBUTE in national and international events through presenting your research, case work, studies, etc. Also, to connect with professionals and experts of your fields.



## **What advice would you give to budding forensic experts?**

Stay curious, keep learning, and never compromise on ethics. Forensic science is about integrity and precision, so focus on building a solid reputation through meticulous work.

## **What is your message to the readers of FORENSICS?**

Embrace forensic science with passion and commitment. This field has immense potential to create a safer and more just society. Let your work speak for itself, and never stop learning. While in the absence of any governing body for forensics nothing stops you from creating your own professional ethics and to define your duty to the society, duty to the client and duty to the court.

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## **Are there any upcoming projects or initiatives at Clue4 Evidence Forensic Lab?**

We are working on advanced training modules for students and professionals, focusing on digital forensics and lie detection. Our aim is to bridge the gap between academia and real-world applications.

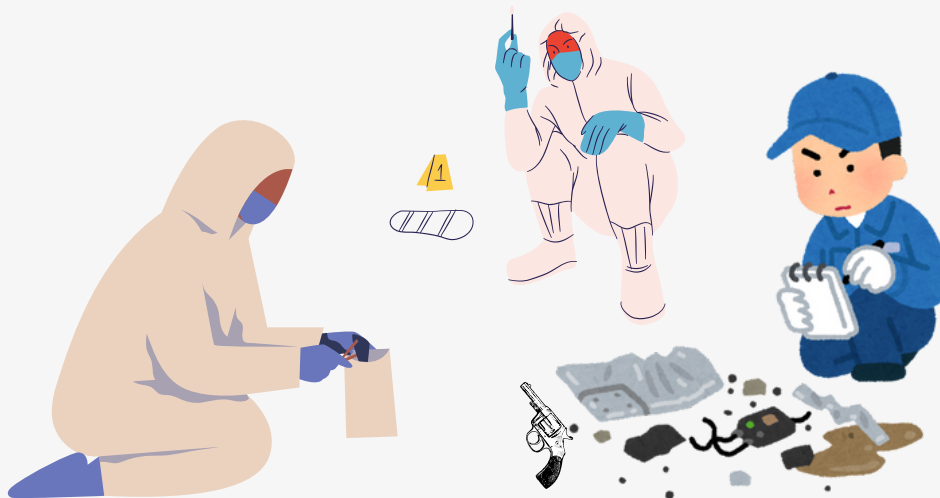


## **About the Interviewee**



*Phaneendar B N, a distinguished expert in forensic and legal sciences, bridges law enforcement, scientific inquiry, and legal advocacy. With an impressive academic background—M.Sc in Physics, M.Sc in Cyber Security, M.Sc in Forensic Science, LLB, and LLM (Torts and Crimes)—and specialized certifications, he brings unmatched technical expertise and strategic insight to every investigation. Currently serving as a Court-Commissioned Forensic Expert, Questioned Document Analyst, Fingerprint Specialist, Cyber Security and Digital Forensics Expert, Polygraph Examiner, Advocate, Trainer, Consultant, and Director of Clue4 Evidence Forensic Lab, Bengaluru, Karnataka, his work exemplifies precision and innovation. As a mentor and leader in the field, Phaneendar B N continues to inspire future professionals and advance the frontiers of forensic science and legal practice.*

**Interviewed by Ms. Varshini H  
(Asst. Professor – Forensic Science)  
Aditya Degree & P.G. College,  
Surampalem**





# Case Study

on

## FORENSIC IMAGE ANALYSIS:

# INVESTIGATING VISUAL ANOMALIES IN A RELIGIOUS RITUAL

Author: Manu Srinivas



*Figure 1: A reference image of a typical Hindu havan ritual, illustrating the environment filled with smoke and fire.*

In today's world, digital images are widely used as evidence in legal proceedings, investigations, and media. With the rise of digital manipulation techniques, ensuring the authenticity of images has become more crucial than ever. This case study examines an intriguing photograph taken during a Hindu *havan* (a religious fire ritual) where the priest's hand appeared to vanish mid-ritual. The objective of the investigation was to determine whether this image had been digitally manipulated or if the anomaly could be explained by natural photographic and environmental factors.

This case highlights the importance of forensic image analysis in debunking visual myths and clarifying truths through science, particularly in matters of image authenticity.

## The Case: The Disappearing Priest's Hand

The photograph in question depicted a priest performing a traditional havan. At first glance, the image appeared normal, but closer inspection revealed that the priest's hand seemed to have disappeared or become distorted, creating an illusion of fading. This raised questions about whether the image had been tampered with to create a supernatural effect or if a logical explanation existed. A thorough forensic analysis was conducted to address these concerns.

### Step 1: Metadata Examination - The Digital Footprint of an Image

Metadata, often referred to as EXIF (Exchangeable Image File Format) data, provides essential details about a photograph, such as camera settings, timestamps, and the device used. Metadata can reveal whether an image has been altered or if editing software was employed.

In this case, metadata extraction showed no evidence of tampering. The timestamps were consistent, the camera settings matched the conditions during the photograph's capture, and there was no indication of post-capture editing. This analysis confirmed that the image had not been manipulated digitally, leading to an exploration of natural photographic explanations.

### Step 2: The Role of Exposure Time and Motion Blur

Exposure time determines how long the camera's sensor is exposed to light, affecting the clarity of moving objects. In the analyzed photograph, the exposure time was 1/33 of a second. This setting was sufficient to capture motion if either the subject or the camera was moving.

An analysis of the pixel structure revealed that the priest's hand was in motion when the image was captured. The observed

distortion was consistent with motion blur, a common photographic phenomenon where moving objects leave a "trail" in the image. The priest's hand moved too quickly for the camera to capture clearly, creating the illusion of disappearance.



**Figure 2: An example of motion blur where the movement creates a vanishing effect in the photograph.**

### Step 3: Aperture and Depth of Field - A Matter of Focus

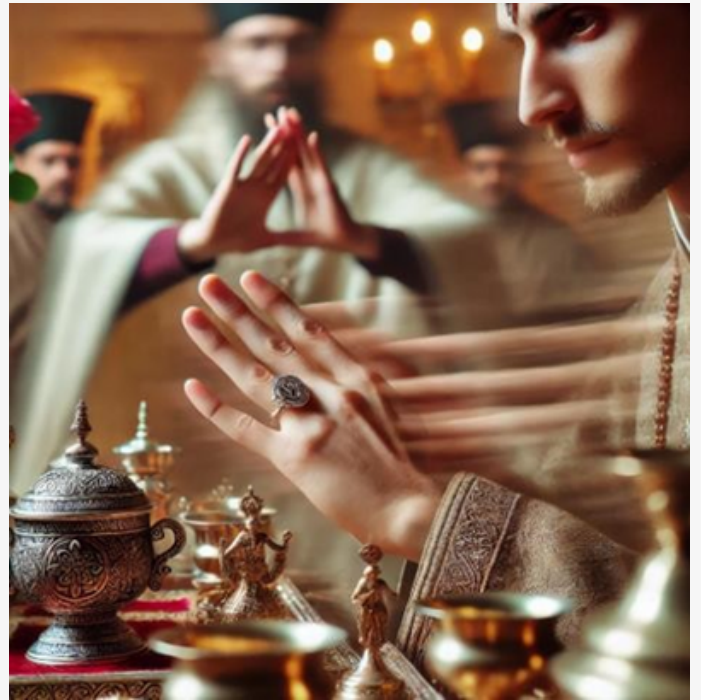
Aperture controls the amount of light entering the lens and impacts the depth of field (DOF), which determines the areas in focus within an image. In this case, the aperture was set to f/1.8, a large opening typically used in low-light situations, such as indoor rituals illuminated by fire. A large aperture creates a shallow depth of field, where only parts of the image in the foreground are in sharp focus, while others appear blurred.

The shallow depth of field contributed to the distortion of the priest's hand. The camera was likely focused on the priest's face or torso, while the hand, moving rapidly, was slightly outside the plane of focus. This further enhanced the illusion of the hand vanishing.

#### Step 4: Environmental Conditions - Heat, Smoke, and Distortion

Environmental conditions also played a significant role in the visual anomaly. The havan ritual involves a sacred fire that produces heat and smoke, which can distort visual elements in photographs. These factors were responsible for a natural phenomenon known as “heat haze,” where light bends or refracts as it passes through layers of varying temperatures.

In the analyzed image, heat haze and smoke caused waviness and haziness, adding to the distortion of the priest’s hand. Combined with motion blur and a shallow depth of field, these environmental effects confirmed that the anomaly was natural.



**Figure 3: An example of shallow depth of field, where the subject is in focus, but the background (and parts of the moving hand) is blurred.**

#### Case Outcome: The Image Was Genuine

The forensic analysis concluded that the photograph was authentic and had not been digitally manipulated. The vanishing hand effect was attributed to natural photographic phenomena— motion blur caused by a short exposure time, distortion from a shallow depth of field, and environmental factors like heat haze and smoke. The priest’s hand had moved too quickly for the camera to capture it clearly, creating the illusion of disappearance.

This case exemplifies how forensic science can demystify visual anomalies without resorting to assumptions of tampering or supernatural causes. Understanding the science behind photography demonstrates that many visual oddities have logical explanations.

#### Key Takeaways

1. **Forensic Image Analysis Is Essential:** Forensic analysis is crucial in an era where digital manipulation is prevalent, ensuring the integrity of visual evidence.
2. **Metadata Verification:** Metadata acts as a digital fingerprint that helps verify the authenticity of images. In this case, metadata confirmed the image had not been edited.
3. **Scientific Photographic Factors:** Exposure time, aperture, and environmental conditions significantly influence how images are perceived.
4. **Technological Advancements:** The evolution of smartphones and editing software makes it imperative for forensic experts to stay updated on emerging technologies.



## Conclusion

Forensic image analysis plays a vital role in uncovering the truth behind visual evidence. This case study highlights how scientific principles and advanced forensic tools can help discern fact from fiction. As digital manipulation techniques become more sophisticated, forensic methods must also advance to ensure the authenticity of evidence. Through rigorous analysis, forensic experts can shed light on even the most perplexing visual anomalies, bridging the gap between mystery and scientific explanation.

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## ABOUT THE AUTHOR



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# DID YOU KNOW?

**Forensic odontologists can identify age, sex, & ancestry from teeth, which are durable and can survive decomposition, revealing key life clues.**

# Case Study



*"The only motive that there ever was to completely control a person; a person I found physically attractive. And keep them with me as long as possible, even if it meant just keeping a part of them."*

## The Demonic World of Jeffrey Dahmer

**Author:** Swarangi Hule

**Jeffrey Lionel Dahmer** also known as Jeffery Dahmer was born on 21st May 1960. His birthplace was Milwaukee, Wisconsin. His parents were Lionel and Joyce Dahmer. He had a dysphoric family where his mother was suffering from depression and even attempted suicide. His father was a chemist and hardly gave him any time. At the age of four, he was suffering from a double hernia and underwent surgeries to cure it. He was a happy, curious and energetic child but after this surgery, he became a loner.

Jeffrey Dahmer enjoyed collecting dead animals from the road sides and dissecting them during his childhood. After dissecting those animals he destroyed their body with chemicals.

Jeffrey's parents got divorce when he graduated from high school. He has seen parental negligence from a very young age which has affected his personality development. He was an alcoholic. He dropped out from Ohio state University due to his alcohol addiction. Later he joined the army in 1978 and he was posted in Germany. He was discharged from the army in 1981 due to his drinking issues. His father tried to send him to rehabilitation centres but nothing could reduce his alcohol addiction.



## Victim Profile: The Milwaukee Cannibal

Jeffrey Dahmer, infamously known as the Milwaukee Cannibal, murdered 17 young males between 1978 and 1991.

1. **Steven Hicks (18, 1978)**: Dahmer's first victim, Hicks was strangled after being lured home while hitchhiking. His remains were discovered in 1991 after Dahmer's confession. He killed Hicks by strangulation and then masturbated on his corpse.
2. **Steven Tuomi (28, 1987)**: He's the only murder victim in Milwaukee for which Dahmer was not charged because of lack of evidence; Dahmer did not recall details but believes he killed Tuomi at the Ambassador Hotel. Tuomi's father Walter, said he was originally told by Milwaukee police that they could do nothing because there was no sign of foul play.
3. **Jamie Doxtator (14, 1988)**: Dahmer offered Doxtator money to come to his grandmother's house in West Allis and pose for pictures or to spend the night with him. Doxtator accepted and the two returned to the grandmother's house, where Dahmer drugged and strangled him. He kept the body in the cellar for about a week before dismembering and disposing of it.
4. **Richard Guerrero (21, 1988)**: He met Dahmer at one of the gay bars, where Dahmer offered him \$50 to spend the night with him. They went back to Dahmer's grandmother's house, where he drugged and strangled Guerrero. He performed necrophiliac acts on the body before dismembering it. He disposed of most of the body parts but kept the skull.
5. **Anthony Sears (24, 1989)**: Dahmer lured him to his grandmother's house, where he drugged and strangled him. Dahmer attempted to preserve Sears' head, even called a taxidermist for advice, but was unsuccessful. He only kept the skull, which he kept in a locker at work, telling other employees it was Fake.
6. **Raymond Smith (33, 1990)**: Dahmer's Oldest victim and First victim in Dahmer's apartment; lured Smith to his new apartment by offering him \$50 to pose for pictures. skull found post-arrest.
7. **Edward Smith (27, 1990)**: Lured to the apartment and killed; his family received a chilling call

warning them to stop looking for her brother because he had killed him.

8. **Ernest Miller (23, 1990)**: Dahmer met Miller outside a book store. Dahmer was attracted to Miller's physique and lured him to his apartment by offering him \$50. Once they were alone, he used a large knife to slash Miller's throat. He bled to death within a minute. Dahmer dismembered the body and saved Miller's skeleton. He then cooked and ate Miller's heart and one of his biceps. The remains were found after Dahmer's Arrest.

9. **David Thomas (22, 1990)**: After drugging him, Dahmer no longer felt attracted to him so he strangled and dismembered him, this time not retaining any of the parts. He had to be identified by the Polaroid pictures Dahmer had taken of him during the dismemberment process.

10. **Curtis Straughter (17, 1991)**: Drugged, handcuffed, and mutilated. Dahmer kept his head, hands, and genitals.

11. **Errol Lindsey (19, 1991)**: Dahmer tried an experiment, trying to turn his victim into a "zombie" He drilled a hole into Lindsey's skull and injected hydrochloric acid into his brain, hoping to reduce him to a permanently unresistant, submissive state. However, the experiment failed. Lindsey woke up complaining of a headache and asked Dahmer the time. Dahmer drugged him again and strangled him, disposed all parts except skull.

12. **Tony Hughes (31, 1991)**: Deaf victim killed using drilling and acid injection.

13. **Konerak Sinthasomphone (14, 1991)**: Escaped but was returned to Dahmer by police, then killed.

14. **Matt Turner (20, 1991)**: Dismembered, with remains stored in a barrel.

15. **Jeremiah Weinberger (23, 1991)**: Boiling water injected into his skull; body dismembered.

16. **Oliver Lacy (24, 1991)**: Killed after a failed chloroform attempt; skeleton preserved.

17. **Jason Bradehoft (25, 1991)**: The final victim, dismembered with remains dissolved in acid.

Dahmer's spree involved necrophilia, cannibalism, and gruesome experiments, leaving a horrifying legacy of cruelty.

## WITNESS:

Glenda Cleveland was Jeffrey Dahmer's neighbour, and the serial killer could have been stopped two months earlier if police had only listened to her. "Are you sure?" she kept asking police on the phone when they insisted that a dazed naked boy trying to escape from Dahmer was an adult involved in a lovers' spat with him.

He was actually 14-year-old Konerak Sinthasomphone, and he was about to become Dahmer's next homicide victim. Cleveland's daughter, Sandra Smith and niece, Nicole Childress had spotted the boy fleeing from Dahmer in the alley on May, 1991.



*Fig. 01: Glenda Cleveland with her daughter Sandra Smith*

## CHILDHOOD & NEGLECT

Multiple deeply upsetting aspects of Jeffrey's childhood played a role in his pathology.

- His mother has a history of mental illness: Joyce, his mother, severely suffered from postpartum depression which also affected Jeffrey

- Jeffrey was reported a victim of sexual abuse: In 1991, Jeffrey's father, Lionel, told probation agent that his son was molested by a neighbour when he was 8 years old.

- His parents had a toxic relationship: Lionel and Joyce had a bitter divorce in 1978. Jeffrey often witnessed their physical and verbal abuse.

- Jeffrey's parents neglected him: When the Dahmer's split in 1978, they fought over custody of his brother David, who was 6 years younger

than Jeffrey, but no thought was ever given to what should happen to Jeffrey. After the divorce, Joyce moved out with David, Lionel remarried and Jeffrey was left alone in the house. He killed his 1st victim at this time. Abuse and neglect also impacted & increase the risk of mental health disorders. As a result, Jeffrey adapted to his isolation and started drinking heavily.

- Jeffrey's father disapproved of his sexuality. Homosexuality was not widely accepted in the 70's and 80's when Jeffrey was growing up. Lionel often made negative comments about homosexuals during his childhood.

## ARREST

In 1991, Dahmer approached 3 men offering them money to pose for nude photographs. A man named Tracy Edwards agreed and followed Dahmer back to his apartment where Dahmer handcuffed him and held a knife to his chest, telling Edwards he intended to eat his heart.

Edwards was eventually able to escape by punching Dahmer and knocking him to the ground; allowing him to run through the unlocked front door. He was able to flag down 2 Milwaukee police officers, whom he led back to Dahmer's apartment.



*Fig. 01: Jeffrey Dahmer with his father Lionel Dahmer and David Dahmer*

## INVESTIGATION

On July 23, 1991, personnel from the Milwaukee Police Department encountered a naked man in handcuffs running in the street. The individual escorted the officers to Jeffrey Dahmer's Apartment, where the victim alleged he had been drugged and assaulted. After officers

gained access to the residence, Dahmer was quickly taken into custody. The victim showed the officers the decapitated head of male in the refrigerator he had previously seen and a full criminal investigation commenced.

### **THE CRIME SCENE**

Personnel from the Milwaukee County medical examiner's office responded to the scene. Per established routine, medical examiner personnel worked closely with the Milwaukee police department independently photographing and documenting the scene and its evidence.

The evaluation of the scene allowed investigators to establish methods of death, begin the preliminary identification process, and demonstrate the deteriorating mental capacity of the assailant. Forensic pathologists assisted with the identification, established the cause of death, and documented injuries that allowed investigators to question Dahmer on various injuries he inflicted upon his victims. Anthropological examination assisted with the identification and also resulted in the establishment of victim profiles.

### **EVIDENCES**

Within the restricted crime scene, the dining area contained recently purchased hardware implements such as tape, a hammer, handsaw, and an electrical drill in the bedroom. They also encountered numerous human body parts including seven skulls, three of which were painted. There were four intact human heads, one dissected postcranial skeleton in a portable freezer, and three partially skeletonized bodies in a 55-gallon drum. The freezer compartment of the refrigerator contained what was later identified as a human heart and large muscles fillets packaged in plastic bags. Other evidence, including large boxes of muriatic acid, degreasing solvents, Polaroids photographs of victims (both alive and in various states of dissection), desiccated male genitals, and hands were recovered.

Scene photographs were essential, not only for the documentation of the initial scene, but in the continual review and analysis of the evidence over time.

The kitchen had no food material—only a can of Crisco grease—which supported later allegations of cannibalism. There was a large art decor table with a large fish tank. Photographs found elsewhere in the apartment showed Dahmer had documented numerous victims that had been posed on table prior to, during, and after dismemberment. Desiccated male genitalia, scalp hair, hands and skulls supported the fact that they were retained as 'souvenirs' in a typical pattern of an organized serial killer.

Hardware implements used to dismember the victims' bodies.



**Fig.03: Dahmer's Living room contained chemicals to sedate his victims**



**Fig. 04: Polaroid photos of victims found by police during Jeffrey's arrest**



**Fig. 05: Hall closet containing acid bottles. Note the cleaned skulls and cooking pot that contained human body parts as souvenirs.**





**Fig. 06: Three of such 55 gallon drums were found at Dahmer's apartment which contained bodies of victims dissolving in acid**

### AUTOPSY FINDINGS

1. Forensic Pathologists initially analysed the body parts and skeletons recovered at the scene. The portable freezer contained, in addition to a decapitated frozen head, defleshed bones and 3480g of tissue cut into irregular, square pieces not exceeding 15cm. The 55-gallon drum contained four decomposing skeletons, which could be approximated using the variable dissection planes of dismemberment. The cleaned, post cranial skeleton could be matched to a skull by the unique atlanto-occipital joints identified by the anthropologist.
2. The paint was removed from the defleshed skulls, which revealed the presence of holes drilled into the frontal regions of the skull. The skulls contained 2, 3 and 4 holes. Examination of the frozen skull revealed the presence of a single hole surrounded by faint, periosteal haemorrhage. The cranium was opened and the brain examined. There was a haemorrhagic wound track through the brain that demonstrated microscopic, organizing inflammation and endothelia inflammation a distance from the wound. These findings indicated a healing injuring of some duration inflicted while the victim was alive. Dahmer reluctantly admitted that he had attempted to create "zombie sex-slaves" by drilling the skulls and injecting acids and other materials.



**Fig. 07: Skulls and tissues of victims in refrigerator, Investigation team collecting the refrigerator**



**Fig. 08: Dahmer made his victims to pose like above portrait and clicked their polaroids**

### COURT TRIAL

Judge Lawrence S. Gram oversaw the trial. Dahmer's defendant was Gerald Boyle, who had previously defended Dahmer in the past. And the District attorney, Michael McCann was appointed as prosecutor. Dahmer pleaded not guilty to 15 charges of

murder on September 10, 1991, His 1st claimed victim, an 18-year-old hitch hiker, Steven Hicks had been killed in Ohio so Dahmer would have to return to that state to face charges. As the body of his 2nd victim had not been found, prosecutors in Wisconsin opted not to charge Dahmer in that instance. On January 13, 1992, Dahmer changed his plea to guilty but insane. This removed the need for a criminal trial, meaning court proceedings would focus on Dahmer's Sanity. The jury decision need not be unanimous; only 10 of 12 jurors would have to agree on Dahmer's mental state for a verdict to stand On February 15, 1992, 10 out of 12 jurors found Dahmer was not mentally ill. As Dahmer had not been determined insane, the question of his ability to control himself did not need to be decided.



**Fig. 09: Jeffrey Dahmer seen in 1991**

## **JUDGEMENT**

Judge Lawrence C. Gram sentenced Dahmer to 15 consecutive life sentences. Dahmer was subsequently tried for a murder in Ohio, where he was found guilty and received another life sentence.

Punishment:

Dahmer was sentenced to 15 consecutive life a 16th consecutive life sentence was added in May for the murder he committed in 1978. The life imprisonment was without parole. It was a total of 941 years of imprisonment.

## **DEATH**

On November 28, 1994, Dahmer was beaten to death by a fellow inmate at Wisconsin's Columbia Correctional Institution. The inmate, Christopher Scarver, claimed Dahmer had been taunting fellow inmates with his cannibalistic infatuation.



**Fig. 10: Local news headlines about Dahmer's death**

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# Forensic Puzzle Quest

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| Dactyloscopy | Exhumation | Laceration   |
| Luminol      | Paternity  | Spectroscopy |
| Testing      | Toxicant   | Trauma       |



# THE CHANGING FACE OF CRIME : INVESTIGATING PLASTIC SURGERY'S IMPACT ON FORENSIC FACIAL ANALYSIS

**Author: Devi N**

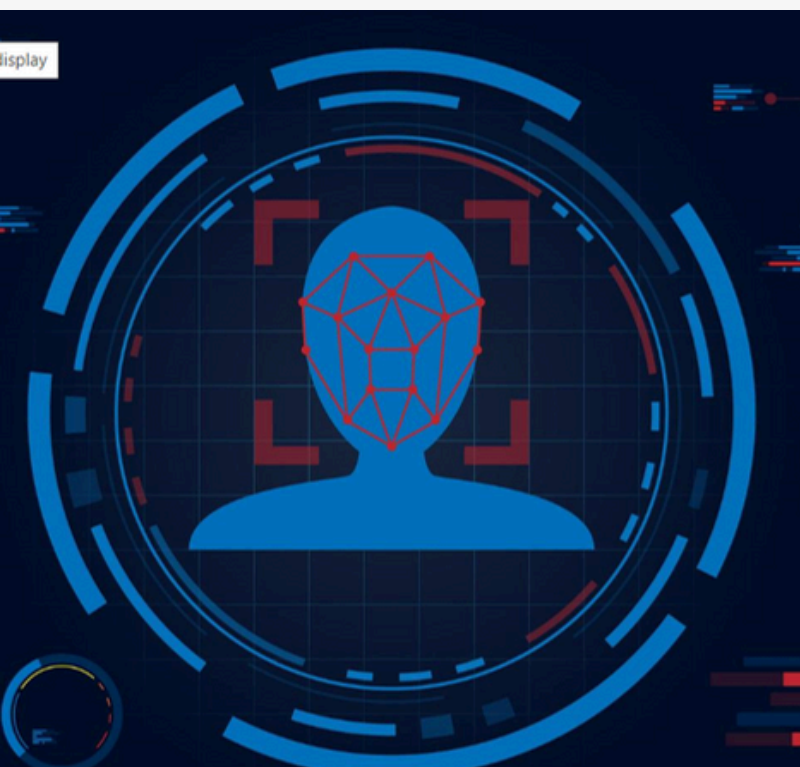
## **ABSTRACT:**

The rising prevalence of facial plastic surgeries for both cosmetic and reconstructive purposes introduces substantial challenges for forensic facial recognition systems. Traditional biometric systems, which depend on the stability of facial features, often struggle to accurately identify individuals post-surgery due to alterations in facial geometry. This review presents a detailed examination of existing literature on the effects of plastic surgery on facial recognition systems, highlighting approaches such as geometrical recognition, region-based methods, and multimodal biometric techniques. While advancements in adaptive and robust recognition algorithms have improved performance, significant gaps remain, especially in handling global surgical changes. The review concludes with a discussion on future research directions, emphasizing the need for adaptive machine learning models and the development of more comprehensive datasets for forensic applications.

Facial plastic surgery, both reconstructive and cosmetic, has seen a rise in popularity due to advancements in medical technology and affordability. While these procedures can enhance appearance or restore function, they pose significant challenges for forensic facial recognition systems that rely on consistent facial geometry for identification. Cosmetic procedures like rhinoplasty, facelifts, and chin augmentations, as well as reconstructive surgeries following trauma, can drastically alter key facial landmarks, reducing the accuracy of recognition algorithms that depend on stable facial features. Unlike other biometric identifiers such as fingerprints or irises, facial features are highly susceptible to intentional changes. Forensic systems, widely used in law enforcement, border control, and security, often struggle to match post-surgery faces with pre-surgery data, leading to potential misidentification or failure to identify individuals. This challenge is particularly critical in criminal investigations or identity verification scenarios where reliable biometric matching is essential.

Forensic Facial recognition has been performed by various methods starting from traditional methods like manual measurements in 1964, progressed with AI and machine learning in 1991, and advanced further with deep learning in 2011. Today, companies like Amazon and Apple leverage AI for real-time facial recognition applications.

As plastic surgery becomes more common globally, there are growing concerns that individuals may alter their appearance to evade detection. These intentional changes complicate biometric systems across various sectors, from law enforcement to public safety.



Addressing these issues requires the development of advanced recognition techniques and the incorporation of additional biometric traits to improve identification accuracy in post-surgery cases. This review synthesizes research on Forensic facial recognition post-plastic surgery, examining methods such as geometrical face recognition, region-based recognition, and multimodal biometric approaches. The primary objective is to analyze the effectiveness of these methods and to identify areas where further research is needed to enhance forensic applications of face recognition technology.

## TRADITIONAL APPROACHES

### Geometrical Face Recognition Systems after Plastic Surgery:

Geometrical facial recognition systems use anthropometric facial landmarks for identification, but post-plastic surgery changes in facial features challenge these systems. El-Said and Atta's 2014 Geometrical Face Recognition After Plastic Surgery (GFRPS) system addresses this through a three-step process: localizing regions of interest (ROIs), measuring geometrical distances post-surgery, and matching them to pre-surgical data with a minimum distance classifier. It achieved accuracy rates of 78.5% for local surgeries and 76.1% for global surgeries, showing high performance in handling surgical alterations.

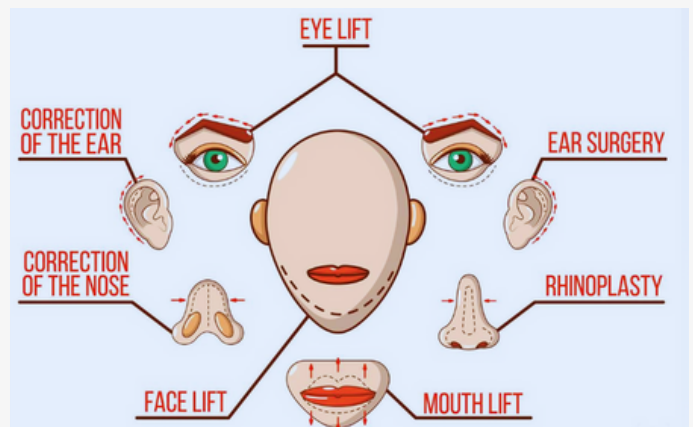
In (2018) Vezzetti, Marcolin, Tornincasa, Ulrich, and Dagnes proposed a method for 3D geometry-based automatic localization of facial landmarks, specifically designed to function effectively even when parts of the face are occluded. This approach offers a robust solution for accurate landmark identification in challenging scenarios, such as those involving facial accessories or partial obstructions.



## RECENT ADVANCEMENTS:

### Region-Based Recognition Approaches

Region-based approaches, such as those proposed by Sabharwal and Gupta (2019), focus on specific facial regions that are less affected by plastic surgery, such as the eyes, nose, and mouth. By isolating these regions and applying techniques such as Speeded Up Robust Features (SURF) and k-nearest neighbors (KNN), the system minimizes the impact of surgery on overall recognition accuracy. This region-based method achieves a recognition rate of 89.7% for local surgeries and 87% for global surgeries, showing superior performance compared to traditional holistic recognition systems.



### Multimodal Biometric Systems

Multimodal biometrics combine various biometric traits, such as shape and texture, to improve recognition performance post-surgery. Mun and Deorankar (2014) introduced a multimodal system using Principal Component Analysis (PCA) and Local Binary Patterns (LBP), combined with periocular features. In (2015) Gulhane, Ladhake, and Kasturiwala conducted a review on recognizing surgically altered face images using multimodal biometric features. Their work focuses on integrating different biometric traits to improve recognition accuracy for faces that have undergone surgical modifications, addressing challenges posed by such alterations in traditional facial recognition systems.



### Robust Algorithms and Adaptive Techniques:

In 2015, De Marsico, Nappi, Riccio, and Wechsler developed a robust face recognition method designed to address the challenges posed by plastic surgery. Their approach introduced advanced adaptive algorithms like FARO (Face Recognition Against Occlusions and Expression Variations) and Split Face Architecture (SFA). These techniques divide the face into smaller, independent regions for analysis, allowing each region to be coded separately. By focusing on more stable areas of the face, their method reduces the effects of occlusion and surgical alterations, significantly enhancing recognition accuracy even after substantial facial modifications.



Image source- Ai Generated

### DISCUSSION:

The literature reveals that region-based and multimodal approaches offer the most promise in addressing facial recognition challenges following plastic surgery. Geometrical systems show potential, particularly for cases of local surgery, but their performance decreases significantly in the case of global surgical alterations. Region-based methods that isolate relatively unaltered facial areas (e.g., the periocular region) demonstrate superior recognition rates. While substantial progress has been made in developing adaptive recognition systems, the field faces several limitations. Most notably, current systems struggle to handle complex, global facial alterations. Additionally, existing facial

recognition datasets often lack comprehensive representations of post-surgery faces, limiting the ability to train and test algorithms effectively across a broad spectrum of surgical procedures. Despite the success of multimodal systems in improving recognition rates, few studies focus on real-world forensic applications where the diversity of facial surgeries poses significant challenges. Region-based and multimodal systems provide a significant advantage over traditional holistic approaches by targeting less-affected facial regions. However, the reliance on these methods introduces challenges in cases where surgery impacts multiple facial regions simultaneously. Moreover, adaptive machine learning models, although promising, require further refinement to accurately predict facial alterations caused by diverse surgical techniques.

### CONCLUSION

Facial plastic surgery continues to pose significant challenges to forensic facial recognition systems. While region-based and multimodal biometric systems offer improved performance, particularly in cases of localized surgeries, global surgical alterations remain difficult to model. The development of adaptive algorithms and region-specific approaches has enhanced recognition rates, but further work is needed to address the complex effects of surgery on facial geometry.

### FUTURE RESEARCH DIRECTIONS:

Future research should prioritize the development of adaptive deep learning models capable of dynamically adjusting to both local and global facial changes. Additionally, the creation of diverse, surgery-inclusive datasets is critical to improving the generalizability of forensic facial recognition systems. Advanced machine learning techniques that incorporate both structural and textural facial features may offer a pathway toward more accurate post-surgery recognition. Moreover, the incorporation of auxiliary biometric traits, such as iris or periocular features, may further enhance the robustness of future systems.

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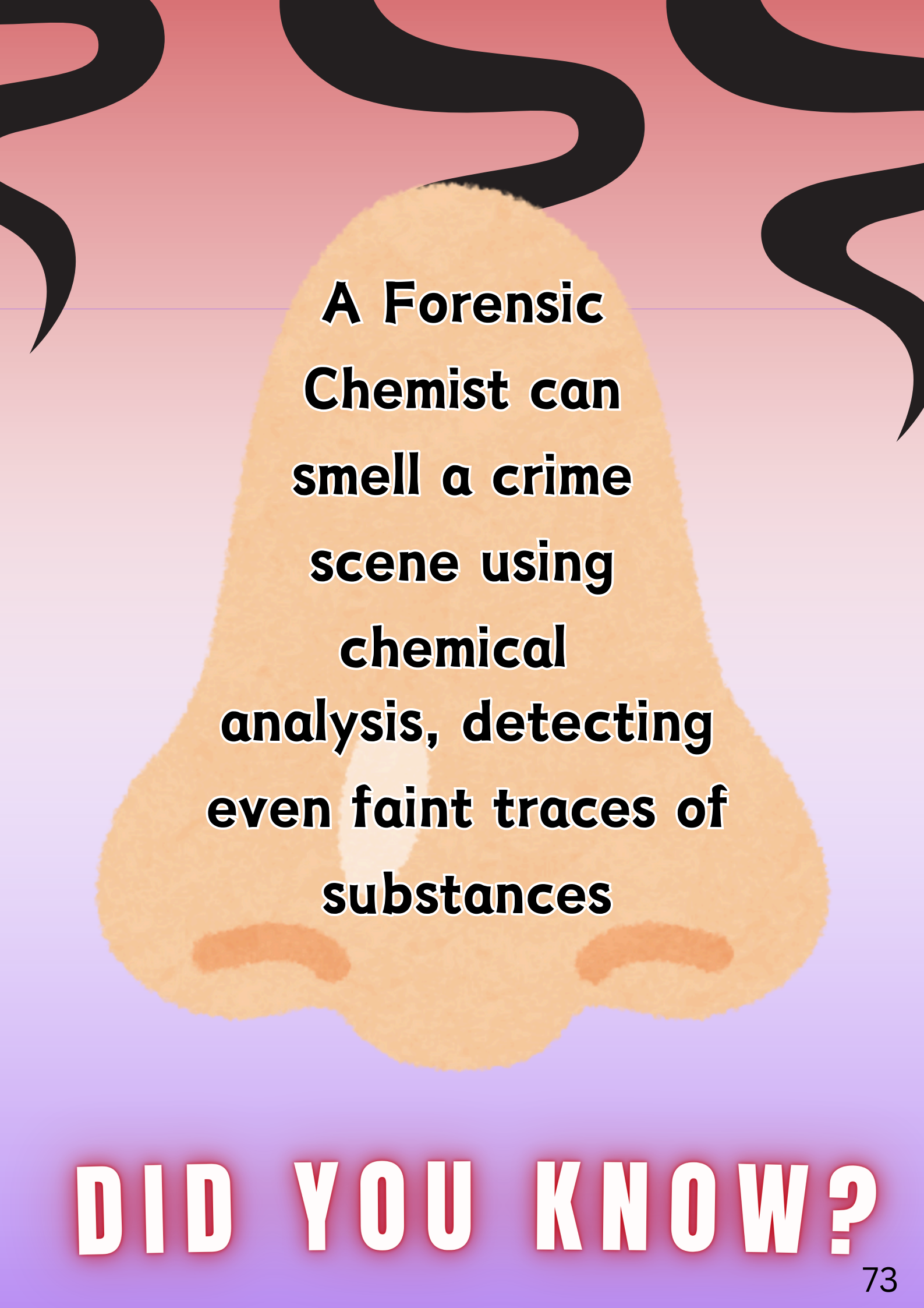
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**A Forensic  
Chemist can  
smell a crime  
scene using  
chemical  
analysis, detecting  
even faint traces of  
substances**

**DID YOU KNOW?**



# FACE BIOMETRICS: TOUCHLESS AND SEAMLESS KEY TO A SECURE WORLD USING FACE RECOGNITION TECHNOLOGY

**Author: Neha R. Vemula**

## INTRODUCTION

Security has always been a concern whether using traditional or advanced authentication methods. In earlier days, this was done using the tokens (something which you have). Later on, when it became difficult to carry the token or the cards, PINs and passwords (something that you know) were invented. The crimes started increasing as it became easy to crack an alphanumeric password, creating a need to build a high-security system. Over decades, the technology has upgraded to a new authentication system known as "Biometrics" (something you are), which aids in identifying a person using his body parts by measuring and analyzing physiological and behavioral traits unique to each individual. Face biometrics is one of the types of Physiological biometrics that uses facial features for individualization. It is the most common methods of identification as everyone has unique face features that help to differentiate from others. This technology applies various algorithms for the detection and recognition of the faces in an image. It also has an added advantage that it does not require any expert to interpret the results. It's a non-intrusive method that is easy to enroll and verify. Various law enforcement agencies and private and government sectors use facial recognition technology.

The facial recognition system utilizes the mono (sequential) and parallel face recognition concepts. In a sequential system, every step is followed by another step. For the Parallel concept, two steps can be performed simultaneously, here multithreading capability is utilized.

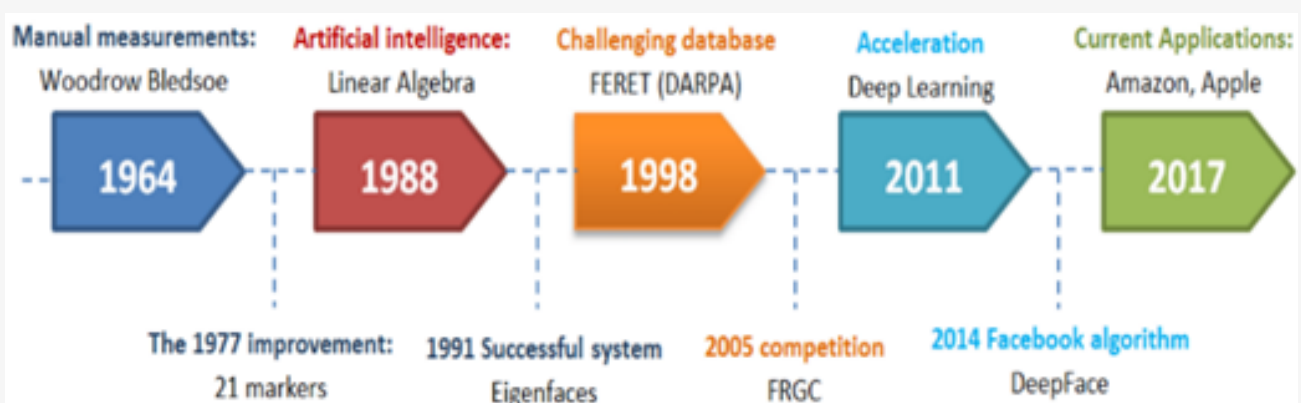
Facial biometrics used for Human Recognition has two primary objectives: **Identification** and **Verification**.

### i. Identification:

In this, the biometric system answers the question "Who is X"? The device captures the face of the template image and compares it with the stored database in the system. This type of comparison is known as the "One-to-Many" search (1×N). Identification applications are common when the goal is to identify criminals, terrorists, or others.

### ii. Verification:

In this, when a user claims to be X, biometric answers the question "Is this X"? by verifying the user. When the user claims his identity using techniques like PIN or Password to verify the user, the facial features of the user template are compared directly to the claimed database in the system. This type of recognition is the "One-to-One" search method (1×1).



**Figure 1: Advancement of FRT over the years**

**Source: Ujjainia, P. et. al., 2024**

## HISTORY

A chronological overview of the advancement of facial recognition technology (FRT) spanning from 1964 to 2023, encompassing diverse aspects of facial biometrics, including soft biometrics, and the role of artificial intelligence, elucidating their contributions and findings in the evolving field is explained below:

### 1964

The American mathematician Woody Bledsoe et al. studied facial recognition computer programming, a semi-automatic method, where 20 computer measures are asked to be entered manually, such as the size of the mouth or the eyes.

### 1977

Goldstein et al. came up with the idea of automated facial recognition, which was further improved by adding 21 additional subjective markers of the face. (e.g., lip width, hair colour)

### 1988

Artificial intelligence was introduced to develop previously used theoretical tools.

Mathematics ("linear algebra") was used to interpret images and convert them into binary representation for further evaluation.

### 1991

Pentland and Turk created new technology for feature extraction and facial recognition, with the help of an algorithm known as 'Eigenfaces' based on a statistical approach to Principal component analysis (PCA).

### 1998

Defense Advanced Research Projects Agency (DARPA) developed the Face Recognition Technology (FERET) program, which provided the world with a particular size database composed of 2400 images for 850 persons.

### 2011

The technology was advanced and accelerated using deep learning methods such as machine learning and artificial Neural Networks.

### 2014

Facebook integrated its security-to-face biometrics that knows how to recognize faces due to its internal NN learning algorithm, DeepFace. The social network claims that the deep face method performs the human eye function up to 97% as it identifies human faces in

digital images with a high degree of accuracy.

### 2015

Arigbabu et al. developed feature extraction methods and other applications such as facial soft biometrics.

### 2017

Apple announced Face ID which had a faster neural network processing speeds, providing a significant increase in the speed of Face ID.

### 2020

Researchers are constantly looking up to 3D facial recognition; The increasing safety concerns triggers the involvement of artificial intelligence (AI) in forensic science and criminal investigation which may lead to automation in the FRT system.

### 2023

Carragher and Hancock explored the performance of human operators and a meticulously accurate Automated Facial Recognition System (AFRS) utilizing a Deep Convolutional Neural Network (DCNN).

## TYPES OF FACIAL RECOGNITION SYSTEMS

The Facial Recognition system is broadly classified under three categories based on the Dimensionality of the image captured. The 3 types are 2D system, 3D system, and Thermal System.

### 1.2D Facial System:

In the 2D system, a two-dimensional image is captured and faces lots of challenges as it does not consist of depth parameters. It required proper lighting condition as poor lighting can cause a decrease in the accuracy of results. In this system, the images are captured in shades of grey, and no color is applied as the differences in dark and light shades of grey are used for facial features recognition.

### 2.3D Facial System:

3D Facial technology systems have been a relief in biometrics by adding a new dimension to the technology that captures the three-dimensional face of an individual. Depth parameters are easily captured using 3D systems. These use special equipment such as depth sensors and 3D stereo cameras. In a 3D facial technology system, faces can be

captured from all angles as required. However, they are generally costly, complex and require more advanced devices to capture and analyze the face.

**3. Thermal systems:**

The heat released from the face has certain patterns that are captured in a thermal system. They are less common and relatively a new concept in facial recognition. The heat patterns emitted from the face are unique to each individual and can be detected both in light and dark conditions, making this technology highly effective and unaffected by lighting environments.

**FACIAL LANDMARKS**

Facial landmarks, also known as Anatomical landmarks denote the anatomy of a face in graphical representation. These points are similar in every human face but the relative distances between the landmarks are unique to each individual which helps in identifying the person through face recognition technology.

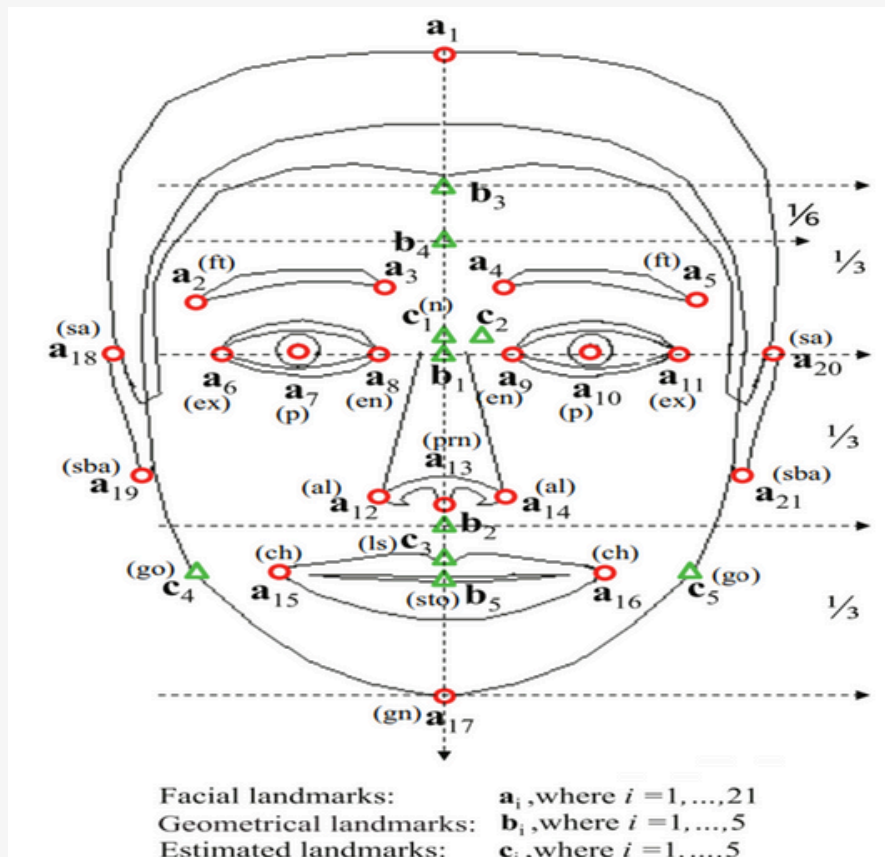
The facial landmarks are divided into three categories: Facial landmarks, Geometrical landmarks, and estimated landmarks.

A. Facial Landmarks: These include 21 Anthropometrical landmarks on the face

(represented as  $a_1$  to  $a_{21}$ ) that are used to detect a human face. These points are considered the most useful for purposes such as face recognition, age estimation, face reconstruction, facial expression detection, and face surgeries. These landmarks are the same in every human face.

B. Geometrical Landmarks: The face is divided into one-third ( $1/3$ ) portions with an imaginary line and the points are placed in the midsagittal plane i.e. line passing from the middle of the face. The geometrical landmarks include points from  $b_1$  to  $b_5$ . These landmarks may vary according to a person's facial proportion and the distance between points.

C. Estimated Landmarks: These are the points that are estimated as per individual facial build. They may vary from person to person due to differences in the thickness of tissue (e.g. Jawline may or may not be visible based on the facial build) and its shape (e.g. The depth in the middle of lips may vary based on shapes of the lips). There are total of Five estimated landmarks from  $c_1$  to  $c_5$ .



**Figure 2: Facial**  
**Source: Custers & Fosch-Villaronga, 2023**



## WORKING PROCESS OF FACIAL RECOGNITION TECHNOLOGY

The facial recognition process is carried out in a series of steps which include: Data Acquisition, Face Detection, Alignment and Normalization, Feature Extraction, Matching, and Decision Making.

### 1. Data Acquisition:

The first step in the process of facial recognition is capturing data or facial data. This data can be in the form of an Image or a Video. The Image captured from the devices can be a 2D, 3D or a Thermal image as per the requirement. A video sample of 1-second duration consists of 25 to 30 frames.

The instruments used for this purpose are: a Laser Dot Projector that projects multiple infrared dots on the face covering the whole area in the image, a Flood Illuminator which flashes light on the image so that the face is properly visible and captured, and an Infrared camera that captures the image of the person

even in the dark condition, which initially captured in pixels can be further converted to numerical code. Various sources are used to capture facial images such as Smartphones, DSLRs, SLR cameras, Webcam, CCTV, etc.

### 2. Face Detection:

Face detection is the second and most crucial step in face recognition technology. An image captured using a face recognition device may consist of a face, many faces, or no faces such that detecting an original face or locating multiple faces from that image is a key step in facial recognition. It involves identifying and analyzing human faces in the captured digital data.

Yan, Kriegman, and Ahuja classified face detection methods into Four categories which also consisted of algorithms and other approaches for detecting faces in an image. The four methods of detection are as follows-

**i. Knowledge-Based:** This method is based on normal human knowledge to detect the faces from an image using some rules. For example, a face must have a nose, eyes, and mouth with their position fixed concerning each other and have

certain measurements in proportions.

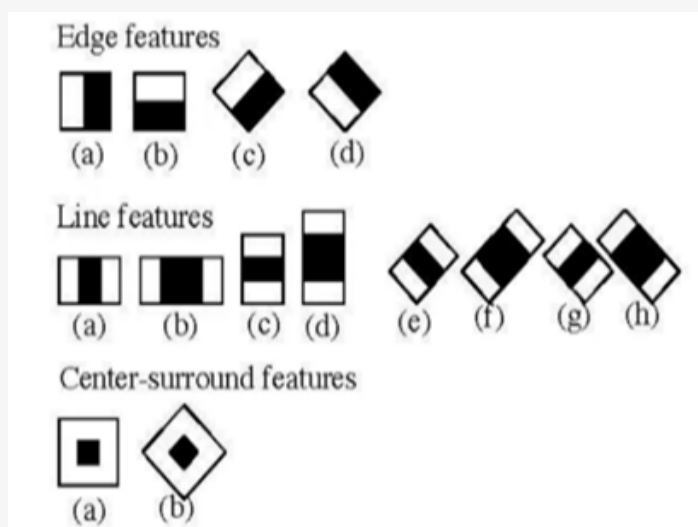
**ii. Feature-Based:** This method locates faces by extracting structural features of the face. The invariant features such as pose, light condition, and expression help the system to differentiate between facial and non-facial regions.

**iii. Template Matching:** It uses pre-defined or parameterized face templates to locate or detect the faces by the correlation between the test images and preselected facial images.

**iv. Appearance-Based:** This is the preferred approach as it adopts statistical analysis and machine learning to locate a face in a selected image. It relies on different algorithms like Eigenfaces which uses Principal component analysis (PCA), a statistical approach to locate characteristics of the face image.

### Viola-Jones Algorithm:

Paul Viola and Michael Jones came up with an object detection framework to solve the problem of face detection which the algorithm achieved with faster, real-time capability and higher detection accuracy. They proposed an algorithm, called Haar-Cascades that is based on Haar-like Features and not pixels. This algorithm can be trained to detect any type of solid object, including human faces and facial features by using Haar-cascades. Examples of Haar-like features that detect faces in grayscale include darker eye regions, brighter nose regions, darker eye sockets, brighter cheeks, etc.



**Figure 3: 3 types of Haar-like features proposed by Viola and Jones for face detection from an Image**

### 3. Face Alignment

Once the face is detected by the system, then it determines the head's position, size, and pose. The face alignment technique uses the landmarks detected in the face and performs the alignment by minimizing the difference between detected landmarks and template landmarks. For the system to register the face it needs to be turned at least 35 degrees towards the camera.

All the input images are brought in a single standardized format to minimize the false acceptance and false rejection rate due to errors in measurements of the facial features. They are set to have equal distances from the margin by parallelizing the lines using transformation techniques such as rotation and scaling.

### 4. Feature Extraction

This is the process that makes face recognition technology more efficient as each individual differs by their facial features which differ from person to person. Facial features are the relative distance between the facial landmarks. Earlier only 5 nodal points were used to extract the facial features then as technologies advanced, 21 landmarks were pointed which then increased to 68 landmarks points. In earlier days, Woodrow extracted the facial features manually and entered them into the system creating a database of the individuals.

As the automation of the facial technology took place, algorithms were developed to localize and extract the facial features automatically. Algorithms such as Eigenfaces and Fisherface are linear subspace methods used for feature extraction. Recent studies propagate Artificial intelligence and machine learning techniques to recognize and verify faces using Neural networks.

### 5. Comparison / Matching

The faceprint value stored in the database is matched with the test image faceprint value for comparison and identification. Once the person is identified then verification occurs. There are various approaches for distance calculation, one of which is Euclidian distance, which is the straight line between two vectors in multi-dimension. The similarity score between the two image vectors is measured and compared to identify a user.

### 6. Decision Making

The decision is based on the similarity score between the test image and the stored database. There are standardized values set for the comparison score. If the matching score is more than or equal to the set value then the person the identified and accepted, otherwise



**Figure 4: 68 Points on Face**  
Source: Tome et al., 2015

the person is not identified or rejected. The decision is made considering certain parameters such as the false acceptance rate and false rejection rate by the system.

## **STATUS OF FRT IN INDIA**

As per NCRB data, crime rates have grown by 28% per 0.1 million population. To increase the conviction rate new technologies are implemented in the police force at national and state levels in India. This technology comprises Face Recognition biometrics that aid the identifying criminals from all over the country. Here are some FRT-based solutions:

### **1) Nationwide Automated Facial Recognition System (NAFRS)**

In July 2019, the National Crime Record Bureau (NCRB) of the Ministry of Home Affairs published a Request for Proposal (RFP) for the National Automated Facial Recognition System (NAFRS). NAFRS is a project that includes the identification of a person based on facial recognition technology. This system will be used for tracking criminals, missing children, and persons and identifying unidentified dead bodies. The data on faces will be collected from a variety of sources such as photographs, videographs, mugshots, and images from CCTVs. NAFRS can gather information timely and relevantly, identify criminals, and detect missing persons among various police organizations and units across the country.

### **2) Automated Multi-Modal Biometric Identification System (AMBIS)**

Maharashtra state became the first to adopt an Automated Multi-Modal Biometric Identification System (AMBIS) to help in police investigations. It uses multi-modal biometrics which includes fingerprint scan, face recognition, iris scan, and palm recognition. It enables the police force to identify and cross-refer the criminals whose fingerprints are captured decades back over paper. It enables the police to directly feed the data of biometrics into the system from the scene of the crime that is connected to the citywide CCTV camera network in Mumbai city as well as the central government CCTNS.

### **3) Punjab Artificial Intelligence System (PAIS)**

Punjab state police started using facial recognition technology under the Punjab Artificial Intelligence System (PAIS) project. This system utilizes a mobile app to recognize and detect faces along with natural language processing to identify criminals.

### **4) Reunion**

'Reunion' is a platform where citizens, NGOs or law enforcement can access facial recognition in cases of missing persons or children. This mobile application uses the FRT in a unique way of matching the geo-tagged images consisting of detailed information about the criminal or user in the lost and found database. It is used to report lost persons when a complaint is lodged and make a database of the missing persons and also to report found persons. Missing person alerts are coordinated between multiple agencies.

### **5) DARPAN/ TSCOP**

Telangana has a large number of FRT projects rolled out. Telangana police also try to solve the problem of missing children and criminal identification. It collects the data and records it along with the national portal. The project Panoptic list of six projects of FRT.

### **6) Central Industrial Security Force (CISF)**

It is in charge of Airport security in India which has proposed an app 'DigiYatra' for access control using facial recognition. It is a technology for travelers by flights that enrolls and verifies the biometrics of the user with the help of face recognition. The policy aims to simplify the process at the airport for check-in process.

### **7) Trinetra (The Third Eye)**

Uttar Pradesh police use this Face recognition technology known as Trinetra which was developed to centralize and digitize criminal records using faces of criminals and suspects. The database of criminals is generated using jail and police data which also include sketch-based search technologies to identify criminals.

### **8) Face Tagr**

This is a citizen app that is launched by Chennai police in a few areas of Chennai and uses FRT to aid in criminal identification and



law enforcement. It is used to match real-time images of the persons that are obtained from CCTV cameras and if a criminal is detected and identified then immediate notification is sent to the police.

## 9) UIDAI (Aadhaar)

Unique Identification Authority of India (UIDAI) incorporated FRT into India's national identity system known as Aadhaar. It uses multi-factor authentication that includes fingerprint, Iris, and Face as their biometric authentication. UIDAI has developed Artificial intelligence-based face authentication which is been used by 47 entities including state government, ministries in central government, and some banks.

## APPLICATION OF FACIAL RECOGNITION TECHNOLOGY

Continuous studies and efforts are being made to develop the face recognition system with the most accuracy to reduce the time taken for identification via face biometrics. Various fields are using face recognition for biometrics purposes as it does not require any expert opinion to interpret the results and it is cost-effective. It is used in day-to-day routine for authentication or identification of users. Some of the applications of face biometrics are video surveillance, Attendance Marking, Security and Access control, Law enforcement, Smartphones, etc.

## ADVANTAGES OF FACE RECOGNITION TECHNOLOGY

The System shows various advantages of face recognition using biometrics. Some of the benefits of FRT are that it requires no physical interaction and no expert opinion, has high accuracy, passive identification, etc.

## LIMITATIONS OF FACE RECOGNITION TECHNOLOGY

Despite its impressive capabilities and advantages following its growing implementations, Facial recognition is not without its challenges and limitations that affect the quality of images. There are many factors affecting the face recognition system, which

often limit the usage of face biometrics as they give False Positive Results (FPR) or False Negative Results (FNR). Limitations are broadly classified into two categories i.e. Intrinsic and Extrinsic factors.

Intrinsic factors include the internal factors that affect the FRT due to the physical condition of the body (e.g. Age, facial expression, identical twins) whereas Extrinsic factors include the external influences that cause disturbance in face detection (e.g. occlusion, illumination, pose)

## LIVENESS DETECTION

To detect whether an image of a face in front of a device is Real or Fake, liveness detection plays a crucial role in authenticating a person based on a reality check. There are various Spoofing techniques used for spoofing the facial recognition system using a fake image that includes:

- 2D Photograph of a valid user placed in front of the camera
- Video of valid-user
- 3D Models of valid-user such as 3D face masks, 3D models, etc.

A photo attack is the easiest and cheapest way of spoofing the technology by placing the photo in front of the device to fool the authentication system. There are various algorithms developed to detect real and fake images, and include anti-spoofing techniques such as Blinking of Eyes and rotating or Nodding of the head. The Algorithms while detecting the features of the face also detect the depth of the eye socket and the angle of the chin which makes it difficult to spoof the technology.

## CONCLUSION

Face Recognition is the analysis of the facial features of each individual to identify a person. Despite having various benefits of face recognition, some limitations challenge the algorithms to detect the face. However, it is accepted worldwide and various databases are created that may help in the identification of a user globally.

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# DID YOU KNOW?



**Forensic Artists  
can reconstruct a  
face from a skull,  
helping to  
identify unknown  
victims/suspects.**





# COLOUR FORENSICS

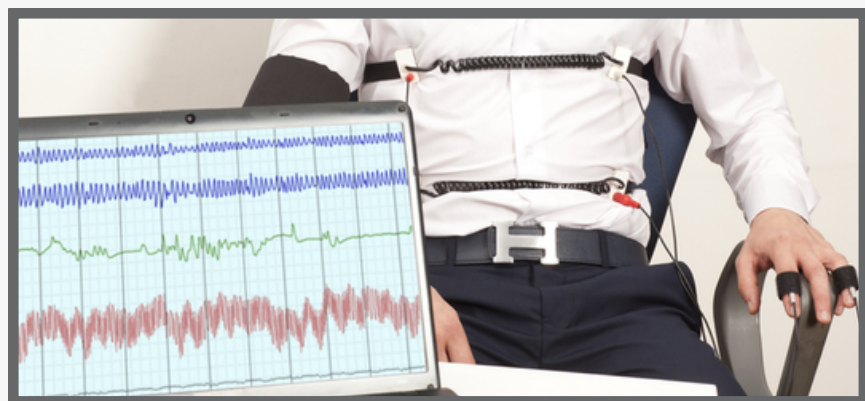
Exploring Colours Forensically

## GREY FORENSICS

*The world of forensic science has long been synonymous with rigorous standards, peer-reviewed methodologies, and courtroom credibility. However, a fascinating and controversial domain is emerging—the "grey zone" of forensic practices. This realm lies between established forensic science and unregulated methods that push ethical, legal, and scientific boundaries.*

### The Rise of Grey Forensics

The rapid evolution of technology and data analytics has fueled the development of novel investigative techniques. From crowdsourced crime-solving apps to private consultants using AI for behavior profiling, these unregulated approaches often fill gaps traditional systems cannot address quickly. However, this "Wild West" of forensic practices is a double-edged sword: while it may uncover critical leads, it also risks compromising justice by introducing questionable evidence.



## **Case Studies: Blurred Boundaries**

**Digital Vigilantism and Crowdsourcing:** Platforms like Reddit and Twitter have played pivotal roles in identifying suspects, but not without errors. In the Boston Marathon bombing, internet sleuths wrongly identified individuals, leading to reputational harm.

**Unaccredited DNA Analyzers:** Some private labs offer DNA analysis without adhering to strict accreditation standards, raising questions about accuracy and admissibility.

**Polygraph Alternatives:** Unregulated tools, such as voice stress analyzers and AI emotion recognition, claim to outperform traditional polygraphs but lack scientific validation.

## **Ethical and Legal Challenges**

Grey forensics introduces profound ethical dilemmas. Without clear oversight, who ensures evidence integrity? How do courts balance innovative methods with the rights of the accused? These practices often operate outside the purview of Daubert and Frye standards, posing significant admissibility issues.

## **The Path Forward**

To navigate this complex intersection, the forensic community must take proactive steps:

**Standardization:** Develop guidelines for emerging practices, including third-party validation and peer review.

**Education:** Train professionals in the ethical implications of grey forensics and inform them of potential biases.

**Collaboration:** Foster partnerships between traditional forensic scientists and innovators to ensure advancements align with legal and ethical standards.

**Legislation:** Advocate for clear policies regulating the admissibility of unconventional forensic methods.

## Conclusion

Grey forensics offers a glimpse into the future of investigations, where innovation meets improvisation. By understanding the risks and rewards of these practices, forensic professionals can harness their potential while upholding justice and scientific integrity. The challenge is clear: finding the balance between evolution and regulation in the ever-expanding world of forensics.

# YELLOW FORENSICS

*Forensic science often delves into the microscopic, the minuscule, and the nearly invisible. But what happens when the focus shifts to a singular color—yellow? Known for its vibrancy, yellow can carry secrets of crimes and mysteries waiting to be unraveled. In this edition of Forensics Magazine, we uncover the pivotal role yellow plays in forensic investigations, from chemical reactions to the secrets held by ancient documents.*

## Traces of Arson: The Chemistry of Sulfur Compounds

Yellow is often the hallmark of sulfur-containing compounds, frequently linked to arson investigations. Forensic chemists can detect yellow sulfur residues at the scene of a fire to determine whether accelerants like sulfuric acid or matches containing sulfur were used. These discoveries can become critical evidence in court, painting a fiery trail of culpability.

### Did You Know?

*Flames burning with a yellow hue often indicate the presence of sodium, which can provide clues about the materials ignited during a blaze.*



# Old Secrets: Decoding Yellowed Manuscripts

Time lends a yellow tinge to ancient paper, documents, and photographs. Forensic document examiners utilize spectral analysis to date and authenticate these materials. By studying the chemical composition of the paper or the ink's degradation, investigators can piece together a timeline or determine forgeries.

## Pollen and Paint: Nature's Yellow Clues

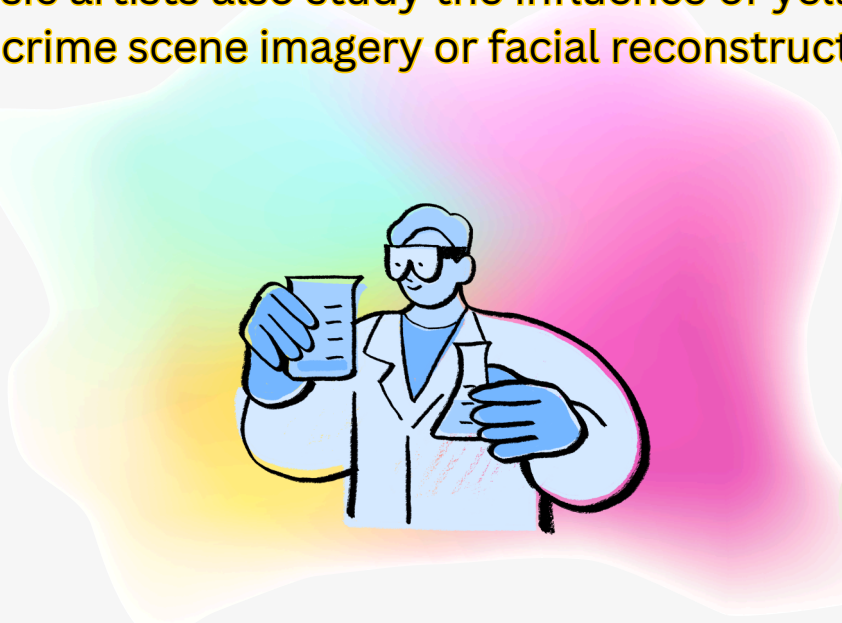
Pollen grains, often yellow, cling to suspects' clothing, hair, or belongings, serving as silent witnesses to a crime. Forensic palynology (the study of pollen and spores) helps place suspects at specific crime scenes. Meanwhile, traces of yellow paint can help link tools or vehicles to a hit-and-run case.

## Biochemical Yellow: The Role of Bilirubin in Forensics

Bilirubin, a yellow pigment produced during the breakdown of red blood cells, can provide critical postmortem clues. Elevated levels in the skin, tissues, or bodily fluids of a victim might indicate poisoning, disease, or organ failure, assisting forensic pathologists in pinpointing causes of death.

## The Psychology of Yellow in Forensic Art and Criminology

Yellow has psychological significance, often associated with caution and attention. Crime scene tape, for example, uses yellow for its high visibility. Forensic artists also study the influence of yellow pigments in reconstructing crime scene imagery or facial reconstructions.



## Expert Insight

"Yellow is not just a color—it's a signal, a chemical identifier, and a piece of the story. In forensic science, it guides us to answers hidden in plain sight," says Dr. Rebecca Lin, a forensic chemist.

## Conclusion

From the vivid sparks of a crime scene to the subtle shades in aging artifacts, yellow has a prominent and fascinating role in forensic science. It's a reminder that even the smallest details—a color, a hue, a stain—can unlock mysteries and bring justice to light.

# BLUE FORENSICS

*In the dim light of a crime scene, investigators often illuminate mysteries with an ethereal glow of blue. This captivating luminescence, achieved through the forensic use of luminol, unveils traces of blood invisible to the naked eye. But the story of blue forensics extends far beyond this iconic reaction. From underwater crime scene investigations to cutting-edge research, this field of forensic science is as enigmatic as it is essential.*

## The Science Behind the Glow: Luminol and Blood Detection

Luminol's star role in forensic science hinges on its ability to react with the iron in hemoglobin. When sprayed on surfaces and exposed to an oxidizing agent, it emits a blue glow—a process called chemiluminescence. This reaction can detect blood diluted up to 1:1,000,000, making it a game-changer in solving cold cases and uncovering hidden evidence.

However, luminol's brilliance comes with challenges. It reacts with other substances like bleach, rust, and plant matter, which can yield false positives. Additionally, it can degrade evidence, meaning investigators must use it strategically. Despite these limitations, luminol remains a critical tool, helping reconstruct events from even the faintest of traces.

## **Blue in the Depths: Aquatic Investigations**

When crimes occur in or near water, forensics dives into uncharted territory. Recovering evidence underwater is fraught with complications: currents can scatter debris, and organic matter may rapidly degrade clues.

Forensic divers employ blue-light fluorescence to locate biological materials in aquatic environments. Under blue light, proteins, oils, and other substances emit a distinct glow, making them easier to identify amidst underwater chaos. In one notable case, fluorescent technology helped locate traces of DNA on a sunken weapon, leading to a successful prosecution.

Additionally, forensic oceanography uses water currents and sediment analysis to trace the origins of submerged evidence. Understanding how tides and flows influence the placement of objects has become crucial in solving mysteries hidden beneath the waves.

## **Beyond Blood: Expanding the Blue Spectrum**

**Fluorescence in Environmental Crime:** Tracking pollutants or illegal dumping using fluorescent markers to identify culprits.

**Biometric Scanning:** Blue light is revolutionizing fingerprint detection, enabling investigators to uncover prints on challenging surfaces like skin and wet materials.

**Cyber Forensics:** While not literally "blue," the concept aligns with analyzing encrypted "blue data streams" in digital investigations, providing clues to cybercrimes.





## **The Future of Blue Forensics**

Innovations are pushing the boundaries of luminol-based techniques and aquatic forensics. Researchers are developing more specific chemiluminescent agents that reduce false positives while enhancing sensitivity. Meanwhile, advancements in underwater robotics and AI promise more precise evidence collection in submerged environments.

Blue forensics also holds potential in humanitarian efforts, from uncovering hidden mass graves to aiding marine conservation by tracking illegal fishing practices.

## **Conclusion**

Whether lighting up crime scenes or exploring the mysteries of the deep, blue forensics represents a fascinating convergence of science and detective work. Its applications continue to grow, shedding light—both literally and figuratively—on the unknown. As we advance, one thing is clear: the future of forensic investigation glows blue.





# **Blood Spatter**

**Patterns can  
reveal the type  
of weapon used, the  
angle of impact and  
even the height of  
the attacker**

**DID YOU KNOW?**

# PREPARE YOURSELF

## **UGC NET & FACT QUESTION BANK**

1. In case of snake bite poisoning which one is suitable sample for analysis ?

- A) Stomach and its contents
- B) Liver
- C) Kidney
- D) Blood

2. Ninhydrin reagent is used for detection of .....

- A) Primary amine
- B) Secondary amine
- C) Secondary amine
- D) Quaternary amine

3. Oleander causes ..... type of action.

- A) Asphyxiant
- B) Cardiac
- C) Corrosive
- D) Irritant

4. .... is the small quantity for Charas as per NDPS Act.

- A) 25 gram
- B) 100 gram
- C) 10 gram
- D) 250 gram

5. .... drug is called meow - meow.

- A) Ephedrine
- B) Pseudo-ephedrine
- C) Mephedrone
- D) Amphetamine

6. Truth serum contains .....

- A) Strychnine
- B) Cypermethrine
- C) Aconite
- D) Sodium pentothal



7. Cesare Lombroso is linked with .....

- A) Ecological School
- B) Classical School
- C) Positive School
- D) Sociological School

8. The Blacky picture test is used to measure .....

- A) Psychosexual development
- B) Prejudice
- C) Stereotype
- D) Role conflict

9. Which of the following is not one of the three things people do to reduce cognitive dissonance ?

- A) Change their behavior
- B) Change their attitude
- C) Form a new attitude
- D) Ignore the conflict

10. The concept of "Self-actualization" is associated with .....

- A) Maslow
- B) Freud
- C) Skinner
- D) Ellis

11. Who wrote the book "A mind that found itself" ?

- A) Binet
- B) Pinel
- C) Clifford Whittingham Beers
- D) Freud

12. Which of the following brain structure is associated with emotion ?

- A) Neurons
- B) Insula
- C) Pons
- D) Amygdala

13. Crime scene can be classified as per the size is .....

- A) Microscopic and Macroscopic
- B) Primary and Secondary
- C) Positive and Negative
- D) Both A and B

14..... is the deliberate and unlawful killing of one person by another.

- A)Suicide
- B)Robbery
- C)Homicide
- D)Burglary

15.Type of organized crime is .....

- A)Dacoit
- B)Robbery
- C)Murder
- D)All

16..... judge's written order for a Police Officer to search a specified place and to seize evidence.

- A)Bail
- B)Search Warrant
- C)FIR
- D)Probable cause

17.Daubert's criteria....

- A)Retesting
- B)Peer review
- C)Potential rate of error
- D)All of the above

18.Secret writings CANNOT be detected and deciphered in documents by .....

- A)Use of UV light
- B)By heating
- C)By applying suitable chemicals
- D)By cooling

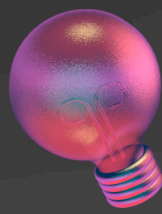
19.Which of the following is a way of storing the same data in different places on multiple hard disks?

- A)Redundant Array of independent Disks (RAID)
- B)Random Access Memory (RAM)
- C)Peer-to-Peer Network
- D)Wide Area Network (WAN)

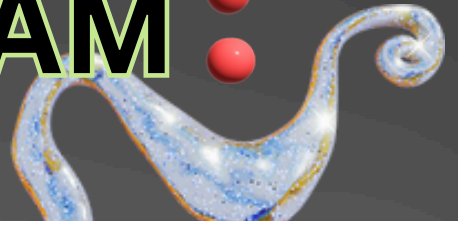
20.The .... is a special database that holds information about the computer's user, installed programs and hardware devices.

- A)Dynamic Link Library (DLL)
- B)Initialization file
- C)Compiled Help Module
- D)Windows Registry

ANSWERS: 1) D, 2) A, 3) B, 4) B, 5) C, 6) D, 7) C, 8) A, 9) C, 10) A, 11) C, 12) D, 13) A, 14) C, 15) D, 16) B, 17) D, 18) D, 19) A, 20) D



# FORENSIC CRYPTOGRAM

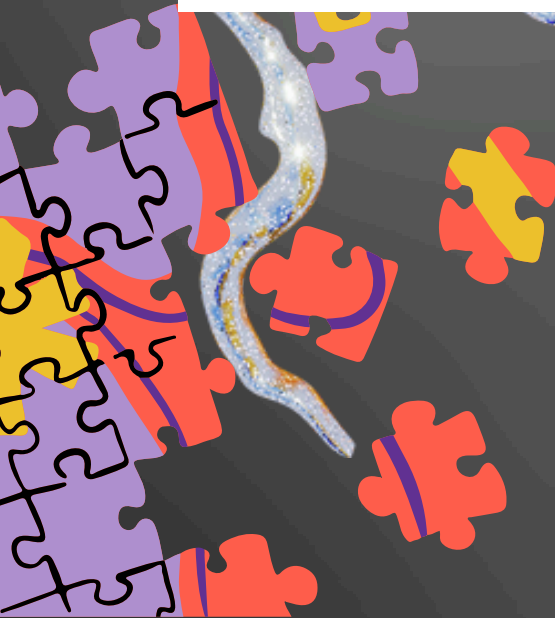


|   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |   |   |   |    |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|----|---|---|---|----|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O  | P | Q | R | S  | T | U | V | W | X | Y | Z |
|   |   |   |   |   |   |   |   | 5 |   |   |   |   |   | 19 |   |   |   | 24 |   |   |   |   |   |   |   |

**S I**  
 — 24 — 8 — 5 — 20 — 16 — 8 — 20

**I S I**  
 — 5 — 16 — 24 — 20 — 2 — 11 — 5 — 8 — 20

**O S I**  
 — 19 — 17 — 18 — 9 — 24 — 6 — 5 — 8 — 20





# PREPARE YOURSELF

## UGC-NET PAPER 1: REASONING APTITUDE

### (1) Number Series:

If there less variation in series, there may be addition logic or subtraction logic

If there more variation in series, there may be multiplication logic or division logic

#### Types of series:

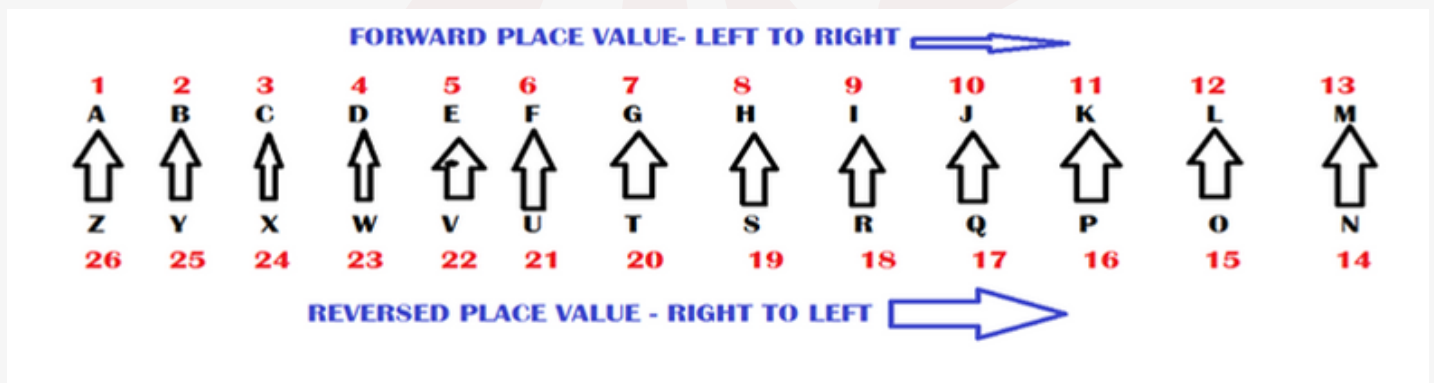
- Prime Number Series
- Addition Series
- Difference Series
- Multiple Series
- Division Series
- $n^2$  Series,  $(n^2 + 1)$  Series,  $(n^2 - 1)$  Series,  $(n^2 + n)$  Series,  $(n^2 - n)$  Series
- $n^3$  Series,  $(n^3 + 1)$  Series,  $(n^3 - 1)$  Series,  $(n^3 + n)$  Series,  $(n^3 - n)$  Series
- Alternating Series

**Example:** Find the next number in the series: 2, 4, 8, 16, 32, \_\_?

Sol. Here, every next number is double the previous number. So, required number =  $32 \times 2 = 64$

### (2) LETTER SERIES

In the 26 letters of the alphabet, the letters from A to M, which are 13 letters, are considered the 1st half. While the letters from N to Z form the second half.



EJOTY- Mnemonic

The positions of alphabets can be remembered with the help of this simple concept, you can easily find out the position of any letter without much effort.

|   |    |    |    |    |
|---|----|----|----|----|
| E | J  | O  | T  | Y  |
| 5 | 10 | 15 | 20 | 25 |

**Example:** Find the next letter in the series: A, C, E, G, \_\_?

Sol. The logic is alternative letters so next letter is H.

### (3) Coding and Decoding

The concept includes both number series and letter series

**Example:** If "DOG" is coded as 4157, how is "CAT" coded?

Sol. C=3, A=1, T=20 i.e.; 3120

### (4) Classification

Tip 1: Classification and odd one out questions aim to judge the candidate's information processing capabilities, creative thinking ability, and evaluation skills.

Tip 2: Questions on classification require a strong vocabulary and general knowledge. So be well versed in these subject areas.

**Example:** Choose the word which is least like the other words in the group.

1. Tiger
2. Lion
3. Leopard
4. Cow

Solution: In this group of words, all animals are carnivorous but cows are herbivorous. Hence, the correct answer is Cow.

### (5) Analogy

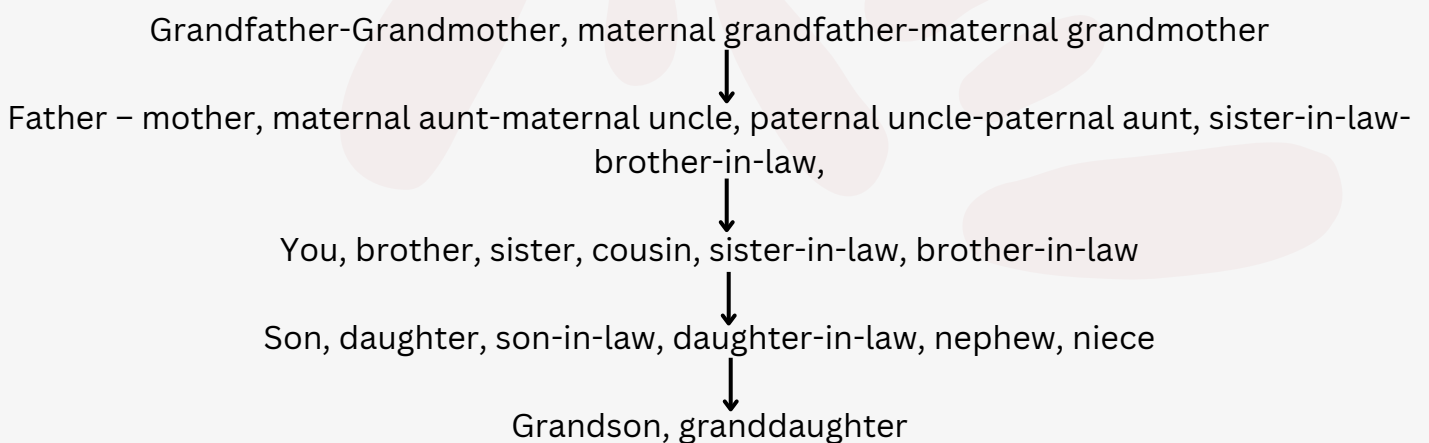
Analogies involve identifying and mapping underlying relationships from one domain to another. Analogy reasoning relies on the idea that if two things share certain similarities, they may also share other, unknown similarities.

**Example:** Book : Library :: Car : \_\_?

- a) Garage
- b) Road
- c) Shop
- d) House

### (6) Blood Relation

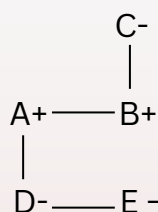
Generally, we will consider 5 generations of people in blood relations including yours.



- Maternal-mother side
- Paternal - father's side
- Male represents - (+)
- Female represents - (-)
- Siblings represents - (-----)
- Wife & husband represents ( )

**Example:** A and B are Brothers. B's Mother is C. A's daughter is D. D's sister is E. How is E related to C?

sol. Grand Daughter



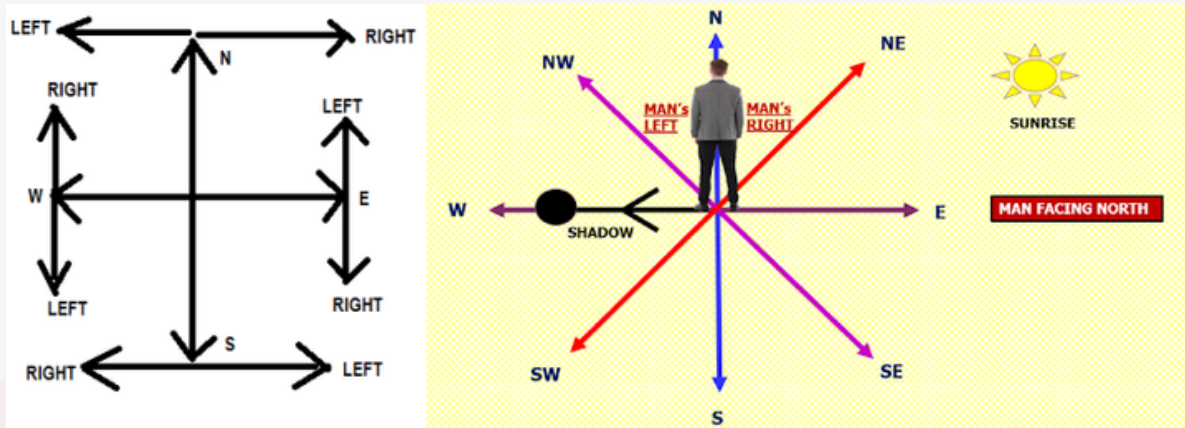
i.e; Grand Daughter

## (7) Directions

Direction is the information contained in the relative position of one point with respect to another point without the distance information. Directions may be either relative to some indicated reference or absolute according to some previously agreed upon frame of reference.

### Topics:

- The right and left directional movement
- The directional reference point
- The directions of sun rays and shadow
- The correct map v/s wrong map
- Directions in Clocks
- Directions in Seating arrangement



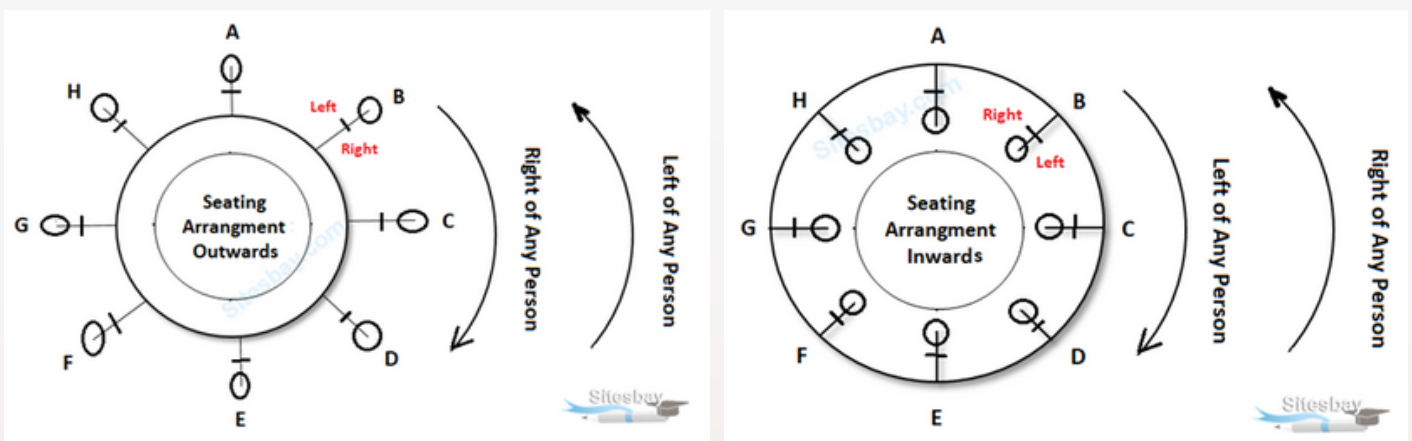
**Example 1:** A man walks 10 meters north, then turns right and walks 5 meters, then turns right again and walks 10 meters. How far is he from the starting point?

- a) 5 meters                      b) 10 meters  
c) 15 meters                    d) 20 meters

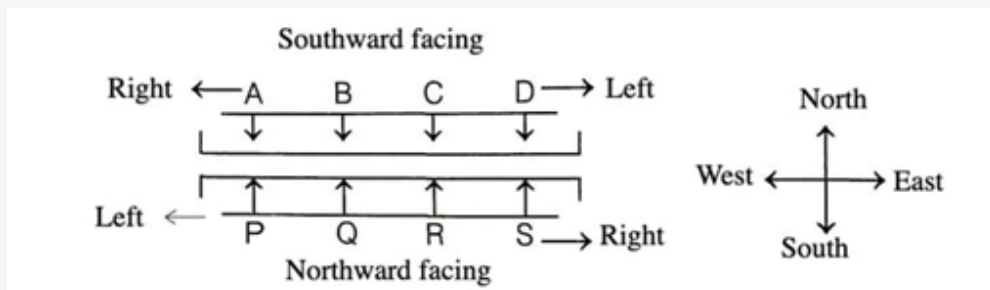
**Example 2:** A woman walks 6 km east and then 8 km north. What is the shortest distance from her starting point?

- a) 10 km                          b) 14 km  
c) 7 km                            d) 12 km

## (8) Seating Arrangements







**Example:** A, P, R, X, S and Z are sitting in a row. S and Z are in the centre. A and P are at the ends. R is sitting to the left of A. Who is to the right of P?

- a) A                      b) X
- c) S                      d) Z

The seating arrangement is as follows:

Therefore, **right of P is X**



### (9) Calendars

Leap Year:

- A year is a leap year if it is divisible by 4. However, if it's a century year (ending in 00), it must be divisible by 400 to be a leap year.
- For example, 2000 was a leap year, but 1900 was not.

Ordinary Year

- Non-leap years are not divisible by 4 or do not satisfy the century rule (not divisible by 400).

Odd Days

- The number of days left after calculating complete weeks in a given period.
- Odd days help in determining the day of the week for a given date.
- For example, if 10 days pass, it's 1 complete week (7 days) and 3 odd days.

#### Day Codes

Days of the week can be assigned numerical codes to simplify calculations:

| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|--------|--------|---------|-----------|----------|--------|----------|
| 0      | 1      | 2       | 3         | 4        | 5      | 6        |

#### Month Codes

Each month is given a code to simplify day calculations, particularly for non-leap and leap years:

| JANUARY                          | FEBRUARY                         | MARCH | APRIL | MAY | JUNE |
|----------------------------------|----------------------------------|-------|-------|-----|------|
| leap year: 6<br>non-leap year: 0 | leap year: 2<br>non-leap year: 3 | 3     | 6     | 1   | 4    |

| JULY | AUGUST | SEPTEMBER | OCTOBER | NOVEMBER | DECEMBER |
|------|--------|-----------|---------|----------|----------|
| 6    | 2      | 5         | 0       | 3        | 5        |

The century codes are used to simplify day-of-week calculations for dates across centuries.

| 1600-1699 | 1700-1799 | 1800-1899 | 1900-1999 | 2000>= |
|-----------|-----------|-----------|-----------|--------|
| 6         | 4         | 2         | 0         | 6      |

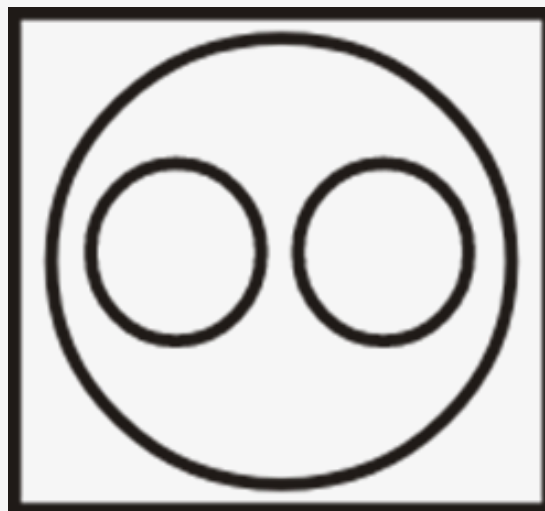
Which year in the future will have the same calendar exactly as 2009?

- A. 2010
- B. 2013
- C. 2015
- D. 2017

Solution: If the total number of odd days between any years is zero or it's a multiple of seven. Then, those two years will have the same calendar.

### (10)Venn Diagrams

Select the set of classes and the relationship among which is best illustrated by the Venn diagram



- A) Shoes, Watches, Goggles
- B) Spectacles, Pens, Diaries
- C) Reptiles, Snakes, Lizards
- D) Daughter, son, Brother

To identify the words associated with the given Venn diagram, let's analyse the diagram. The diagram consists of two small circles within a larger circle, indicating that the two circles belong to the same category represented by the larger circle. Since the two small circles do not intersect or overlap, they do not share any similarities. Now, if we check the options, it is clear that only the third option satisfies the condition stated by the given Venn diagram. In this case, both snakes and lizards fall under the category of reptiles and are not interconnected

# DID YOU KNOW?

**Pollen Grains are  
incredibly resilient  
and can place  
people or objects  
at  
specific  
location**



KNOW WHAT'S IN THE TREND

# FINGERPRINT TECHNOLOGY...!!

## Advancements in Fingerprint Detection: A Detailed Insight into the DCS 5 Imaging System

### INTRODUCTION

The science of fingerprint detection has evolved significantly, incorporating advanced imaging technologies to ensure precise and efficient identification. The DCS 5, developed by Foster + Freeman, stands as a state-of-the-art system designed for the capture, enhancement, and analysis of fingerprints. Utilizing cutting-edge imaging techniques across the ultraviolet (UV), visible (VIS), and infrared (IR) spectra, the DCS 5 enhances the visualization of latent, contaminated, or chemically treated fingerprints. This article provides an in-depth exploration of the capabilities, components, and applications of the DCS 5, illustrating how it advances forensic fingerprint detection.

### TECHNOLOGICAL CAPABILITIES OF DCS 5

The DCS 5 is built as a comprehensive imaging solution, capable of detecting fingerprints on nearly any surface. Its high-resolution camera, enhanced with specific macro lenses, ensures exceptional image quality. The system integrates advanced digital enhancement tools, simplifying the process of extracting maximum detail from fingerprints. DCS 5 enables the use of precise wavebands of illumination, spanning UV to IR, to visualize various fingerprint types and materials.

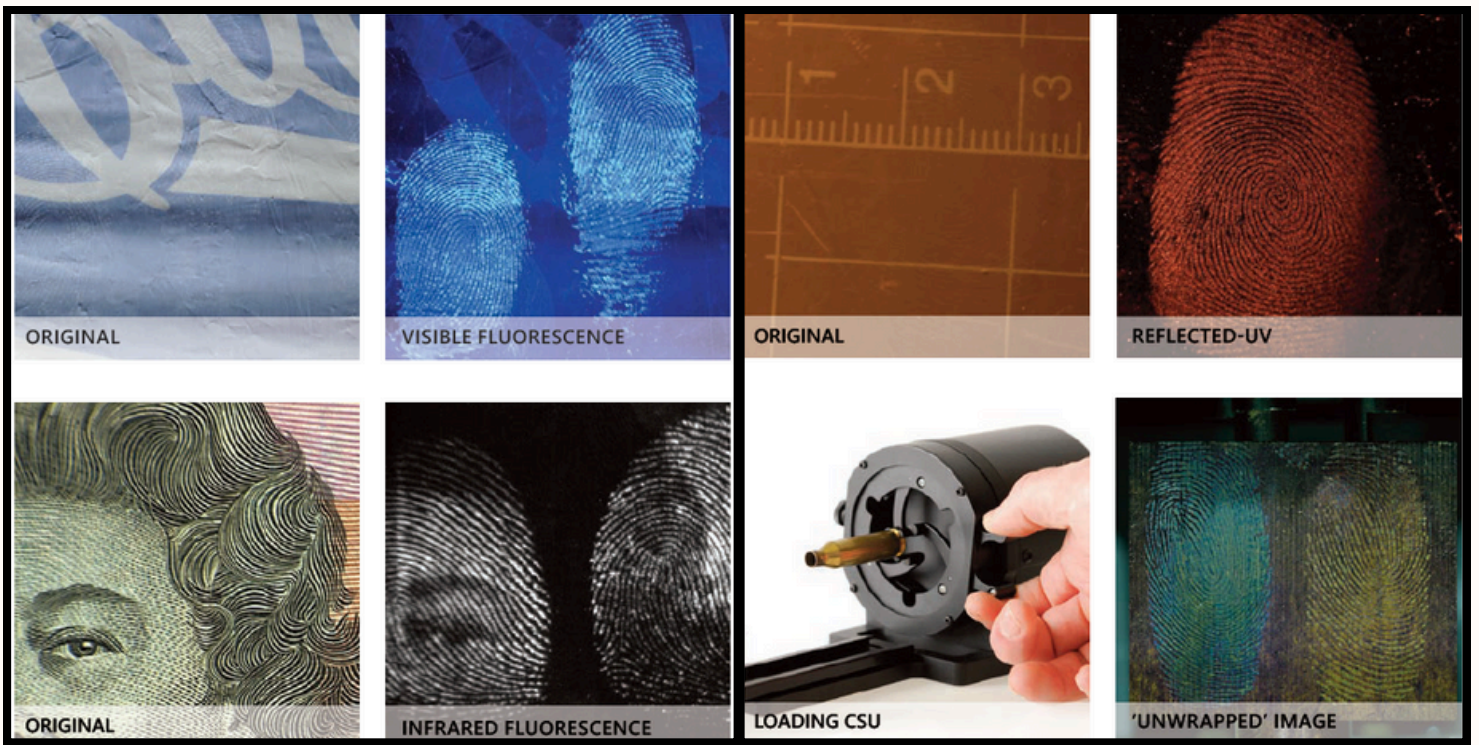
#### 1. Fluorescence Imaging:

The DCS 5 leverages fluorescence imaging, a technique used for enhancing latent fingerprints treated with substances like Ardrox, DFO, and BY40, as well as fluorescent powders. This imaging approach relies on specific wavelengths of light to induce fluorescence in these substances, which enhances the fingerprint's visibility. DCS 5's multi-wavelength ring light allows operators to select the optimum wavelength, maximizing fluorescence intensity and improving the quality of fingerprint visualization.

#### 2. Infrared Imaging:

Infrared (IR) imaging is another key feature of the DCS 5, particularly beneficial when dealing with backgrounds that interfere with fingerprint visibility. Many chemical treatments, such as Physical Developer, and certain powders absorb IR light and appear dark, while interfering backgrounds may reflect IR, appearing white. Foster + Freeman's new fpNatural 1 powder fluoresces under IR, eliminating background interference and revealing clear fingerprint images. This innovation demonstrates the system's ability to work with complex surfaces, including patterned and reflective materials.





**Figure. Various Evidences under DCS 5**

### 3. Reflected Longwave UV Imaging

DCS 5's UV imaging capability is particularly useful on surfaces like glass and plastic, which absorb UV light and appear dark, thereby improving the contrast between the fingerprint and its background. This technique is effective for both treated and untreated latent fingerprints. The system's software further enhances these images by allowing for background reduction, improving the visibility and clarity of fingerprints on difficult surfaces.

## *APPLICATIONS OF DCS 5 IMAGING TECHNIQUES*

### 1. Cylindrical Surface Unwrapping:

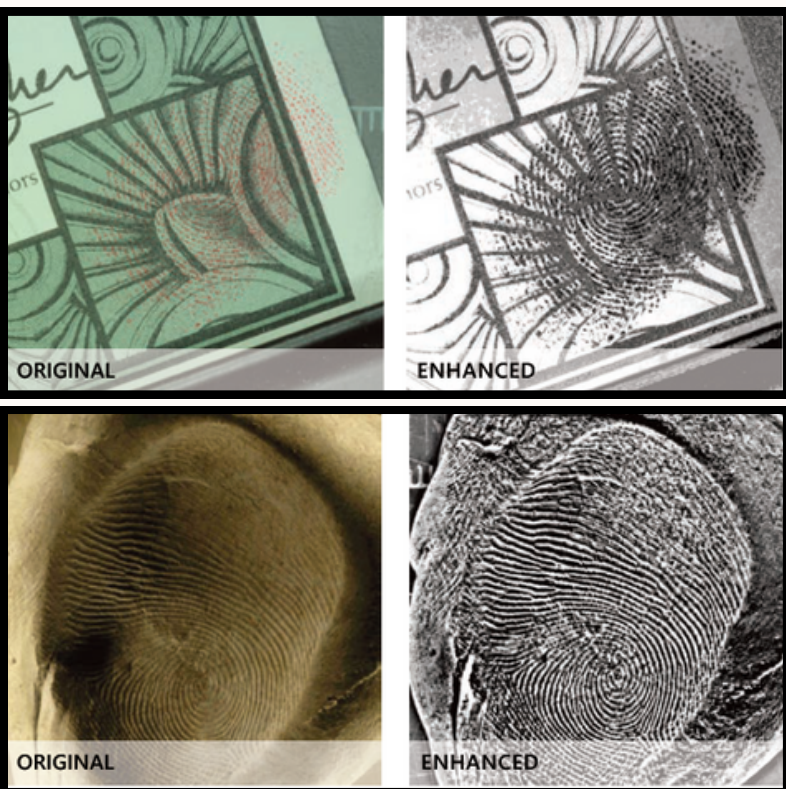
Fingerprint examination is often required on cylindrical surfaces such as bullets, pens, and bottles. The DCS 5 integrates a Cylindrical Surface Unwrapper (CSU), allowing the system to extract two-dimensional (2D) images of fingerprints from these three-dimensional (3D) objects.

This capability simplifies the analysis of curved surfaces, enabling accurate fingerprint capture and identification on objects that previously posed significant challenges.

### 2. Digital Enhancement and Processing:

The digital enhancement tools built into the DCS 5 system allow operators to refine fingerprint images by removing interfering backgrounds and improving contrast. The software's intuitive drop-down menus offer easy access to advanced processing routines, enabling the enhancement of prints developed with various chemical treatments, dyes, stains, and dusting powders. Each processing step is carefully documented, ensuring that the integrity of the evidence is maintained through an audit trail.





#### 4. Comparison and AFIS Search:

The DCS 5 software also includes a comparison module, allowing operators to display two fingerprint images side by side for detailed comparison and enhancement. This module provides an affordable Automated Fingerprint Identification System (AFIS) capability, enabling users to manage a database of up to 5,000 fingerprint records. Both 1:1 and 1:n searches can be performed, saving valuable time in the identification process.

## KEY COMPONENTS OF THE DCS 5 SYSTEM

For example, fingerprints developed with Ninhydrin, often appearing on multi-coloured or textured backgrounds, can be significantly improved through the DCS 5 software's ability to isolate the fingerprint details from the background noise. Additionally, the system offers 3D enhancement for impressions in soft materials, providing better contrast and clarity for fingerprints that may be obscured by the surface texture.

### 3. Audit Trail and Image Validation

One of the critical features of the DCS 5 system is its robust image validation and audit trail capability. When fingerprints are captured and enhanced using DCS 5, the system records all steps in the processing and enhancement procedure, including details about the operator, the software, and the computer used. This detailed audit trail is essential for maintaining the chain of custody and ensuring the credibility of the evidence presented in court. Enhanced or processed images lose their status of authenticity unless supported by the system's audit trail, which provides transparency and accountability.

The system is composed of several specialized components, each designed to maximize the efficiency and accuracy of fingerprint detection:

#### Custom-Modified DSLR Camera:

The core of the system is a pro-grade DSLR camera, the Nikon D6, customized for UV-Vis-IR imaging. The camera is equipped with various specialist lenses, such as the 105mm Vis-IR macro lens, the 60mm UV transmitting lens, and the 85mm Vis-IR tilt/shift lens, each designed for specific imaging applications.

#### Illumination Sources:

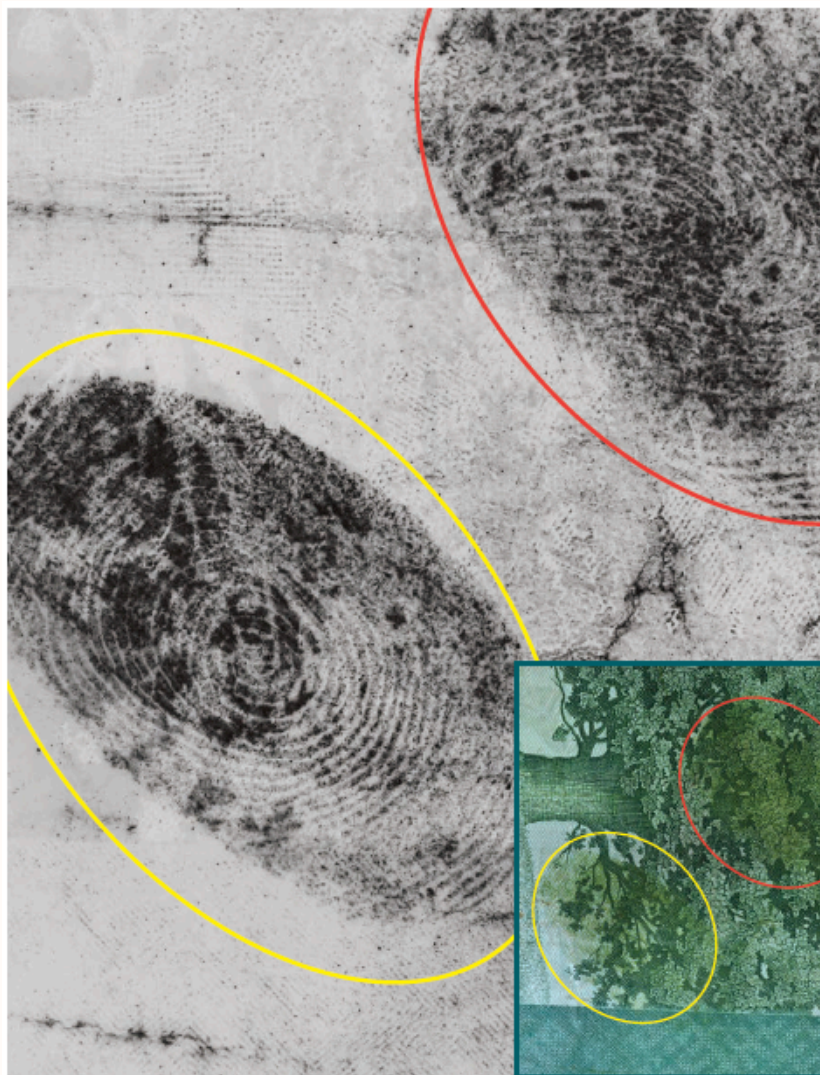
The DCS 5 uses a multi-wavelength ring light that offers a range of narrow wavebands from UV to red light. Additional light sources include halogen light packages, IR imaging tools, and forensic light sources, all of which contribute to the versatility of the system. These sources provide targeted illumination, essential for revealing latent prints on a variety of surfaces.



## Cylindrical Surface Unwrapper:

The CSU works by virtually "unwrapping" the surface of these cylindrical objects, transforming the 3D surface into a flat, 2D image. This significantly improves the ability to visualize and analyze latent finger marks, providing clear, high-resolution images for forensic examination. The combination of **advanced imaging technology** and specialized software makes it possible to reveal latent fingerprints that would otherwise be challenging to capture due to the object's shape or texture.

This technique is especially beneficial in criminal investigations, as it allows for the detection of fingerprints on surfaces like bullets or syringes, where latent prints are typically difficult to detect and capture using conventional methods.



## CONCLUSION

The DCS 5 system represents a significant advancement in the science of fingerprint detection, offering forensic experts the tools to capture, enhance, and analyze fingerprints with unprecedented precision. Its ability to work across a wide range of wavelengths, combined with specialized lenses and advanced software, ensures it can handle even the most challenging surfaces and backgrounds. With features like audit trails, digital enhancement, and AFIS search capabilities, the DCS 5 sets a new standard for forensic fingerprint identification. As technology continues to evolve, systems like the DCS 5 will play a crucial role in the future of forensic science, ensuring that vital evidence is uncovered and accurately presented in the pursuit of justice.





# **Aditya Educational Institutions: Empowering Excellence Through Experience**

**At Aditya Educational Institutions, we believe that education shapes not just careers but lives. Established in 1984, with over three decades of academic excellence, we have consistently nurtured learners into exceptional individuals who leave an indelible mark in their fields.**

**Our journey began with a public school, addressing the foundational needs of primary and secondary education. Today, Aditya encompasses a spectrum of 60 institutions, offering courses from KG to PG, including CBSE schools, Junior Colleges, Degree Colleges, Postgraduate programs, Engineering, Pharmacy, Management, Nursing, and Teacher Training institutions. With a dedicated faculty of 6,000 and a vibrant student body of 60,000, we stand as a beacon of holistic education.**

**Aditya's approach emphasizes not just learning but cultivating a lifelong love for knowledge. Our teaching methods integrate innovative pedagogy with a focus on personal and intellectual growth, ensuring students are equipped to excel in a competitive world.**

**Rooted in a vision of academic excellence and inspired by the wisdom of distinguished academicians, we are committed to nurturing young minds to rise to future challenges. Aditya Educational Institutions continue to transform dreams into reality, shaping a brighter tomorrow, one learner at a time.**





**ADITYA**  
*A Trend Setter*



**ADITYA - INTRODUCED FOR  
THE FIRST TIME IN ANDHRA PRADESH  
UNDER GRADUATION  
& POST GRADUATION  
COURSES IN**

**FORENSIC SCIENCE and  
CYBER FORENSICS**



**Come Witness the Journey in Forensic Science at ADITYA**



**GRADUATION: 3 Years**

**POST GRADUATION: 2 Years  
M.Sc. Forensic Science**

**SUBJECT GROUPS:**

**1. B.Sc. FORENSIC SCIENCE**

Forensic Science (MAJOR) and Chemistry (MINOR)

**2. B.Sc. CYBER FORENSICS**

CYBER FORENSICS (MAJOR) and FORENSIC SCIENCE (MINOR)

**Dept. of FORENSIC SCIENCE**

**SPECIALIZATIONS:**

1. CYBER SECURITY

2. DIGITAL FORENSICS & INFORMATION SECURITY

3. QUESTIONED DOCUMENTS & FINGERPRINTS

4. CHEMISTRY & TOXICOLOGY

5. DNA FINGERPRINTING

**Aditya Degree and PG College, Aditya Nagar, ADB Road, Surampalem**

**Call @ 9701576663, 9030500961, 8978296668 | email : principalforensic@aditya.ac.in**

**adminforensic@aditya.ac.in | Website: <http://aditya.ac.in/forensic-science>**

## IMPORTANCE OF FORENSIC SCIENCE

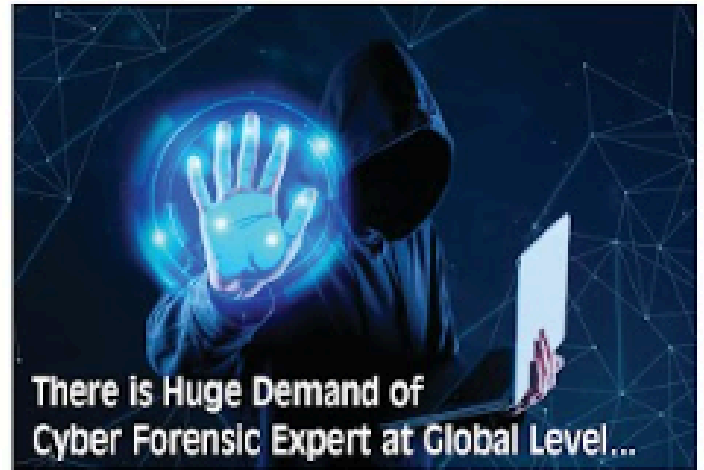


Forensic Science helps in investigating the crime in a scientific way by identifying the evidence at the crime scene. The evidence analysis and evaluation by the expert helps in delivering speedy Justice. Crime is increasing day by day. The techniques, which are adopted by the criminals can be prevented and investigated by Forensic Science. Forensic Science has huge demand due to new emerging trends in crimes such as Cyber crimes, Economic frauds, White collar crimes etc.

**B.Sc. FORENSIC SCIENCE, B.Sc CYBER FORENSICS and M.Sc. Forensic Science** has been started at ADITYA DEGREE AND PG COLLEGE, SURAMPALEM campus to fulfill the needs of the student community. Aditya Degree and PG College is the first college in both the Telugu states and the Second College in South India offering B.Sc. Forensic Science, B.Sc. Cyber Forensics and M.Sc. Forensic Science Affiliated to Adikavi Nannaya University, Rajamahendravaram.

### Course Details for B.Sc Forensic Science, Cyber Forensics and M.Sc Forensic Sciences

|                   |   |
|-------------------|---|
| Course Level      | Under Graduate                                    |
| Duration          | 3 years (6-Semesters)                             |
| Examination Type  | Semester system (VI - Sem Internship)             |
| Admission Process | OAMDC / Merit                                     |
| Course Level      | Post Graduate                                     |
| Duration          | 2 years (4-Semesters)                             |
| Examination Type  | Semester system (IV - Sem Project Cum Internship) |
| Admission Process | APPGCET / Merit                                   |



**There is Huge Demand of Cyber Forensic Expert at Global Level...**

### B.Sc. FORENSIC SCIENCE

**Forensic Science (Major) & Chemistry (Minor)**

Eligibility: Intermediate (10+2) in science stream (M.P.C/ Bi.P.C) with 60% marks.

### B.Sc. CYBER FORENSICS

**Cyber Forensics (Major) & Forensic Science(Minor)**

Eligibility: Intermediate (10+2) in science stream (M.P.C/ Bi.P.C) with 60% marks

With the proliferation in the internet and mobile phone usage, there is a rise in the number of cyber security incidents in the country and world. Proactive tracking by CERT-In including its Cyber Swachhta Kendra and National Cyber Coordination Center (NCCC) and improved cybersecurity awareness among individuals and



**Lakhs of cases are pending due to lack of Forensic Scientists / Experts**



## M.Sc. CYBER SECURITY

## M.Sc. DIGITAL FORENSICS & INFORMATION TECHNOLOGY

### Eligibility :

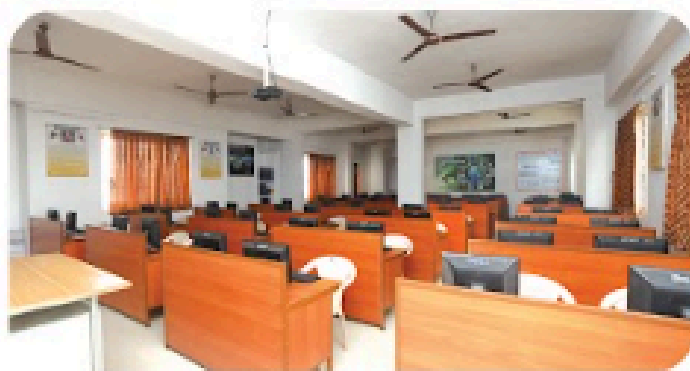
B.Sc. Forensic Science or Any Graduate with Computer Science as one of the subjects.

### Employment Areas:

Central or State or Regional Forensic Science Labs, CLUES TEAM, Private Cyber Labs, CDAC, Universities / Educational Institutes, etc.

### Employment Positions:

Cyber security Analyst, Cyber security specialist, Network security Engineer, Research Assistant or Research Scholar, Lecturer / Assistant Professor, Cyber Security Trainer, etc.



### Cyber Forensic Lab :

Our college has a well-established Computer lab with well advanced software and Forensic tools related to Cyber Forensics, Digital Forensics & Mobile Forensics. Based on the tools and applications students can pursue various live project works and succeed in getting good experience in the lab. There are a number of certified courses

## M.Sc. QUESTIONED DOCUMENTS & FINGERPRINTS

### Eligibility :

B.Sc. Forensic Science or Any Graduate with Chemistry as one of the subjects.

### Employment Areas:

Central or State or Regional Forensic Science Labs, Fingerprint Bureau, Private Forensic Science Labs. Banking & Insurance sector, Universities / Educational Institutes, Private Detective Agencies, Law firms, etc.

### Employment Positions:

Handwriting Expert, Documents Expert, Fingerprint Expert, Research Assistant or Research Scholar, Lecturer/Assistant Professor, etc.



### Questioned Documents Laboratory:

- Video Spectral Comparator (VSC)
- ESDA - Electrostatic Detection Apparatus
- Trinocular Stereo Microscope (Regula)
- OTHERS: UV Chamber, 10x Regula Magnifiers with Incident and UV Lights.

### Fingerprints & Impressions Laboratory:

- RUVIS- Reflected Ultraviolet Imaging System:
- OTHERS : Fingerprint kit, Footprint kit, Iodine Fuming Chamber, Arrowhead software for enhancement of Fingerprints etc.

### QD and Fingerprint Lab :

Aditya College houses state-of-the-art forensic facilities: the Fingerprint Lab, equipped with RUVIS and an Iodine Fuming Chamber for latent print analysis, and the Questioned Document Lab, featuring VSC, ESDA, and UV Chamber for document authentication. These labs offer hands-on training, enabling students to master essential forensic techniques and contribute effectively to investigative processes.



## M.Sc. FORENSIC CHEMISTRY & TOXICOLOGY

### Eligibility :

B.Sc. Forensic Science or Any Graduate with Chemistry as one of the subjects

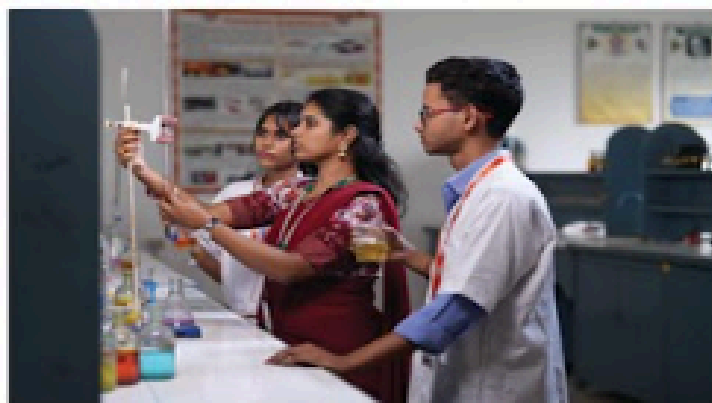
### Employment Positions:

Forensic Chemist, Toxicologist, Scientific Assistant, Research Assistant or Research Scholar, Lecturer/Assistant Professor, etc.

### Employment Areas :

Central or State or Regional Forensic Science Labs, CLUES TEAM, Private Forensic Science Labs, Pharmaceutical companies, Chemical Industries, Hospitals, IICT, NIOH, IISc, Universities / Educational Institutes, etc.

The laboratory deals with trace evidence analysis of Drugs, Alcohol, Arson and Explosive residues, gunshots residues, oils and fats, Bribe trap samples, Analysis of Metals and Soil etc. through various spot tests after extracting them from biological / non-biological matrices. Various Extraction techniques are applied in isolation of this evidences followed by chromatographic procedures to confirm the presence of suspected evidence. The laboratory consists of Apparatus of TLC, Extraction methods, Muffle Furnace, UV Chamber, Microscopes etc.



## M.Sc. FORENSIC DNA FINGERPRINTING

### Eligibility :

B.Sc. Forensic Science or Any Graduate with Biology as one of the subjects.

### Employment Areas:

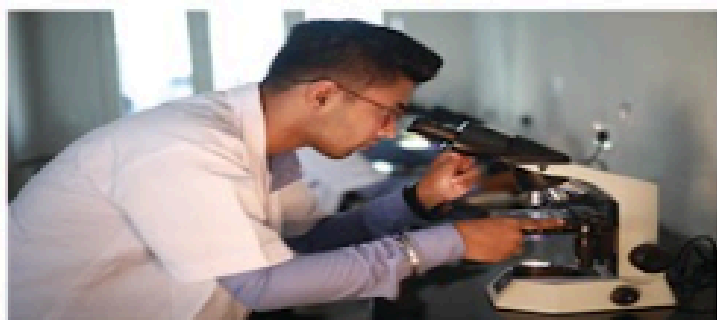
Central or State or Regional Forensic Science Labs, CLUES TEAM, Private Forensic Science Labs, Biotech Labs, Chemical Industries, CCMB, CDFD, NIN, Universities / Educational Institutes, etc.

### Employment Positions:

Forensic Biologist, Wildlife Biologist, Serologist, DNA , Expert, Scientific Assistant, Research Assistant or Research Fellow/ Research Scholar, Lecturer/Assistant Professor, etc.

## FORENSIC INSTRUMENTS

- Compound Microscopes
- Stereomicroscopes
- Comparison Microscopes
- Automatic Centrifuge of 2500 RPM

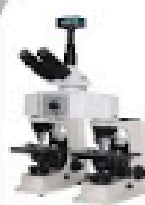


### UV-spectrophotometer Applications:

Quantitative analysis of Forensic analytes like drugs, explosives, plant extracts, poisons, etc. Applied in various Forensic fields such as Chemistry, Toxicology, Narcotics, DNA Fingerprinting, etc



UV-spectrophotometer



Comparison Microscope



Stereo Microscope



Centrifuge



Compound Microscope

This laboratory deals with physical evidence pertaining to living beings like, human and animal, materials of plant origin, bacteriological and entomological examination, morphological examination of materials like hairs, wool, fibers, diatoms, pollen grains etc. The laboratory consists of UV Spectro photometer, Electrophoresis – Horizontal & Vertical, Automatic Centrifuge, Autoclave Incubator, Hot Air Oven , Compound Microscopes & Stereo Microscop -es, etc.

## Crime Scene Simulations

We are providing training to students on processing the scene of crime for physical evidence by simulating Indoor and Outdoor crime scenes in the campus. Thorough hands - on training will be given on search methods, HLP of physical evidence, documentation & photography of crime scene. The Crime Scene Investigation Laboratory is equipped with Alternative Lights Source, Crime Scene Kit, Explosive Detection Kit, Wildlife Evidence Collection Kit and GSR Collection kit.

## Crime Scene Visits

Our students visit crime along with police officers to understand the Modus Operandi and also assist CLUES team officers in processing the crime scene for physical evidence. Whenever crime occurs within the 100KM radius of college, students will be called for a crime scene visit to understand the nature of crime which is very important for students.



## Reveal Forensic light Kit

## FORENSIC MUSEUM

First in South India as an academic Institution, Aditya has developed a Forensic Museum. The exhibits presented in the museum signifies various physical evidence like Ammunition, Firearm, Human Skeleton, Tool mark, Impressions, Documents, Digital Evidences, etc.,. Makes the beginners and visitors understand Forensic Science.



Processing of Outdoor Crime Scene

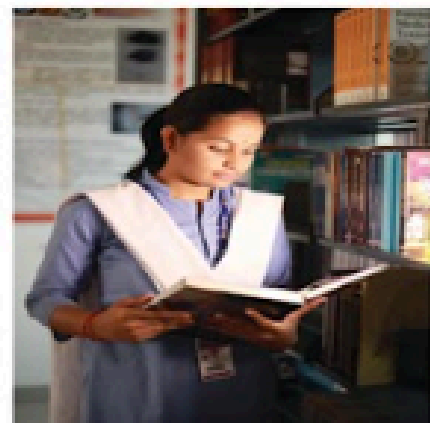


Processing of Indoor Crime Scene

## LIBRARY

The Library has a rich collection of more than 1000 volumes of advanced text in Forensic Sciences and reference books comprising of 500 titles exclusively in Forensic science which proves to be highly beneficial to both the students and the faculty for the augmentation of their knowledge.

The library also provides book-bank facility to both the faculty and the students of the college. To complement class room teaching with E-Learning, the library has computing facility comprising 13 PCs with internet access.



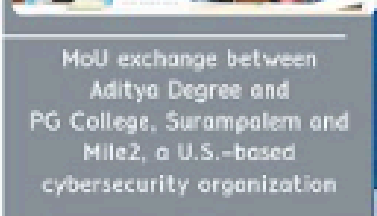


Felicitation of Dr. A. S. N. Chakravarthy on the occasion of Cyber Forensic Expert Lecture.

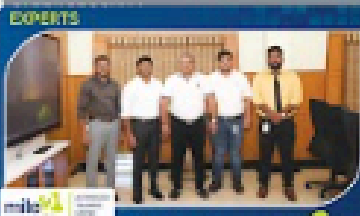
MoU exchange between Aditya Degree and PG College, Surampalem and Sherlock Institute of Forensic Science, New Delhi.



MoU exchange between Aditya Degree and PG College, Surampalem and Clue4 Evidence Forensic Lab, Bangalore.



MoU exchange between Aditya Degree and PG College, Surampalem and Mile2, a U.S.-based cybersecurity organization



EXPERTS

Inauguration of Forensic Art-O-Wall by Dr. N. Suguna Reddy, Dr. Ranjeet Singh, Mr. Phaneendar B.N., and Mr. Vilas Anil Chavan.



## Guest Lectures by the Experts:

- ◆ Experts from CFSL / SFSL & Private Forensic Labs.
- ◆ Officers from NCB, FPB, IB, etc.
- ◆ Officers from various police organizations like SVPNPA, APPA, TSPA, CDTI, CLUES team, etc.
- ◆ Scientists from CCMB, CDFD, IICT, NIN, etc.
- ◆ Faculty from NICFS, GFSU, OU, GIFS Nagpur, Aurangabad & Mumbai, etc.



2-DAY NATIONAL CONFERENCE ON "NEW AGE FORENSICS: UNVEILING MYSTERIES IN THE DIGITAL ERA"

## MoU's



## National Science Day Celebration Forensic Sciencistry - 2024



## Placements

**ADITYA DEGREE AND P.G. COLLEGE SURAMPALEM**

B.Sc. Forensic Science | B.Sc. Cyber Forensics | M.Sc. Forensic Science

|              |               |                      |                |              |
|--------------|---------------|----------------------|----------------|--------------|
| Infosys      | Tech Mahindra | MIRACLE              | TCS            | Cognizant    |
| 20   2023-24 | 14   2023-24  | 3   2023-24          | 4   2023-24    | 3   2023-24  |
| gampact      | keka          | toppr                | NICE EDUCATION | HETERO       |
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| TCS          | SUTHERLAND    | 100+ STUDENTS PLACED |                |              |
| 1   2023-24  | 27   2023-24  |                      |                |              |

## Transport Facilities ...

With a fleet of 250 buses, a transport facility is provided to every corner of the district for the students and staff at regular intervals, so that they can reach the institutions in time and return safe to their domiciles as per their daily schedule.





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**An Autonomous  
Institution**



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**Department of Forensic Science**

**Aditya Degree and PG College.**

Aditya Nagar, ADB Road, Surampalem

Office Number : 9701576663, 9030500961, 8978296668

For Admissions : 7095076663 / 7095076664 / 7095076665

Email : [mscforensic@aditya.ac.in](mailto:mscforensic@aditya.ac.in) / [adminforensic@aditya.ac.in](mailto:adminforensic@aditya.ac.in)

Website : <http://aditya.ac.in/forensic-science>

Distances from nearby  
towns/cities to ADITYA

- Kakinada - 25 kms.
- Rajahmundry - 30 kms.  
(Domestic Airport)
- Samalkota - 10 kms.  
(Railway Junction)
- Visakhapatnam - 174 kms.  
(International Airport)



# ADITYA PHARMACY COLLEGES

Won Education Excellence Award 2022 for being  
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 Approved by UGC

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BACHELOR OF PHARMACY

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Email: [office@adityapharmacy.edu.in](mailto:office@adityapharmacy.edu.in) | [office@acop.edu.in](mailto:office@acop.edu.in)

ADB Road, SURAMPALEM, Kakinada District - 533 437, Andhra Pradesh.

web: [www.adityapharmacy.edu.in](http://www.adityapharmacy.edu.in) | [www.acop.edu.in](http://www.acop.edu.in)



# HEALTH IS WEALTH

In spite of rapid advances made in medicine, still ill health is our uninvited and frequent visitor. Man continues to confront newer diseases and the fight against the infectious agents goes on. To fend off the visitor there is an imperative need for us to use medicine. We know that quality medicines through profession of pharmacy can restore health quickly, hence Aditya is engaged in producing eminent pharmacy professionals. Multi-layer courses like **B.Pharmacy, M.Pharmacy & Pharm.D** and Research are available under same roof.

Aditya Group of Pharmacy Colleges creating an environment that opens up a new world of opportunities, we believe that making of a quality pharmacy profession is equally important as that of medicine. Hence since 20 years the organization is keen in producing highly eminent pharmacy professionals. Highly facilitated Library with 20000 volumes of books and 125 National and International Journals along with e-journals, latest drug information sources such as Micromedex, Knimbus, Delnet and NDL along with our Digital Library.

Consultancy and Research Development Cell was established to develop and carry novel research work providing decent platform for the research activities with an enhanced research healthy environment in the campus. We have over 25 MOU's with various organizations that would help teaching fraternity and student community to involve in various educational, research and industrial programs.

## CORE SUBJECTS INCLUDE:

- Human Anatomy & Physiology
- Pharmacology
- Clinical Pharmacy
- Pharmaceutics
- Clinical Toxicology
- Pharmacotherapeutics
- Hospital Pharmacy
- Clinical Research



## B. PHARMACY (Bachelor of Pharmacy)

B.Pharmacy is a 4-year degree course and students of B.Pharm are specially trained in various industrial pharmacy subjects making them highly proficient and practical oriented. Large number of drug companies employ the B.Pharm qualified candidates in their Production, Quality Control and Analysis departments.

The GPAT is a nationwide test conducted by PCI for admission into M.Pharm courses throughout the country in different Universities.

- Aditya gives intensive coaching to students from their 3rd year to do well in GPAT test.
- Every week GPAT model tests are conducted in the college.
- Along with the syllabus, GPAT syllabus is also covered.
- GPAT rank is also taken as a basis for admission into research organisations.

## ADVANCED LEVEL PHARMACY DEGREE : Pharm D

Doctor of Pharmacy (Pharm.D) is a six-year course. Students who have passed Intermediate with BiPC / MPC or D.Pharm are eligible for admission into this course. The period of six years duration is divided into two phases the first phase consists First, Second, Third and Fourth academic year and the second phase consists V & VI th Year clerical ship, internship or residency training and during sixth year involves posting in speciality units.

## M. PHARMACY (Master of Pharmacy)

M.Pharm - in the following specialisations is offered:

- Pharmaceutical Technology
- Pharmaceutical Analysis
- Pharmacology
- Pharmaceutics

Post Graduate students receive intensive instruction and training in their respective specialisations.



## CAREER OPPURTUNITIES

### In INDIA

- **Health Care (Hospital)**  
Clinical Pharmacist, Drug Information Provider.
- **Clinical Research Organisation**  
Clinical Research Associate,  
Clinical Trail site Manager,  
Clinical Team Leader,  
Clinical Data Management.
- **Public Health Sector**  
Community Pharmacist  
(Individual & Chain Pharmacies)
- **Research and Development**  
Bioavailability / Bioequivalence studies.
- **Pharmaco Vigilance**  
Drug Safety Associate
- Medical Advisor for Health Insurance Companies
- Medical Writing and Publications

### ABROAD

- Pharm.D degree is the only recognized qualification for practice in hospitals and clinical settings in North America and European countries
- High Demand in Middle East Countries
- There is acute shortage of qualified Pharm.D professionals
- More than 50% of currently working Pharmacist are above age of 45 years - so wide opportunities exist for budding young Pharm.D degree holders
- Highly paid profession on par with other leading services such as medical or software personnel
- Pharmacist personnel requirements are projected to increase over the next 20 years.
- Authorities believe that the only strategic option to meet this shortage is offering ready immigration to international pharmacist.

### ADITYA A SYNONYM FOR PLACEMENTS

145 2022- 23  
Placements

134 2023- 24  
Placements

## YOU WILL ✓

- ✓ Perform regular ward rounds in various departments in the hospital.
- ✓ Provide patient medication counselling to patients / patients care givers.
- ✓ Monitor adverse drug reactions and suggest management strategies.
- ✓ Suggesting best therapeutic alternatives to other health care professionals with the help of pharmacotherapeutic expertise.
- ✓ Perform case study discussions to improve core of knowledge, skills, attitudes to meet professional competencies.
- ✓ Provide drug related detailed information to other health care professionals and patients.
- ✓ Serve as a bridge between physicians and patients.

## ADVANTAGE ADITYA

- An (MoU) has been established between the Trust Hospitals, a facility boasting 500 beds located in Kakinada, and GSL Hospital, which accommodates 1200 beds in Rajamahendravaram.
- **Department Specializations:**  
General Medicine, Paediatrics, Gynecology, Surgery, Orthopedics, pathology, S.T.D, Anaesthesiology, E.N.T., Neurology
- Pharm.D students are trained in multispeciality Hospitals (Teaching Hospital) to impart advanced clinical pharmacy & Pharmacy Practice Training.
- Well established Pharmacy Practice Department in Trust Hospital, Kakinada & GSL Hospital, Rajamahendravaram
- On line access to latest drug information sources such as Micromedex, Drug Dex etc, subscription to latest journals on clinical and pharmacy practice areas
- Seminars / Group Discussions and conference presentations with the core clinical faculty and physicians in GSL & TRUST Hospitals.
- Our Pharm.D students published research articles and case studies along with GSL & TRUST Hospitals Medical staff in reputed Scientific Journals.





We reaffirm our commitment and invite eligible students to join us to reap full benefits of Pharm.D course offered in ADITYA



## ADITYA HOSTELS - (AC / Non-AC) - Home away from Home

- Comfortable, hygienic surroundings, individual grooming and counseling.
- Separate hostels for boys and girls on the campus (AC/Non-AC).
- Well ventilated rooms with attached bathroom, balcony, individual wardrobe & study table.
- An exclusive library with digital and multimedia facility, newspapers, magazines, journals, books related to academics and competitive exams like GRE, GATE etc.
- Resident faculty who address the personal and academic needs of students in their respective blocks.
- Large dining halls and myriad of options in food keeping in view the various cultural backgrounds of the students.
- Solar water heating systems in each block.
- Computer Center with Wi-Fi and LAN connectivity.
- Uninterrupted power supply round the clock.
- On campus Bank facility (Canara Bank).
- Tie-ups with multispecialty hospitals which provide adequate health care facilities to students.
- Students are provided with all the amenities of a saloon and beauty parlour. · GYM Facility.
- Apollo Hospital (shine) Functioning 24/7 in campus.

### BOYS HOSTELS



### GIRLS HOSTELS



### COLLEGE NAME

### COUNSELLING CODES

**ADITYA PHARMACY COLLEGE (A)**

Accredited by NAAC "A" Grade

**APCS**

**ADITYA COLLEGE OF PHARMACY (A)**

Accredited by NAAC "A" Grade

**ACPS**

### CAMPUS :

ADB Road, SURAMPALEM-533437, Kakinada Dist., A.P.

### CORPORATE OFFICE :

Aditya Academy, Srinagar, KAKINADA-533003, Kakinada Dist., A.P.

### REGIONAL OFFICES :

KERALA | WEST BENGAL | TAMILNADU | ODISHA | BIHAR | JHARKHAND  
CHATTISGARH | NORTH EAST



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# ADITYA UNIVERSITY

Established under Andhra Pradesh Private Universities (Establishment and Regulation) Act, 2016

Formerly known as **ADITYA ENGINEERING COLLEGE (A)**



## 200 ACRES LUSH GREEN CAMPUS

### ACCREDITATIONS

|   |   |  |
|---|---|--|
| <br>6 UG Programs<br>Accredited by NBA under Tier I | <br>Accredited by NAAC with A++ Grade                   | <br>Recognized by UGC under sections 2(f) and 2(b) |
| <br>Recognized as SIRO by DSIR                      | <br>Civil Engineering Dept. Labs are Accredited by NABL | <br>DST Sponsored Technology Business Incubator    |

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# A

GRADE

Category: GOLD

## The Green Institutional Rankings 2024

## MERIT SCHOLARSHIPS upto 100%

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SCHOLARSHIP

## ASAT

### ADITYA'S SCHOLASTIC APTITUDE TEST

for B.Tech aspirants every saturday & sunday.

For more details visit:

[www.adityauniversity.in](http://www.adityauniversity.in)

Cell: 70360 76661, 70950 76663 / 4 95536 49666

Surampalem, Kakinada Dist., Andhra Pradesh - 533 437.



# IMPECCABLE PLACEMENT RECORD

Above 30 LPA **2 Adityans**

Above 25 LPA **10 Adityans**

Above 15 LPA **15 Adityans**

Above 10 LPA **33 Adityans**

Above 8 LPA **206 Adityans**

Above 7 LPA **220 Adityans**

Above 6 LPA **447 Adityans**

Above 5 LPA **498 Adityans**

Above 4 LPA **1070 Adityans**

Above 3 LPA **1945 Adityans**

# 3124

Offers & Still Counting...

# 2024  
PLACEMENTS

# Highest Packages

## # 2025 PLACEMENTS

**Walmart** with Stipend  
₹1 Lakh Per Month



Lakhs Per Annum  
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## # 2024 PLACEMENTS

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|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| ₹30.55<br>TCS | ₹29.54<br>TCS | ₹29.52<br>TCS | ₹28.57<br>TCS | ₹28.55<br>TCS | ₹28.57<br>TCS | ₹27.52<br>TCS | ₹25.55<br>TCS | ₹25.55<br>TCS |
|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|

## ĀJĪVIKĀ - Career Development Division

Aditya is the 'First stop' for companies in the recruitment process. In this regard utmost care is taken to groom students according to the needs of the industry by the Training and Placement cell. The Training and Placement cell, hosted by a special wing titled "AJIVIKA" which means employment, relentlessly tries to keep up the name by running various programs and collaborating with various industries and organizations. Placement training kick starts at the first year of the students study and continues up to the fourth year with major focus on Reasoning, Aptitude, Soft-Skills, Technical skills etc. A thoroughly researched and developed syllabus is framed according to the needs of the industry and is dealt by experienced mentors.

### OUR TOP RECRUITERS

|         |           |           |         |
|---------|-----------|-----------|---------|
| Infosys | wipro     | accenture | Jio     |
| aws     | ValueLabs | IBM       | kyndryl |
| ABB     | Capgemini | darwinbox | MAERSK  |

## PROGRAMMES OFFERED

### BACHELOR OF TECHNOLOGY

- Civil Engineering
- Electrical & Electronics Engg.
- Mechanical Engineering
- Electronics & Communication Engg.
- Computer Science & Engineering
- Information Technology
- Artificial Intelligence & Machine Learning
- Data Science
- Petroleum Technology
- Mining Engineering
- Agricultural Engineering

### MASTER OF TECHNOLOGY

- Structural Engineering
- Power Electronics & Drives
- Thermal Engineering
- VLSI Design
- Computer Science & Engineering

### PHARMACY

- B.Pharmacy - M.Pharmacy - Pharma D

### Master of Business Administration

### MBA (INTEGRATED)

### Master of Computer Applications

### B.Sc. & M.Sc. - Forensic Science

## # STUDENTS FROM 20 COUNTRIES & 18 STATES

• AFGHANISTAN • BANGLADESH • BHUTAN • COTE D'IVOIRE • DR CONGO • GHANA • GUINEA • LESOTHO  
• MOZAMBIQUE • MALI • NEPAL • NIGERIA • RWANDA • SUDAN • SOUTH SUDAN • SWAZILAND • TANZANIA  
• UGANDA • ZAMBIA • ZIMBABWE

• ANDHRA PRADESH • ANDAMAN AND NICOBAR ISLANDS • ASSAM • BIHAR • CHHATTISGARH • DELHI • GUJARAT  
• HARYANA • JHARKHAND • JAMMU & KASHMIR • KERALA • MANIPUR • MAHARASTRA • MIZORAM • NAGALAND  
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- 10000\* Certified Students      60\* Tech Coaches

## ADITYA Makes a World of Difference!

### Challenging and Conducive Learning Environment

- Problem solving approach to learning
- Individual Mentoring and guidance from faculty
- Modern class rooms and labs
- State of the art hardware, software and digital learning management systems
- Team approach to innovation and creativity
- Fun filled Academic Engagements
- Digital Library with 2700+ e-books

## ADITYA TECHNICAL HUB



Established on the 3rd of February 2016, in view of demand-supply gap scenario, exponential opportunities and dynamic challenges in the 21st century. Aditya has taken call for a change in our thinking on engineering practices and education.



### T-CONNECT

T Connect is a freshmen awareness program that help one get acquainted with modern technologies



### IGNITE CODER

Ignite Coder is an exclusive training program for 1st years for excelling the coding skills at very 1st year.



### BECOME CODER

Become coder is another exclusive coding program of ours that prepares individuals to ace their career.



### OWL CODER

The owl coder program is a exclusive vigorous training program that prepares individuals to program logically and in a efficient manner.



### DRIVE READY

Drive ready is a semester long program that focuses primarily on making trainees career ready.



### IN-CAMPUS INTERNSHIP

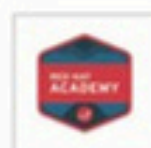
Our in campus internship program has been initiated to help the right individuals put their skills to use by working alongside our team.



### PROJECT SPACE

Project Space is a exclusive event that has been implemented to help trainees put their skills to the test by working on various real time projects.

## INDUSTRY IMMERSIONS







Girls Hostels



Boys Hostels



- Comfortable, hygienic surroundings, individual grooming and counseling.
- Separate hostels for boys and girls on the campus (AC / Non-AC).
- Well ventilated rooms with attached bathroom, balcony, individual wardrobe & study table.
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- Wi-Fi and LAN connectivity.
- Uninterrupted power supply round the clock.
- On campus Bank facility (Canara Bank).
- Separate guest house for parents.
- Students are provided with all the amenities of a saloon and beauty parlour.
- Round the clock Ambulance Facility.
- Apollo shine functioning 24/7 on campus.
- Tie-ups with multispecialty hospitals which provide adequate health care facilities to students.
- Fully equipped gym.

## CREDENTIALIALS

|                        |                                     |                           |                                |                             |
|------------------------|-------------------------------------|---------------------------|--------------------------------|-----------------------------|
| <p>ARIIA<br/>26-50</p> | <p>NPTEL<br/>AA</p>                 | <p>THE WEEK<br/>59</p>    | <p>Times ENGINEERING<br/>9</p> | <p>DATAQUEST<br/>59</p>     |
| <p>AAA</p>             | <p>THE ACADEMIC INSIGHTS<br/>32</p> | <p>siliconindia<br/>4</p> | <p>10 Knowledge Gateway</p>    | <p>CAREERS 360<br/>AAA+</p> |

## EAPCET COUNSELLING CODES

|  |   |
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|  | <p><b>ADITYA UNIVERSITY - ADTPPU</b><br/>www.adityauniversity.in   Accredited by NBA (Tier 1) &amp; NAAC "A++" Grade</p>  |
|  | <p><b>ADITYA COLLEGE OF ENGG. &amp; TECH. (A) - ACET</b><br/>www.acet.ac.in   Accredited by NBA &amp; NAAC "A+" Grade</p> |
|  | <p><b>ADITYA PHARMACY COLLEGE (A) - APCS</b><br/>www.adityapharmacy.edu.in   Accredited by NAAC "A" Grade</p>             |
|  | <p><b>ADITYA COLLEGE OF PHARMACY (A) - ACPS</b><br/>www.acop.edu.in   Accredited by NAAC "A" Grade</p>                    |

For Admissions:

Cell: 70360 76661, 70950 76663/4 ☎ 95536 49666

Aditya Nagar, ADB Road, Surampalem - 533 437, Kakinada Dist., Andhra Pradesh, INDIA.



# ***Thank You Note***

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***Dr. N. Suguna Reddy***

**Secretary  
Aditya Degree Colleges,  
Andhra Pradesh**



Dear Readers,

We sincerely thank you for the overwhelming support you have shown for India's first-ever bimonthly forensic science magazine. The exceptional response to our previous issues has been both inspiring and gratifying, resonating deeply with professionals, enthusiasts, and the broader forensic community across the nation.

As we unveil our third issue, we are thrilled to bring you an even more enriching array of articles, groundbreaking research, and thought-provoking discussions aimed at advancing the field of forensic science. Your invaluable feedback drives our commitment to uphold the highest standards, fostering meaningful progress in this critical discipline.

Thank you for being an integral part of this journey. We eagerly anticipate continuing to provide you with valuable insights and celebrating the advancements shaping the future of forensic science.



# ADITYA COLLEGE OF FORENSIC SCIENCES & CYBER SECURITY SURAMPALEM

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