



AI And New Era Of Criminal Investigations

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Abstract

Artificial Intelligence (AI) is the branch of Computer Science which deals with the creation and study of intelligent tools/applications/software/agents/techniques the one can act, learn autonomously. AI is a well known field which plays a critical role in the advancement of forensic science and helps Forensic Scientist/Experts/Investigators in handling, Documentations and analysis of evidence across different levels. It saves time, costs & permits them to concentrate on crucial tasks with dedication and enough time and can help to create a data library for future reference that can be greatly helpful in criminal investigations. The various challenges faced by forensic Experts can be resolved by AI, It offers both advancement and challenges. It advances the enhancement in evidence analysis with improved reliability and accuracy. The biggest challenge is Ethical and privacy consideration. Currently, AI can be supporting every branch of Forensic Science including DNA fingerprinting unit, Forensic Ballistics, Forensic Anthropology, Forensic Dentistry and Odontology, Cyber Forensic, Voice recognition and Biometric Unit.

KEYWORDS: Forensic, AI, Crime, Investigation, Technique, Crime scene reconstruction.

INTRODUCTION

Digital analysis is the key aspect of all the change and developments in the present scenarios. Since the last few years, AI is thriving in almost all the fields as AI can be helping and supporting in the decision making processes. Basically AI applications or tools are designed for specific purposes but sometimes these are used for multipurpose as well. As AI is incorporated in all fields, Forensic is also one of them. In Forensic Science AI can be helpful a lot, Such as AI is being used through Digital forensics. Digital Forensic is a growing field that requires computing power, data sets to solve cases. Forensic investigations involve conducting evidence analysis, extracting information from 'mysterious' sources that may be fruitful or not. In these types of cases, AI plays an important role in dealing with the comparison of big data sets. In investigations, AI gives assistance to Forensic Experts to manage data, documentation and meta analysis across different levels. It aids to not only save time but they can focus on critical tasks with proper dedication and enough time.[1] **Tournois and Lefevre (2021)** gave an account of AI tools which are used by experts i.e., Forensic Pathologists. The aim of this review is to identify the specific AI tools used in forensic Science.[2] In Forensic Medicine, the most difficult task is to determine the PMI (Post Mortem Interval). Generally Experts use Entomology to determine PMI or time since death. **Mayassa Hachem et al. (2019)** concluded that femoral blood can be used directly with the help of a proposed device along with AI to detect the cholesterol, LDH level. Another property is pH also can be measured from the AI tools.[3] **C. Annadurai et al. (2022)** gave an account on advanced techniques which helps to protect the data transmission and detect the trespasser in the Biometric Authentication system using features and classification techniques. Kernel based Principal Component Analysis is used to extract features, and classification is done by using Convolution VGG-16 network architecture.[4] **Veldhuis et al. (2022)** describes the design and use of XAI to predict the number of individuals involves through DNA profiling, any kind of ML model can be use for that.[5]

WHAT IS AI?

AI stands for Artificial Intelligence. It is the branch of Computer Science which deals with the creation and study of intelligent tools/applications/software/agents/techniques the one can act, learn autonomously. In simple terms, It is the pursuit to replicate the human cognitive operations by machines such as by computer systems, it is referred to as Artificial Intelligence. The usage of AI is such as sketch making, Pattern recognition, data analysis, documentation, identification or recognition of suspect/victim/individual etc.[6]

WHAT IS FORENSIC SCIENCE?

Forensic science is the use of scientific work and methodologies to investigate judicial cases such as criminal cases. It helps to generate legal or scientific proof/evidence for judiciary purposes. Forensic Science is consists of various branches or divisions such as DNA Fingerprinting, Ballistics, Chemistry & toxicology, Voice analysis etc.[7]

AI IN FORENSIC SCIENCE

In various fields, with the rapid development in technology, specifically in Forensic Science, it will become easy to perform crucial tasks. AI can be very significant in crime scene investigation. During investigations, AI helps Forensic Scientist/Experts/Investigators in handling, Documentations and analysis of evidence across different levels. It saves time, costs & permits them to concentrate on crucial tasks with dedication and enough time. It helps to create a data library for future reference that is greatly helpful in criminal investigations.

AI can be effective tools in various aspects such as-

- I. Comparison and analysis of data such as images
- II. Addressing suitable methods/techniques according to case
- III. Pattern recognition such as Fingerprints recognition, voice identification
- IV. Provide clear cut explanation of reasoning process
- V. Reduce the chances of false negative & false positive results
- VI. Perform systematic evaluations
- VII. Represent statistical data
- VIII. Crime scene reconstruction
- IX. Documentation in a systematic way & so on.[8]

Table: 1 Shows advantages & disadvantages of AI [9]

ADVANTAGES OF AI		DISADVANTAGES OF AI	
I.	Automation	I.	Ethical concern
II.	Systematizing	II.	Security risks
III.	Innovation[10]	III.	Privacy concern
IV.	Availability	IV.	Lack of Empathy
V.	Reducing human error[11]	V.	Job replacement
VI.	Better decision	VI.	Lack of Emotions
VII.	Complete repetitive and crucial tasks[12]	VII.	Lack of box-thinking
VIII.	Unbiased decision		
IX.	Assistance		
X.	Enhance efficiency		
XI.	Cost saving		
XII.	Time saving		

XIII.	Detection of diseases[13]
XIV.	Detect Fake news[14]

AI bid a number of advantages such as enhancement in accuracy and efficiency, automation etc. As every technology has advantages and disadvantages, AI also has some disadvantages consisting of Job replacement due to automation and privacy concerns. (Table 1)

APPLICATION OF ARTIFICIAL INTELLIGENCE

1. AI IN FORENSIC DENTISTRY

Dentistry is a relatively modern field; Forensic Odontology has played a very important role in the development of Dentistry. In the legal matters such as Mass Disasters [15], sexual assault, criminal activities and child abuse, the opinion of Dentist is important and imperative for the identification. Specially, if dental pieces are only available evidence then dentists have a responsibility to bring justice to the victim or sufferer and their families. AI based techniques can be very helpful in this field such as Artificial Neural Networks, Machine Learning, Computer Technology and Deep Neural Networks etc. Another application of AI which includes the Dental Identification by analyses dental images like radiographs and comparison done of individuals on the basis of their teeth and jaw both.[16]

2. AI IN CYBER FORENSICS AND CYBERSECURITY

The usage of AI speeds up the analysis of huge databases and detects the dark steps that can't be detected by Human analysts.[17]AI based tools can be used to aid in the data breaches, cyber attacks such as Dark trace, FortiAI.

3. AI IN PATTERN RECOGNITION

Pattern recognition plays a vital role in multitudinous fields comprehended Forensic Science, In which experts analyze big datasets by using probabilistic and statistical procedures to recognize and compare particular patterns. These patterns can be Fingerprint pattern, Facial pattern, Handwriting pattern etc. It helps to detect patterns that can be critical in recognize individual & solving crime.[18]Neural Networks have applications in numerous fields which includes Voice recognition, fingerprint recognition, visual scenes, iris recognition etc.[19]

4. AI IN CRIME SCENE RECONSTRUCTION

It is very difficult to recreate the crime scene during the investigation of a serious crime scene for the law enforcement agencies for the justice purpose.[20] A crime scene is the place where offence/crime has occurred and the place from where forensic evidences can be gathered or collected. [21] [22]There are some Immersive techniques, including Augmented Reality (AR)[23], Virtual Reality (VR)[24], and Mixed Reality (MR) have moreover ultra modernize in 3- Dimensional crime scene reconstruction.[25] These techniques provide the information superimpose and permit the jurors to deal with crime scene if they were present.[26]

5. AI IN SOLVING SEXUAL ASSAULT

Through visual examination the stains can be observed easily. AI plays an important role in case of sexual assault by detecting the spermatozoa on the body and clothes. Sometimes, Experts may miss these stains by visualizing or

due to insufficient samples. By using CNN, AI microscopy imaging , provides optimized precise sperm stains images. It can be helpful to analyze the blood patterns on clothes.[27]

6. AI IN FORENSIC MEDICINE & TOXICOLOGY

Zou Y et al. affirms that AI technique is evolved expeditiously in data processing and used by some scientists as a classic method for evaluating the post-mortem interval. Nowadays, AI enhanced digital autopsy is trending in Forensic medicine. It involves machine learning tools analyzing body images which are obtained through MRI & CT scan. The AI technique uses these images to determine the pathological state in organs by comparing it with a big data set. [28]

7. AI IN DNA PROFILING

Forensics is an interdisciplinary field that examines, analyses the various types of evidence and draws conclusions. Forensic Experts require to apply their knowledge to elucidate the data with no biasness. AI can help to compare the STR alleles with the data generated by Capillary Electrophoresis.[29][30][31][32]

8. AI IN QUESTIONED DOCUMENTS

AI has substantially modernized the Document examination by enhancing the accuracy, efficiency and scope of evaluating documentary evidence. The various AI techniques simplify auto data extraction, categorization, and detection of abnormality and fraud in the documents. These techniques can easily identify the alterations, forgeries and inconsistencies in ink patterns. In addition, techniques including 3D- topography mapping are used to evaluate the ink and paper, writing impression, ink layering and pressure variations.[33]

9. AI IN BALLISTICS

Generally, the procedure for bullet comparison is comparing two samples by using a comparison microscope, one is evidence that is collected from the crime scene and another is a reference sample. There are various AI tools and techniques such as IBIS or Bal Scan.[34]IBIS stands for Integrated Ballistics Identification System, Basically it is a computerized database used by FSLs.[35]It helps to examine the class and individual characteristics of Firearms including rifling marks.

Table 2: Shows the AI tools along with their function in various branches of Forensic Science

<u>AI Tools</u>	<u>Functions</u>
1. NSFW (Not Safe For Work)	<ul style="list-style-type: none"> · Detect pornographic images · Detect & filter NSFW images
1. PhotoDNA	<ul style="list-style-type: none"> · To recognize & clear away CSAM (Child Sexual Abuse Material)
1. Amazon Rekognition	<ul style="list-style-type: none"> · To identify Faces by analyzing photographs and video.

<p>1. Kairos</p>	<ul style="list-style-type: none"> · To recognize Face, Aliveness · To check ID document using manual web interface and API
<p>1. Azure AI</p>	<ul style="list-style-type: none"> · Analyze the digital evidence
<p>1. CNN (Conventional Neural Network)</p> <p>2. AFIS or NFIS</p>	<ul style="list-style-type: none"> · Analyze the images and videos · Classify the Fingerprints
<p>1. NLP (Natural Language Processing)</p> <p>2. Aylien Text Analysis API</p> <p>3. Lexalytics</p>	<ul style="list-style-type: none"> · Analyze unstructured text data example social media posts, chat logs and emails · Compare the documentary evidence
<p>1. Clear view AI</p> <p>2. FaceFirst</p> <p>3. NEC NeoFace</p>	<ul style="list-style-type: none"> · Identify suspects & missing person on the basis of their facial characteristics in CCTV or photographs
<p>1. Nuance Verifier</p> <p>2. Agnitio Voice ID</p>	<ul style="list-style-type: none"> · Identify the suspects by evaluate voice recordings
<p>1. Digital Image Analysis</p> <p>2. Amped FIVE</p> <p>3. Cellebrite UFED Physical Analyzer</p>	<ul style="list-style-type: none"> · Enhance and compare the photographs taken from crime scene
<p>1. ANDE rapid DNA</p> <p>2. STRmix™</p>	<ul style="list-style-type: none"> · Develops DNA profile automatically by using evidence such as mouth swab
<p>1. Undetectable.ai</p>	<ul style="list-style-type: none"> · Detect fake news

<p>1. 3D Hawk Camera</p> <p>2. FARO X 130 Scanner</p>	<p>·Convert crime scene into 3D model crime scene</p> <p>·Crime scene reconstruction</p> <p>·Documentation of Crime scene</p> <p>·Crime scene investigations</p>
<p>1. IBIS or Bal Scan</p>	<p>· Examination of firearms</p>

AI tools comprise a variety of techniques that are designed to accomplish critical and important tasks that need human intelligence. Machine learning (ML) algorithms, particularly functionized for analyzing the big data sets, another one is drones are designed for multipurpose, in Forensics it can be utilized to produce photographs and helps in 3D crime scene reconstruction. (Table 2)

Discussion

The various tools and techniques of AI play a very significant role in advancing and automated the criminal investigation system. Nowadays, AI aided in almost every division or branch such as Forensic Ballistics, DNA profiling unit, Voice recognition Unit, Cyber Forensic, Questioned Document Unit, Crime Scene Unit and most important in Forensic Medicine. AI gives accurate, efficient and rapid results that are very useful for the purpose of justice.

Conclusion

As discussed the different applications of AI in various fields and their prospect uses in criminal investigations and Forensic Science in aid to experts and Police officers. It is concluded that AI can be a powerful tool which plays a critical role in Forensic Science. It saves time, costs & permits them to concentrate on crucial tasks with dedication and enough time. It helps to create a data library for future reference that is greatly helpful in criminal investigations.

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