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Role of Technology in Crime Investigation

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Abstract

The role of technology in crime investigation has evolved significantly over the years, revolutionizing the way law enforcement agencies gather evidence, analyse data, and solve crimes. This paper provides a comprehensive examination of the multifaceted relationship between technology and crime investigation, spanning historical developments, current applications, emerging trends, and future prospects. Beginning with an overview of ancient surveillance methods and the advent of modern forensic techniques, the paper explores the transformative impact of digital technologies such as DNA analysis, computer forensics, surveillance systems, and data analytics in enhancing investigative capabilities. Case studies highlight the pivotal role of technology in solving complex criminal cases, from cybercrimes and terrorism to organized crime and cold cases. Ethical considerations, privacy concerns, and legal frameworks surrounding the use of technology in crime investigation are also addressed, emphasizing the need for responsible and transparent practices. Furthermore, the paper examines emerging trends such as artificial intelligence, blockchain forensics, and quantum computing, offering insights into their potential implications for the future of crime investigation. By providing a comprehensive analysis of the role of technology in crime investigation, this paper aims to inform policymakers, law enforcement professionals, researchers, and the public about the opportunities and challenges presented by technological advancements in the pursuit of justice and public safety.

Keywords: *Technology, crime investigation, cybercrimes, Case studies, artificial intelligence*

Introduction

Crime investigation has been significantly influenced by technological advancements over the years. This paper aims to delve into the multifaceted role of technology in crime investigation, exploring its evolution, impact, challenges, and future prospects. Beginning with an overview of the historical development of forensic technology, the paper examines the various technological tools and techniques employed in crime investigation, including DNA analysis, digital forensics, surveillance systems, and artificial intelligence. The benefits of technology in enhancing investigative efficiency, accuracy, and capabilities are discussed, alongside the ethical and legal considerations surrounding its use. Furthermore, the paper explores the challenges and limitations associated with the integration of technology in crime investigation, such as privacy concerns, data security issues, and the digital divide. Finally, the paper outlines future trends and emerging technologies that are poised to shape the landscape of crime investigation in the years to come. Through comprehensive analysis and discussion, this paper aims to provide insights into the dynamic relationship between technology and crime investigation and its implications for law enforcement, justice systems, and society as a whole.

Tool and Techniques Used in Crime Investigation.

The procurement of computerized proof is a basic part of present-day wrongdoing examination, worked with modern strategies like imaging and protection of computerized media and chain of care conventions. Imaging includes making precise duplicates of advanced gadgets, guaranteeing that unique proof remains in salvageable shape while agents examine its items. Chain of care conventions lay out a reported path of guardianship for proof, guaranteeing its suitability in court by exhibiting that it has been taken care of safely and without altering.

Investigation and assessment of advanced proof depend on methods like information recuperation and remaking, metadata examination, and catchphrase and example look. Information recuperation procedures empower agents to recover erased or harmed records from advanced gadgets, giving important experiences into suspects' exercises. Metadata examination includes analyzing the secret information implanted inside computerized documents, for example, timestamps and geolocation data, to lay out the setting of proof. Catchphrases and examples look through empower specialists to filter through immense measures of advanced information productively, recognizing pertinent data connected with crimes.

Understanding and announcing computerized proof require relationship and contextualization of proof and documentation and show of discoveries. Relationships include interfacing different bits of proof to recreate the succession of occasions prompting crimes, while contextualization gives understanding into the thought processes and expectations of suspects. Documentation and show of discoveries include ordering extensive reports and introducing proof in an unmistakable and convincing way, guaranteeing that insightful discoveries are successfully imparted to partners, including examiners, safeguard lawyers, and juries.

DNA Analysis

DNA analysis plays a crucial role in crime investigation due to its unique ability to identify individuals with high accuracy. Here's a brief overview of how DNA analysis is utilized in crime investigations. DNA examination in wrongdoing examination has changed scientific science, empowering policing to tackle violations, distinguish culprits, excuse the blameless, and guarantee a fair outcome is given. It has turned into a fundamental apparatus in present day criminal examinations, giving dependable and experimentally legitimate proof to help official procedures.

Collection of DNA Evidence: The primary significant stage in DNA examination is the assortment of organic examples from the crime location. These examples might incorporate blood, spit, semen, hair, skin cells, and other natural liquids or tissues. Legitimate assortment procedures are fundamental to forestall pollution and save the respectability of the DNA proof. Scientific examiners utilize different devices and strategies to gather tests, including swabs, sterile compartments, and defensive stuff like gloves and veils. Each example is painstakingly reported, named, and bundled to guarantee chain of guardianship and keep up with evidentiary honesty all through the examination cycle.

Extraction and Purification: Once gathered, DNA should be extricated and cleansed from the organic examples to eliminate pollutants and other cell material. A few extraction strategies are ordinarily utilized in scientific research facilities, including natural extraction, silica-based extraction, and attractive globule refinement. These techniques include tearing open the phones to deliver the DNA, trailed by sanitization moves toward confine the DNA from proteins, lipids, and other cell parts. The decontaminated DNA is then measured and surveyed for quality prior to continuing to the following phase of examination.

DNA Profiling: DNA profiling, otherwise called DNA fingerprinting or hereditary profiling, includes dissecting explicit locales of the DNA particle that change between people. The most generally involved technique for DNA profiling is polymerase chain response (PCR), which enhances designated districts of the DNA through rehashed patterns of warming and cooling. Short couple rehashes (STRs) are the favoured hereditary markers for measurable DNA examination because of their high changeability and biased power. After PCR intensification, the DNA pieces are isolated by size utilizing slender electrophoresis or gel electrophoresis, creating a remarkable DNA profile for every person.

Database Comparison: DNA data sets assume a vital part in wrongdoing examination by putting away DNA profiles from known people for correlation with crime location proof. These data sets contain profiles from sentenced guilty parties, arrestees, and now and again, willful entries from people. The Consolidated DNA Record Framework (CODIS) is a public DNA data set in the US that works with the sharing and examination of DNA profiles among policing at the nearby, state, and government levels. Via looking through DNA data sets, agents can recognize expected suspects, interface cases, and create insightful leads in light of DNA matches.

Interpretation and Analysis: Deciphering DNA proof requires cautious investigation of DNA profiles acquired from crime location tests and examination with realized reference tests. Scientific researchers survey the meaning of DNA matches by working out likelihood known as match probabilities or probability proportions. These probabilities demonstrate the probability that a DNA match happened by some coincidence, considering elements like the quantity of matching alleles, populace frequencies of alleles, and the size of the DNA information base. In situations where various patrons are available in a DNA test, complex blend examination procedures are utilized to deconvolute the DNA profile and recognize individual donors.

Mechanical cutoff points can appear in changed structures:

Strength Restricts:

These limits connect with the most extreme burden or power that a mechanical part can endure before disappointment. This incorporates factors like yield strength, extreme strength, and exhaustion strength of materials. Engineers break down these cutoff points to guarantee that parts can endure expected loads during typical activity and surprising occasions like effects or over-burdens. Strength restricts in forensic science allude to the restrictions forced by the actual properties of materials or substances experienced during examinations. These limitations portray the limits inside which proof can be examined, deciphered, and used successfully. Understanding and exploring strength limits are fundamental for legal professionals to guarantee the unwavering quality and precision of their discoveries.

Solidness Cutoff points:

Firmness limits allude to the greatest twisting or dislodging that a construction can go through while keeping up with satisfactory execution. Unreasonable disfigurement can prompt unsteadiness, loss of usefulness, or even underlying disappointment. Engineers assess firmness cutoff points to guarantee that parts and designs keep up with their planned shape and capability under different burdens and natural circumstances. Solidness cutoff points in forensic science the place where actual proof changes from a strong to a non-strong state, impacting its dependability, protection, and reasonableness for examination. This idea is especially applicable in cases including short-lived or delicate materials where the conservation of evidentiary honesty is principal.

Warm Cutoff points:

Warm restricts relate to the greatest temperature range inside which a mechanical framework can work without unfavourable impacts. Intensity can corrupt materials, lessen oil adequacy, and cause warm development, which might prompt layered changes or obstruction with moving parts. Engineers consider warm cutoff points to forestall overheating and warm pressure prompted disappointment in mechanical frameworks. In forensic science, especially in the examination of natural proof, the idea of warm endpoints assumes a critical part in deciding the time span inside which certain occasions happened. Warm endpoints allude to the period during which natural examples, like blood, spit, or tissues, stay reasonable for investigation, conservation, and identification of significant markers or qualities. The feasibility of natural proof is affected by different elements, including ecological circumstances, temperature, moistness, and openness to pollutants. Warm limits are laid out in view of exact information and logical exploration to depict the ideal window of time inside which natural examples hold their trustworthiness and utility for legal examination.

Wear and Rubbing Cutoff points:

In the realm of forensic analysis, wear and scouring limits address basic edges in the assessment of actual proof, especially in cases including materials like textures, materials, and surfaces. These endpoints are demonstrative of the level of wear, erosion, or contact experienced by a thing, offering significant bits of knowledge into its set of experiences, use, and possible contribution in a wrongdoing. Wear endpoints allude to the degree of actual disintegration or debasement saw on an item because of rehashed use, grinding, or openness to ecological elements. While analyzing clothing, for instance, wear examples, for example, fraying, diminishing of texture, or loss of variety might give hints about the recurrence and power of purpose, as well as the exercises in which the wearer locked in. Likewise, wear on devices or instruments might demonstrate their recurrence of use, the kind of errands performed, and the circumstances under which they were utilized, helping with the remaking of occasions or exercises connected with a crime.

Natural Cutoff points:

In any examination, there are normal endpoints where the heading or focal point of the request might move, grow, or thin. These endpoints are in still up in the air by different variables, including the accessibility of proof, the movement of the examination, legitimate contemplations, and asset limitations. One pivotal normal endpoint happens during the underlying phases of the examination while deciding the degree and limits of the request. This includes characterizing the particular wrongdoing being scrutinized, distinguishing expected suspects or people of revenue, and framing the analytical procedures to be utilized. At this crossroads, specialists might lay out beginning theories in view of accessible data, which act as an establishment for additional request.

Use of Algorithms and AI

The use of algorithms and AI could make the criminal justice system more transparent and effective. Algorithms are used by the police and courts to determine whether a defendant is a flight risk or is still a danger to the public. This can be seen as upgrading judges with machine learning. This system works by looking into the criminal records and court records of criminals and it determines whether they will re-offend. These predictions include looking into the individual demographic factors such as sex, age, race, social security, area they live in and the reason for their prior arrests. When tested on over a hundred thousand more cases that it hadn't seen before, the algorithm proved better at predicting what defendants will do after releasing than predictions made by the judges. In theory, this concept could help the courts cut crime by defendants awaiting trial by as much as 25% without changing the numbers of people waiting in jail. Alternatively, it could be used to reduce the jail population awaiting trial by more than 40%, while leaving the crime rate by defendants unchanged.

A few issues have been raised by researchers from the use of this technology. The issues that were raised were about the possibility that the use of algorithms could discriminate and stereotype against certain age groups and individuals; some have argued that inputting historically biased data into these models contributes to a perpetuation of 'bad data', because the algorithm uses each new case as a reference for the next. But training an algorithm on the results of previous mistakes merely means they can be made without human intervention in the future. Last year an investigation by ProPublica found that commercial software developed to help determine which convicts should receive probation was more likely to incorrectly label black people than white people as 'high risk'.

The utilization of calculations and computerized reasoning (AI) in wrongdoing examination has become progressively common as of late, offering policing useful assets for breaking down information, recognizing designs, and anticipating crime. In any case, the mix of calculations and man-made intelligence in wrongdoing examinations isn't without its difficulties and discussions. The following are a few central issues with respect to the utilization of calculations and artificial intelligence in.

Crime Examination:

Calculations and man-made consciousness (artificial intelligence) have become significant devices in wrongdoing examination, upsetting the manner in which policing break down information, distinguish designs, and focus on leads. Through AI calculations, tremendous measures of organized and unstructured information, including wrongdoing reports, witness articulations, observation film, and criminal records, can be handled and broke down to reveal stowed away bits of knowledge and relationships. Prescient policing calculations use verifiable wrongdoing information to gauge future crime, empowering policing to dispense assets all the more successfully and proactively forestall wrongdoing. Besides, computer-based intelligence fuelled facial acknowledgment innovation supports distinguishing suspects and people of interest by looking at facial elements caught in reconnaissance film or photos against a data set of known people. By utilizing calculations and man-made intelligence

in wrongdoing examination, policing can upgrade their analytical capacities, smooth out tasks, and at last add to more secure networks.

Facial Acknowledgment:

Facial acknowledgment innovation, driven by modern calculations and artificial intelligence, has arisen as an amazing asset in different spaces, including policing, and recognizable proof. By dissecting facial elements like the size, shape, and course of action of eyes, nose, and mouth, facial acknowledgment calculations can precisely match people against information bases of known faces or produce biometric layouts for ID purposes. In wrongdoing examination, facial acknowledgment innovation assumes a significant part in recognizing suspects, finding missing people, and improving observation capacities. Policing use facial acknowledgment frameworks to check swarms, screen public spaces, and track the developments of people of interest. Be that as it may, concerns have been raised in regards to security, exactness, and predisposition related with facial acknowledgment innovation, provoking calls for administrative oversight and moral rules to guarantee capable arrangement and use.

DNA Assessment:

The utilization of calculations and computer-based intelligence in DNA assessment has changed criminological science, empowering fast and exact examination of DNA proof in criminal examinations. AI calculations are utilized to robotize different parts of DNA handling, including test extraction, intensification, and examination, decreasing the time and assets expected for measurable DNA profiling. Simulated intelligence fuelled programming can decipher complex DNA profiles, recognize potential matches in DNA data sets, and create factual probability proportions to survey the strength of DNA proof. Moreover, prescient calculations can dissect DNA information to construe phenotypic qualities, for example, eye tone, hair tone, and heritage, from DNA tests, giving extra insightful leads. By utilizing calculations and artificial intelligence in DNA assessment, legal labs can improve their ability to distinguish suspects, excuse the honest, and tackle cold cases, adding to the organization of equity.

Risk Examination:

Calculations and computer-based intelligence are progressively utilized in risk examination frameworks to survey the probability of future criminal way of behaving and illuminate dynamic in law enforcement procedures. These frameworks break down different gamble factors, including criminal history, segment attributes, and social markers, to produce risk scores or groupings for people associated with the equity framework. Risk examination calculations help judges, parole sheets, and policing in deciding bail choices, condemning suggestions, and parole qualification, planning to streamline public security while limiting detainment rates and recidivism. Notwithstanding, concerns have been raised in regards to the decency, straightforwardness, and potential predispositions innate in risk examination calculations, especially with respect to their effect on minimized networks.

Endeavours to work on algorithmic decency and responsibility are fundamental to guarantee that risk evaluation frameworks add to even-handed and only results in the law enforcement framework.

High level Criminal science:

In cutting edge criminal science, calculations and man-made reasoning (computer-based intelligence) are utilized to examine complex datasets and model criminal ways of behaving, supporting specialists and policing in understanding and anticipating wrongdoing elements. High level calculations can handle immense measures of information, including wrongdoing reports, guilty party profiles, financial markers, and geographic data, to recognize patterns, relationships, and hazard factors related with crimes. AI calculations can recognize unpretentious examples and oddities in information, empowering crime analysts to foster prescient models for wrongdoing areas of interest, guilty party profiling, and early mediation procedures. Besides, computer-based intelligence controlled prescient investigation can estimate future criminal way of behaving, illuminate asset distribution, and guide wrongdoing anticipation endeavors. Nonetheless, moral contemplations with respect to information protection, predisposition, and responsibility should be painstakingly addressed to guarantee mindful utilization of calculations and simulated intelligence in cutting edge criminal science examination and practice.

Electronic Case The board:

Electronic case the board frameworks influence calculations and simulated intelligence to smooth out and streamline the administration of criminal cases inside policing and legal frameworks. These frameworks mechanize different parts of case handling, including information passage, archive the executives, planning, and work process the board, diminishing regulatory weights and upgrading productivity. AI calculations can classify and focus on cases in view of variables like seriousness, direness, and asset accessibility, working with direction and asset assignment. Moreover, simulated intelligence fuelled prescient investigation can figure case results, evaluate suit gambles, and illuminate vital dynamic by legitimate experts. Notwithstanding, challenges connected with information security, interoperability, and framework coordination should be addressed to guarantee the adequacy and dependability of automated case the executives' frameworks in the law enforcement space.

Presentation of Evidence:

Presentation of evidence plays a crucial role in criminal trials, as it allows prosecutors and defense attorneys to present their case to judges, juries, and other stakeholders in a clear, compelling, and persuasive manner. With the advent of technology, the presentation of evidence has evolved significantly, enabling legal professionals to leverage various technological tools and platforms to enhance the effectiveness of their arguments and presentations. This section explores the use of technology in presenting evidence during criminal trials, including its applications, benefits, and ethical considerations. Presentation of evidence plays a pivotal role in legal processes, incorporating the approaches, methods, and tactics employed to showcase evidence, witness accounts, and exhibits

to the judiciary, jurors, or arbiters. A successful demonstration of evidence is crucial for constructing compelling arguments, affirming trustworthiness, and shaping the result of a legal matter. Here are several essential aspects and factors to bear in mind:

Clarity and Organization:

Clarity and organization in the context of presenting evidence refer to the systematic arrangement and clear articulation of information to ensure that it is easily understandable, coherent, and persuasive. Basically, it includes organizing the show in a legitimate way and conveying central issues plainly to the crowd. Lucidity envelops the utilization of language and visual guides that are succinct, clear, and liberated from uncertainty. Moderators endeavour to express their contentions and proof in a way that is effectively fathomable to the crowd, keeping away from specialized language, tangled language, or excessively complex clarifications. Clear informing assists with disposing of disarray, lessen the gamble of error, and guarantee that the crowd gets a handle on the expected significance of the proof being introduced.

Clear messaging:

Clear messaging refers to the effective communication of information in a manner that is easily understood by the audience. With regards to introducing proof, clear informing includes articulating central issues, contentions, and proof in a succinct, direct, and unambiguous way. The objective of clear informing is to guarantee that the crowd gets a handle on the planned significance of the proof being introduced without disarray or misconstruing. This expects moderators to utilize plain language, stay away from specialized language or complex phrasing, and improve on complex ideas into edible lumps. By utilizing language that is available to the crowd, moderators can upgrade cognizance and maintenance of data.

Visual Aids:

Visual aids are supplemental materials or devices used to improve correspondence by passing data on through visual means. These guides incorporate outlines, charts, graphs, photos, recordings, maps, and other visual portrayals that supplement verbal clarifications. The basic role of visual guides is to make mind boggling or dynamic ideas more reasonable and paramount for the crowd. They effectively build up central issues, give setting, and connect with the crowd's visual faculties, in this way improving appreciation, maintenance, and by and large viability of correspondence. With regards to introducing proof, visual guides assume a critical part in explaining data, featuring significant subtleties, and assisting the crowd with bettering comprehend the meaning of the proof being introduced

Conclusion:

In conclusion, the integration of technology into crime investigation has revolutionized the field, offering the two open doors and difficulties for policing, scientific specialists, and overall sets of laws around the world. All through this investigation, we have dove into different parts of how innovation

has reshaped the scene of wrongdoing examination, from the assortment and investigation of computerized proof to the utilization of cutting-edge reconnaissance frameworks and scientific devices.

One of the main headways achieved by innovation is the digitization of proof. Computerized proof, going from messages and virtual entertainment presents on observation film and GPS information, has become progressively predominant in criminal examinations. This shift has required the improvement of particular scientific strategies and apparatuses to extricate, break down, and decipher advanced proof precisely. In any case, the sheer volume and intricacy of advanced information present difficulties as far as information the board, protection concerns, and guaranteeing the acceptability of proof in court.

In addition, innovation has worked with the computerization and smoothing out of analytical cycles, empowering policing to improve their productivity and viability. Robotized facial acknowledgment frameworks, prescient investigation, and AI calculations have been sent to recognize suspects, anticipate wrongdoing areas of interest, and dissect examples of criminal way of behaving. While these advancements hold guarantee for further developing wrongdoing identification and avoidance, moral contemplations with respect to exactness, predisposition, and protection should be painstakingly addressed to alleviate possible dangers and defend individual freedoms.

Moreover, innovation has changed the idea of crime itself, bringing about new types of cybercrime, for example, hacking, wholesale fraud, and online misrepresentation. As hoodlums exploit weaknesses in computerized frameworks and organizations, policing must persistently adjust their analytical procedures and capacities to battle these advancing dangers. Joint effort among public and confidential areas, global participation, and progressing innovative work are fundamental in remaining in front of cybercriminals and guaranteeing the security of advanced framework.

Notwithstanding its job in examination and wrongdoing counteraction, innovation has likewise affected the organization of equity and the lawful cycle. The utilization of advanced proof in court procedures has brought up clever legitimate issues in regards to genuineness, chain of authority, and the unwavering quality of electronic records. Courts and legitimate experts should wrestle with these issues while maintaining standards of fair treatment and guaranteeing the fair and evenhanded treatment of all gatherings included.

Looking forward, the eventual fate of innovation in wrongdoing examination holds tremendous potential for development and progression. Arising innovations, for example, blockchain, man-made consciousness, and quantum figuring are ready to additionally change how wrongdoings are researched, recognized, and arraigned. Notwithstanding, as we embrace these mechanical developments, it is basic to work out some kind of harmony between tackling their advantages and tending to their related dangers and suggestions.

All in all, the job of innovation in wrongdoing examination is multi-layered, complex, and persistently advancing. While innovation offers uncommon chances to improve our capacity to address violations

and direct equity, it additionally presents critical difficulties and moral quandaries that should be explored with care and prescience. By embracing development, encouraging cooperation, and maintaining major standards of responsibility and regard for individual freedoms, we can saddle the force of innovation to make a more secure and all the more only society for all.

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The Handbook of Computer Crime Investigation: Forensic Tools and Technology" by Eoghan Casey

Bare Acts: -

Information Technology Act, 2000 (India) - This act addresses various cybercrimes and the legal framework for investigation and prosecution using technology.

Electronic Communications Privacy Act (ECPA) (United States) - ECPA regulates the interception of electronic communications and the use of electronic surveillance in criminal investigations.

Computer Fraud and Abuse Act (CFAA) (United States) - CFAA addresses unauthorized access to computer systems and the use of technology in committing fraud and other cybercrimes.

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