A Review of the Application of Artificial Intelligence in Criminal Investigation

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Abstract.
In recent years, new types of crimes have emerged, posing a great threat to the safety of communities and citizens. Traditional criminal investigation measures are too passive and are not conducive to preventing and combating crimes. Currently, artificial intelligence is being used to improve policing and criminal investigations in a variety of ways, including video image detection, crime data mining, crime prediction, and more. Of course, the application of artificial intelligence may also pose certain risks, such as violating citizens' personal privacy. This paper mainly introduces the main applications of artificial intelligence in criminal investigation at present and puts forward reasonable suggestions for existing problems and risks, in the hope that artificial intelligence can be better applied to criminal investigation activities.

Keywords: *Artificial Intelligence; Community and Citizen Security; Criminal Investigation; Applications*

1 INTRODUCTION

Artificial intelligence, abbreviated as AI, is one of the hottest research projects of the moment. From the "Turing test" in 1950 to John McCarthy first coined the term "artificial intelligence" at the Dartmouth Conference in 1956, which marked the official birth of AI [1, 2]. In the process of development, AI has covered almost all social fields such as politics, economy, medicine, biology, etc. Similarly, the advent of the era of big data has also provided convenience for criminals, spawned new means of committing crimes and new types of crimes, breaking the limitations of traditional crime time and space, leading to the inability of the traditional investigation model and investigative measures to solve cases in a timely and effective manner. This provides the necessary conditions for applying AI, such as machine learning (ML) and image recognition, to the field of criminal investigation.

In view of the important role played by AI in criminal investigation, many scholars have begun to study the specific application of AI in criminal investigation. For example, Arshath Raja et al. used machine learning (ML) to identify and cluster crime patterns, which improved the accuracy of crime pattern recognition [3]; McKendrick has used AI to predict terrorist attacks based on the analysis of relevant data amounts to facilitate scientific and effective deployment of counter-terrorism resources [4]; Helm and Hagendorff expound on Challenges for AI in the structure against hidden organized crime, AI can only promote the development of intelligent policing under the premise of ensuring the security of personal and group data [5].

2 OVERVIEW OF ARTIFICIAL INTELLIGENCE

2.1 *The conception of artificial intelligence*

AI is a human-like behavior, a human-like thinking, a rational thinking, and action [6]. AI is a technical discipline specializing in the research and development of human intelligence theories, methods, technologies, and application systems [7]. To put it simply, AI is to use machines to simulate advanced human behaviors such as thinking, understanding, and decision-making by constructing intelligent artificial systems.

2.2 *Types of artificial intelligence*

According to different levels, AI can be classified as weak AI, strong AI, and super AI [8]. Weak AI is the most widely used AI at this stage, which refers to AI systems that realize specific functions in a professional field, such as speech recognition, intelligent search, etc. [9]. Weak AI has approached or even surpassed humans in some specific fields, such as expert systems. Strong AI is a kind of AI that approximates human level, with the ability to think almost as well as humans and with self-awareness. At the current level, it is far from reaching the level of strong AI, and it still takes a long way to achieve it. Super AI, as the name implies, is an intelligence that surpass (perhaps slightly, or far exceed) human intelligence in all aspects, and can solve difficult problems that humans cannot solve.

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3 THE MAIN APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN CRIMINAL INVESTIGATION

3.1 *Video investigation*

As one of the commonly used criminal investigation measures in the era of big data, video investigation refers to the use of computer image processing technology to analyze and judge the video image data collected by video surveillance, and quickly locate criminal suspects. In the past, it mainly used "human sea tactics", that is, manually searched and compared the suspect targets one by one through the collected video and image data. But with all kinds of surveillance all over the streets, the explosion of video surveillance data collected and stored has led to an exponential increase in the workload. The previous "human sea tactics" were not only time-consuming, labor-intensive, but also easily overlooked important information, requiring repeated browsing and viewing. In addition, the quality of the obtained videos was uneven, and some of them were stored for a short time, which further led to low efficiency. Nowadays, relying on AI computer recognition technology (portrait recognition, vehicle trajectory recognition, vehicle type recognition, gait recognition, etc.) can well solve the above problems. AI technology can automatically process massive video data, extract and retrieve target features, and correlate other types of information to realize automatic identification, discovery, comparison, and alarm of suspected targets (persons and vehicles), and can also describe the behavior of criminal suspects It completely frees the investigators from the heavy search and comparison activities, greatly improves the efficiency of the investigation. It is conducive to the rapid detection of case clues, the identification of suspects, and the tracking and arrest of criminal suspects [10]. In a sense, AI technology has broadened the traditional video investigation ideas and has become one of the main technologies to catch criminal suspects.

3.2 *Crime data mining*

Data mining is the process of extracting hidden, previously unknown, and potentially valuable information and knowledge from a large amount of data in a database [11]. Data mining covers technologies in related fields such as statistics, AI, databases, and visualization techniques. Using data mining technology, crime-related data can be screened out from massive data (such as communication data, network data, video data, and physical evidence data), and deeply excavate the associations and laws hidden behind various data, so as to find the investigation clues and evidence materials and further point out the investigation direction, and on this basis, risk assessment and crime prediction can also be carried out to promote the construction of investigation information and data. At present, common data mining techniques include cluster analysis, regression analysis, association analysis, etc. The main process is through the correlation analysis of the characteristics of criminals, activity trajectory, case situation, traces, and physical evidence, etc., to find out the basic information of the criminal suspect, the information involved in the case, electronic information, trajectory information, case information, then establish a comprehensive model of criminal behavior analysis, infer the suspect's foothold and the areas where they may continue to commit crimes. In addition, data mining technology can also play an important role in computer and network crime forensics.

3.3 *Crime prediction*

The phenomenon of crime, which appears to be episodic on the surface, but in fact it is the result of a combination of various social factors, and there are certain laws and connections in the deep. For example, the famous forensic scientist and criminologist Lombroso has obtained the time distribution law of theft crimes through empirical research and analysis. In comparison, there are more in winter than in summer. Some scholars have studied other crimes and analyzed some spatial and temporal distribution laws. Most of these analyses are descriptive analyses, which do not reach the height of predictive analysis. AI has changed the traditional investigation mode, making it possible to carry out more scientific and accurate predictive analysis of crimes by combining massive data. Crime prediction is mainly divided into crime type prediction, crime time and space prediction, offender prediction, crime trend analysis, victim prediction, recidivism prediction, etc. According to the needs of investigation and handling, the collected and extracted data are mined, integrated, analyzed, and collided to summaries the relevant factors, characteristics, and laws of crimes. Then construct a crime prediction model, which can predict the types, numbers, victim groups, area, and time, etc. that may occur in the future [12, 13]. With the aid of the intelligence-led investigation model, police agencies can formulate targeted measures, scientifically optimize police resources to improve the accuracy of prevention, reduce crime rates in the region, while maximizing the benefits of limited police resources and reducing human bias in decision-making. For example, for common crimes such as theft and robbery, we can use machine learning (ML) algorithms - LSTM algorithm, genetic algorithm, neural network, etc. to analyze the crime spatiotemporal sequence. Through data such as population density, time, location, economic status, police force distribution, weather, temperature, etc., trained by the above algorithms. ARIMA model, exponential smoothing model or neural network model is constructed to fit the crime trend, based on which RMSE and F1Score are used to evaluate the prediction effect of the model to achieve the purpose of predicting crime. There are many more crime prediction methods, such as

K-means algorithm, SVM algorithm, Knox algorithm, random forest algorithm, gray system theory method, etc.

4 CHALLENGES AND SOLUTIONS FOR THE APPLICATIONS OF AI IN CRIMINAL INVESTIGATION

Although the application of AI in criminal investigation has achieved certain advantages, we must also clearly recognize that AI brings great benefits and may also bring major risks. At present, the application of AI in criminal investigation is still relatively elementary, and there are many problems. For example, insufficient application depth, lack of professional teams, data barriers, and potential legal risks. Only by solving these problems can AI applications reach new heights.

4.1 *Low degree of application*

For the present, AI technology has been widely used in criminal investigation, but overall, it is relatively elementary and fragmented, mostly concentrated in intelligence retrieval, criminal data mining, video investigation, etc. There are still many places that have not been deeply involved, such as interrogation. Due to the late application of AI in criminal investigation, it is mainly used to assist investigators in handling cases, lacking in-depth independent analysis capabilities. In addition, the phenomenon of "data silos" is serious [14]. The systems and data between various police forces and departments are not interoperable, and it is impossible to smoothly realize data sharing, build models, and carry out police linkage and coordinated operations. Especially when it comes to cross-regional and cybercrime cases, it takes a lot of time, manpower and financial resources, resulting in extremely low investigation efficiency. It is urgent to establish a unified intelligence information system to achieve data exchange and sharing, break down data barriers, maximize the value of various data, establish an integrated reconnaissance mechanism for synthetic operations and collaborative operations, and promote the in-depth application of AI technology in the field of reconnaissance.

4.2 *Lack of information technology talents*

The lack of professional talents and the inability to keep up with the development of AI are the important factors that hinder the application of AI technology in criminal investigation. AI equipment systems from research and development, application to maintenance and update require a large number of talents, and police academies also lack corresponding training courses. Therefore, police agencies need to establish cooperation with enterprises to find a breakthrough [15]. Jointly develop systems and software according to actual needs, improve the ability of investigators to use AI to solve cases.

4.3 *Expansion of criminal investigation power*

While AI changes the traditional investigation mode, it also further expands the criminal investigation power of the police departments. AI investigation is built on informatization and data. which inevitably infringes on the legal rights and privacy of ordinary citizens while mining and analyzing all kinds of relevant data and video surveillance [16]. In recent years, the exercise of investigative powers beyond the bounds of the phenomenon has occurred [17]. The application of AI has further exacerbated this phenomenon, leading to the contradiction between "power" and "right". In this regard, there are loopholes in the law. Therefore, on the one hand, under the premise of ensuring that the investigative power is not exercised beyond the limits of the law, we should encourage and guide the lawful investigative behaviors, make AI better serve the investigation work, integrate AI technology embedded in the investigation power into the framework of the law, and strengthen the legal control, supervision, and remedies of investigation behaviors. On the other hand, police authorities should also establish and improve AI technology application norms, review and filing mechanism and responsibility tracing mechanism to prevent abuse of AI instruments and criminal investigation power, and to ensure the use of AI investigation equipment and systems within a reasonable, legal, and standardized framework. To truly realize the exercise of criminal investigation power in the context of AI, there are laws and systems to follow [18].

5 CONCLUSION

This study provides an overview of AI and its applications in the field of criminal investigation, focusing on the application scenarios and possible risks and corresponding countermeasures in the application process. The rapid development of AI has had a positive and profound impact on human beings. How to better apply AI in various fields is a question we must think about. Only by maximizing the use of AI technology and avoiding its potential risks can AI be better applied to criminal investigation.

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