ISSN: 2664-9640

Intelligent Target Recognition Technology Empowers the Improvement of Urban Public Safety Governance Capabilities

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Abstract

The governance of urban public safety faces the dilemma of complex risks and insufficient effectiveness of traditional methods. Intelligent target recognition technology provides core support for solving this problem. This paper analyzes the multi-dimensional mechanism that this technology enables urban public security governance, and points out that it relies on convolutional neural network (CNN), transformer architecture and edge computing to build three mechanisms, namely, real-time accurate perception, active risk early warning, and cross sectoral collaborative decision-making, to promote the transformation of governance mode from passive response to active prevention and control. At the same time, this article reveals the four constraints faced by technology in practical implementation, including technological robustness, data privacy, institutional ethics, and organizational capacity. Based on this, we propose countermeasures and suggestions to promote model optimization and multimodal integration, improve regulatory standards and ethical review, strengthen data sharing and business process reengineering, and look forward to future research directions such as continuous learning, explainable AI, and privacy computing, providing a systematic reference for improving the efficiency of urban security governance.

Keywords

Intelligent Target Recognition; Urban Public Safety; Public Safety Governance.

1. Introduction

While cities gather resources and drive economic growth, they also face increasingly complex public safety risks, including terrorist attacks, large-scale stampedes, traffic accidents, natural disasters, mass incidents, and various security crimes. These risks have the characteristics of strong suddenness, wide impact, and far-reaching effects, posing severe challenges to the urban governance system [1]. The traditional public safety governance model mainly relies on human patrols, video surveillance, manual review, and post emergency response, which have inherent defects such as perception lag, information silos, and passive response [2]. Especially in large cities, the massive amount of surveillance video data far exceeds human processing capabilities, and the governance efficiency of traditional methods is approaching the ceiling.

In recent years, artificial intelligence technologies represented by deep learning have made breakthrough progress, providing new technological possibilities for the transformation and upgrading of urban public safety governance. Among them, intelligent target recognition technology covers core capabilities such as object detection, behavior recognition, multimodal data fusion, and edge real-time computing based on convolutional neural networks (CNN) and Transformer architectures, and has demonstrated significant application value in fields such as security monitoring, traffic management, counter-terrorism and stability maintenance [3].

This study combines technology empowerment theory, collaborative governance theory, and social technology system theory to enrich the academic dialogue on technology driven

ISSN: 2664-9640

governance change. Its practical significance lies in providing systematic decision-making references for urban managers when introducing and deploying intelligent target recognition systems, helping them balance institutional support and ethical compliance while pursuing technological efficiency. Multi dimensional analysis of empowerment mechanisms, application scenarios, and constraining factors; Finally, propose countermeasures and suggestions, and look forward to future research directions.

2. Mechanism Analysis of Intelligent Target Recognition Technology Empowering Urban Public Safety

Intelligent target recognition technology, as a core application in the field of artificial intelligence, is deeply integrated into the urban public safety governance system. It reconstructs the governance logic from key links such as perception, warning, and response, forming a multi-dimensional and full chain empowerment mechanism, providing core support for solving traditional governance difficulties and improving security governance efficiency. Typical application scenarios are shown in Table 1.

Table 1. Typical application scenarios of intelligent target recognition technology

Application Scenarios	Technical means	Improvement of governance efficiency
Security for large-scale events	Crowd density detection+abnormal behavior recognition	Real time warning and rapid evacuation
Traffic safety management	Vehicle/pedestrian target detection+violation recognition	Accident prevention and law enforcement efficiency
Counter terrorism and stability maintenance	Facial recognition+suspicious item detection	Precise prevention and control, quick locking
Emergency response to natural disasters	Remote sensing target recognition+disaster assessment	Quick search and rescue, loss assessment
Community security	Intelligent access control+perimeter intrusion detection	Grassroots prevention and control, reducing the incidence rate of cases

2.1. Real Time Perception and Precise Recognition Mechanism

Traditional urban public safety governance relies on manual patrols and video replays, which have shortcomings such as limited perception range, insufficient recognition accuracy, and delayed response time, making it difficult to meet the security control needs of massive dynamic scenes. Intelligent target recognition technology relies on CNN, Transformer architecture and other core algorithms [4], and combines the edge real-time computing ability to build a global, accurate and efficient perceptual recognition system, realizing the leap from passive discovery to active capture.

What about technology, it breaks the limitations of space and manpower. Some key places in the city, such as transportation hubs, commercial streets and large venues, are equipped with intelligent monitoring. Monitoring can watch 24 hours a day, forming a full coverage perception network. The system can handle many channels of high-definition videos at the same time, unlike people who can only watch one by one, the efficiency goes up and everything can be grasped in real time. Besides recognition, it can recognize very complex targets. Intelligent target recognition technology can not only see the basic characteristics of people and cars clearly, but also grasp the key points of abnormal behavior and dangerous things. For example, in a crowded place, it can immediately see who is running, who is pushing and who is always staying, as shown in Figure 1. In traffic, it is also possible to catch incidents such as running red lights, going in the wrong direction, and parking recklessly. Its accuracy is much higher than that of humans, and it won't get lost due to fatigue or distraction. Edge computing allows data to be processed directly by the camera, and the response time is extremely short, from finding

ISSN: 2664-9640

the target to calling the police, which is only a few milliseconds. This will grab valuable time for the later treatment, solve the long-standing problem of late discovery and inaccurate recognition, and add a solid line of defense to public safety.

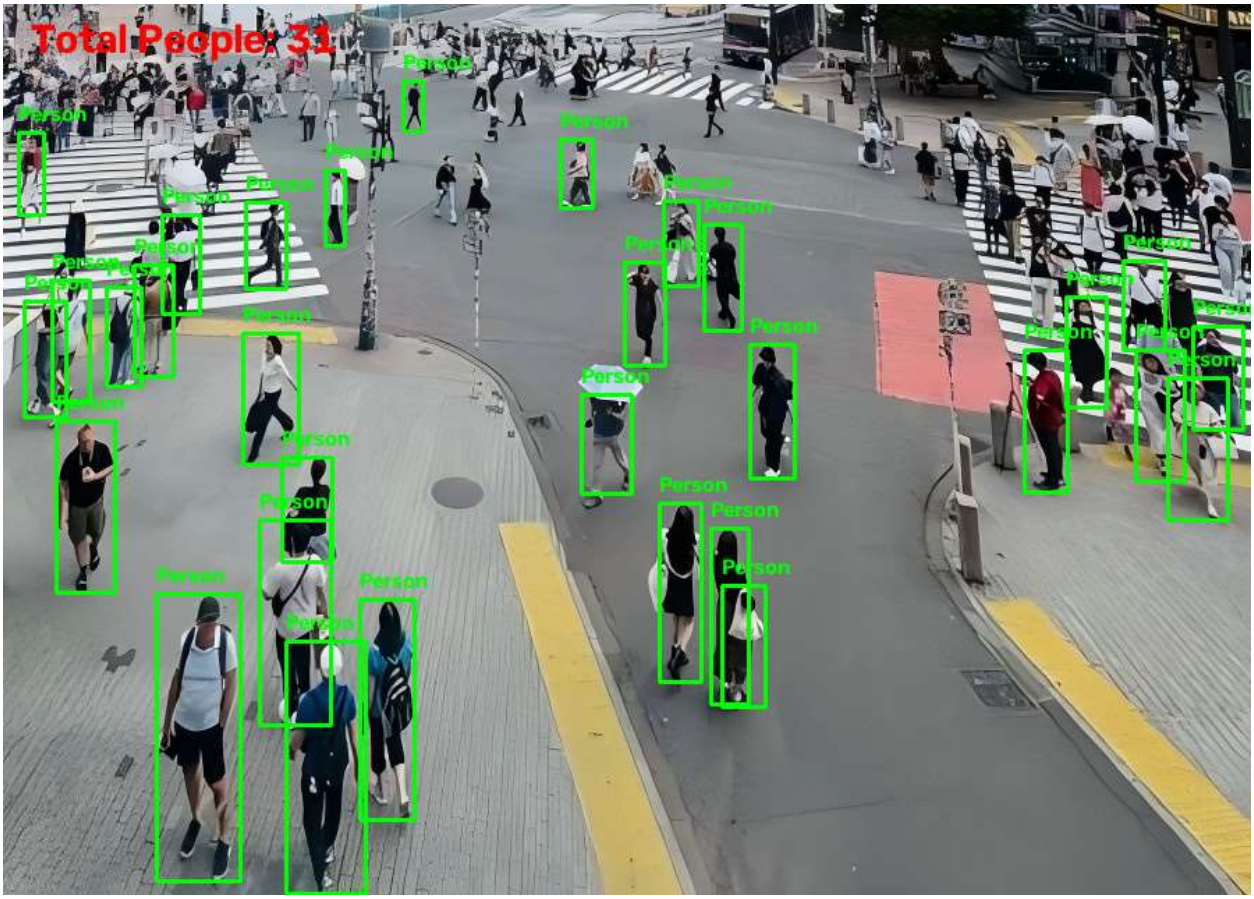

Figure 1. YOLOv8s target recognition in densely populated areas

2.2. Risk Warning and Proactive Prevention and Control Mechanism

Urban public safety is characterized by its sudden arrival and rapid spread. In the past, the method was basically to take care of the accident, and there was no ability to predict in advance and take the initiative to intervene. As a result, it costs a lot of money to deal with, and the loss is also great [5-6]. Now this intelligent target recognition technology, relying on its powerful data mining and analysis capabilities, has established a closed-loop prevention and control system from risk discovery to early warning to intervention. In this way, the governance model has changed from passive coping to active prevention.

This technology uses several kinds of data together, such as video surveillance, sensors, people flow and weather, and then uses deep learning algorithm to build a risk early warning model. In this way, the potential security risks can be identified and calculated dynamically. For big risks such as terrorist attacks, large-scale trampling and natural disasters, the system will analyze how the risks have evolved according to historical data and current situation, and guess in advance when it may happen, where it will happen and how big its impact will be.

For example, when holding a large-scale event, the system will always keep an eye on the crowd density, walking speed and gathering trend, combined with the upper limit of the venue. If the crowd density is close to the warning line, it will automatically call the police to remind managers to quickly divert and limit the flow to prevent trampling from the roots. In traffic management, the system can see which road sections and time periods are prone to accidents in advance, and then arrange traffic police to guide them in advance to reduce accidents. In

ISSN: 2664-9640

addition, this technology can give early warning at different levels according to the size of risks, and different risk levels push different information to provide accurate decision-making basis for different levels of management departments. It can also be connected with the emergency resource dispatching system, so that the early warning information can be matched with the prevention and control forces to ensure that the risks can be suppressed as soon as they arise. In this way, urban public safety risk prevention and control will be more advanced and more active.

2.3. Collaborative Response and Decision Support Mechanism

Urban public safety governance involves public security, transportation, emergency, fire protection and other departments. Under the traditional governance model, the problem of information islands among departments is prominent, data is difficult to share, and response is lack of coordination, which leads to low efficiency of emergency response [7]. Intelligent target recognition technology takes data as the core link, breaks down departmental barriers, builds a cross-departmental and cross-level collaborative response and decision support system, and realizes the upgrade from decentralized disposal to collaborative linkage [8].

At the level of collaborative response, technology builds a unified intelligent control platform to achieve real-time aggregation and interconnection of data from multiple departments. When the system identifies security risks and issues warnings, the platform automatically synchronizes and pushes core data such as target information, risk types, location coordinates, etc. to relevant departments such as public security, transportation, and emergency response. Each department starts the disposal process synchronously according to the preset division of responsibilities, avoiding information transmission delay errors and responsibility shifting. For example, in the event of a sudden traffic accident, the platform automatically pushes information such as the location of the accident, casualties, and surrounding traffic flow to the traffic police, emergency medical, and fire departments. The traffic police quickly implement traffic guidance, emergency medical personnel accurately rush to the scene, and the fire department prepares for rescue in advance, forming an efficient closed loop of collaborative disposal among multiple departments.

At the level of decision support, technology relies on big data analysis and visualization techniques to provide scientific decision support for emergency response. The system can integrate real-time on-site data, historical cases, resource distribution and other information, deduce risk evolution trends through algorithm models, generate optimal disposal plans, and provide intuitive and accurate decision-making references for commanders [9]. At the same time, the system can dynamically track the disposal process, provide real-time feedback on the disposal effect, assist command personnel in adjusting strategies in a timely manner, and ensure the scientific and efficient nature of emergency response. The deep integration of collaborative response and intelligent decision-making greatly improves the collaborative efficiency of cross departmental emergency response, effectively solves the problems of information asymmetry and fragmented response in traditional governance, and provides solid guarantees for urban public safety emergency response.

3. Challenges and Constraints

Although intelligent target recognition technology has shown great potential in improving the governance capacity of urban public safety, it still faces multiple challenges and constraints in the actual deployment and application process, mainly reflected in the following four levels (Figure 2).

ISSN: 2664-9640

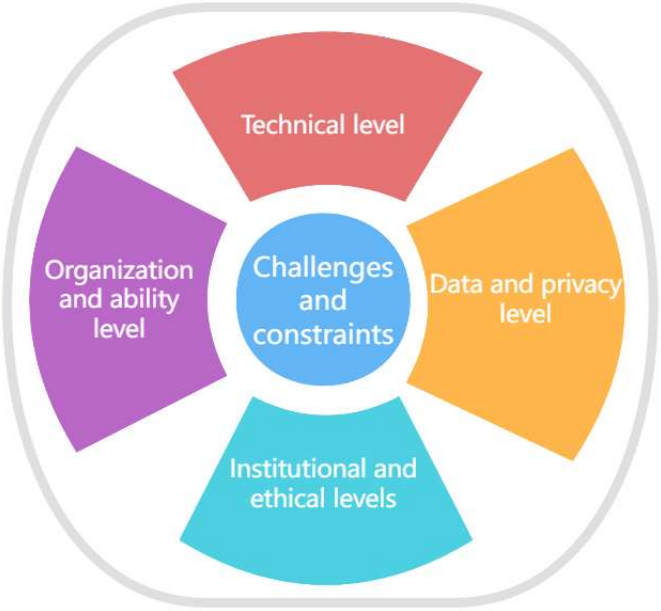

Figure 2. Multiple challenges and constraints faced by intelligent target recognition technology

(1) Technical level

The performance of intelligent target recognition system is highly dependent on the accuracy, robustness and generalization ability of the algorithm model. However, in complex urban scenes, factors such as illumination change, occlusion, visual angle difference and dense overlapping of targets often lead to the decline of recognition accuracy. In addition, the existing models do not perform well in the face of rare events or small sample targets, and there are frequent false positives and false negatives. The computing power limit of edge devices also restricts the real-time processing ability, especially in the scene of large-scale video streaming concurrency, system delay and resource consumption become bottlenecks. Compatibility between different vendors' devices and platforms increases the difficulty of system integration.

(2) Data and privacy level

The training and operation of intelligent target recognition technology need a lot of high-quality annotation data, especially the image and video data involving sensitive information such as face, gait and license plate. It brings double dilemmas: on the one hand, the cost of data collection and annotation is high, and it is difficult to obtain enough diversified real scene data due to privacy protection regulations; On the other hand, there is a risk of leakage in the process of data storage, transmission and use. Once it is abused or illegally accessed, it may infringe on citizens' privacy [10]. How to achieve privacy protection while ensuring data availability has become a key problem for technology landing.

(3) Institutional and ethical levels

At present, for the application of intelligent target recognition technology in the field of public safety, the relevant laws and regulations are not perfect, and there is no unified technical standard, evaluation mechanism and supervision framework. For example, the application boundary of face recognition technology, the legal responsibility of early warning information and the interpretability of algorithm decision have not been clearly defined [11]. In addition, algorithm bias may lead to unfair treatment of specific groups and trigger a crisis of social trust. Without an effective ethical review and public participation mechanism, the legitimacy of technology application will be questioned.

(4) Organization and ability level

ISSN: 2664-9640

The effective operation of intelligent target recognition system not only depends on the technology itself, but also needs to match the corresponding organizational ability and personnel quality. In reality, many urban management departments still have problems such as weak information foundation, high barriers to cross-departmental data sharing, and rigid business processes [12]. The acceptance and proficiency of frontline workers in new technologies vary greatly, and there is a lack of systematic training and technical support. In addition, the disconnect between technology and business has led to systems being "built but not used" or "used but not optimized", failing to truly integrate into daily governance processes, resulting in a phenomenon of "technology suspension".

4. Suggestions and Prospects for Countermeasures

4.1. Technological Optimization Path

In response to the problems of insufficient recognition accuracy, limited robustness, and edge computing power bottlenecks in current intelligent target recognition systems in complex scenarios, technological optimization should focus on the following directions:

Improve the generalization ability and robustness of the model. In the city, the lighting, shading and perspective are different. These situations are too complicated. Therefore, we have to invest more money in the frontier directions of self-supervised learning, domain adaptation and small sample learning. We must also get some enhanced training strategies for rare events and long tail distribution to reduce false positives and false negatives. It is necessary to design a lightweight model architecture, so as to make the model small and convenient to install on edge equipment without reducing the accuracy too much.

Promote multimodal fusion and edge intelligence collaboration. Don't just rely on video as a mode, we must integrate all the data of radar, infrared, acoustics and Internet of Things sensors to build a cross-modal joint identification framework. In this way, under the bad conditions of extreme weather and night, the perception ability of the system can also be improved. It is also necessary to optimize the collaborative computing architecture between the edge and the cloud, and use model segmentation, dynamic unloading and caching to reduce the transmission delay and reduce the burden on the central server.

Establish a unified set of technical standards and interoperability specifications. At present, the equipment and platforms of different manufacturers are always incompatible, so it is necessary to promote the formulation of unified interface protocols, data formats and system docking standards in the industry. Let the software and hardware ecology be open and interoperable, so that the cost of system integration and the complexity of operation and maintenance can be reduced.

4.2. Path of Institutional Construction

Institutional guarantee is the prerequisite for the benign landing of technology, which needs to be promoted from three dimensions: laws and regulations, standard evaluation and ethical supervision [13]. Accelerate the introduction of specialized regulations for the application of intelligent target recognition technology in the field of public safety, clarify the usage boundaries, authorization procedures, and responsibility attribution of technologies such as facial recognition and behavior analysis, clarify the full lifecycle compliance requirements for data collection, storage, sharing, and destruction, and establish clear legal red lines for technology applications. Develop mandatory or recommended national standards for algorithm performance, data quality, system security, etc., establish an independent third-party evaluation and certification system, conduct regular testing and public disclosure of core indicators such as recognition accuracy, response delay, and privacy protection level, and use standardization to drive technological quality improvement. Establish an interdisciplinary

ISSN: 2664-9640

algorithm ethics review committee to conduct pre ethical assessments on high-risk application scenarios such as sensitive population identification and large-scale monitoring; At the same time, we will broaden the channels for public awareness and participation, enhance the transparency and social acceptance of technology deployment through methods such as hearings and public disclosure systems, and prevent social trust crises caused by algorithmic bias.

4.3. Path of Governance Capacity Building

The full utilization of technological efficiency depends on the synchronous upgrading of organizational capabilities, and efforts need to be made to solve the dilemma of "technological suspension".

1) Consolidate information infrastructure and data sharing mechanisms. Increase investment in the construction of urban public safety perception networks, and fill in the gaps and deficiencies in monitoring blind spots such as old residential areas and remote areas; Break down the data barriers between departments such as public security, transportation, emergency response, and fire protection, establish a cross departmental data sharing directory and security exchange platform, and achieve real-time communication and collaborative response of risk information.

2) Strengthen personnel training and business process reengineering. Provide technical operation and data analysis training on hierarchical classification for frontline staff to enhance their proficiency and application ability of the new system; Promote the deep integration of technical systems with existing business processes, optimize standard operating procedures for alarm reception, analysis, scheduling, and disposal based on technical characteristics, and avoid formalism of "building for the sake of building".

3) Cultivate a team of versatile talents. Encourage cooperation between universities, research institutions, and practical departments to cultivate composite management talents and technical backbones who understand both public safety business and are proficient in artificial intelligence technology, providing intellectual support for continuous technological iteration and innovative governance models.

4.4. Future Research Directions

Looking ahead to the future, research on empowering urban public safety governance with intelligent target recognition technology can be deepened and expanded in the following directions:

One is continuous learning and research aimed at the open world. The current model relies heavily on closed datasets for training, making it difficult to adapt to the constantly emerging new target types and security threats in urban environments. In the future, continuous learning, incremental learning, and lifelong learning mechanisms for open scenarios should be explored to enable the system to have the ability of autonomous evolution and knowledge updating.

The second is interpretability and trustworthy AI research. Improving the transparency and interpretability of the algorithm decision-making process, making the warning basis and risk rating logic understandable and auditable by humans, is the key to enhancing the trust of managers and supporting scientific decision-making. We need to strengthen the research and application of explainable AI technologies such as causal reasoning, attention visualization, and decision path tracing.

The third is research on privacy computing and federated learning. In the context of increasingly strict data privacy protection regulations, exploring a distributed model training paradigm based on privacy computing technologies such as federated learning, secure multi-party computing, and differential privacy, to achieve secure collaboration of "data available but invisible" and break the tension between data sharing and privacy protection.

ISSN: 2664-9640

The fourth is the research on human-machine collaboration and intelligent decision-making. Going beyond the simple logic of "technology replacing humans", we will conduct in-depth research on the optimal collaboration mode between human experts and AI systems in risk assessment and emergency response, construct a collaborative decision-making framework that complements humans and machines and has clear rights and responsibilities, and promote the intelligent and refined governance of urban public safety to a higher level.

5. Conclusion

Intelligent target recognition technology enhances the efficiency of urban public safety governance by building a full chain empowerment mechanism that includes real-time perception, risk warning, and collaborative response. At the level of technological empowerment, it relies on deep learning algorithms to break through the temporal and spatial limitations of traditional human monitoring, achieve millisecond level abnormal behavior recognition and risk prediction, and shift urban safety prevention and control from passive response to active intervention; Under the framework of multimodal data fusion and cross departmental collaboration, technology drives public security, emergency and other departments to form an efficient collaborative response loop, reducing the risk of losses in large-scale events. However, the implementation of technology still faces challenges such as insufficient algorithm robustness, data privacy conflicts, lagging institutional norms, and weak organizational adaptability. To achieve this, systematic measures such as optimizing lightweight models, protecting privacy in federated learning, improving legislative standards, and cultivating composite talents are needed to crack the problem. Future research should focus on open world continuous learning, explainable AI decision-making mechanisms, innovative privacy computing paradigms, and human-machine collaborative governance models, promoting the development of intelligent target recognition technology towards greater autonomy, transparency, and socialization, and providing theoretical support and practical paths for building resilient urban security systems.

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