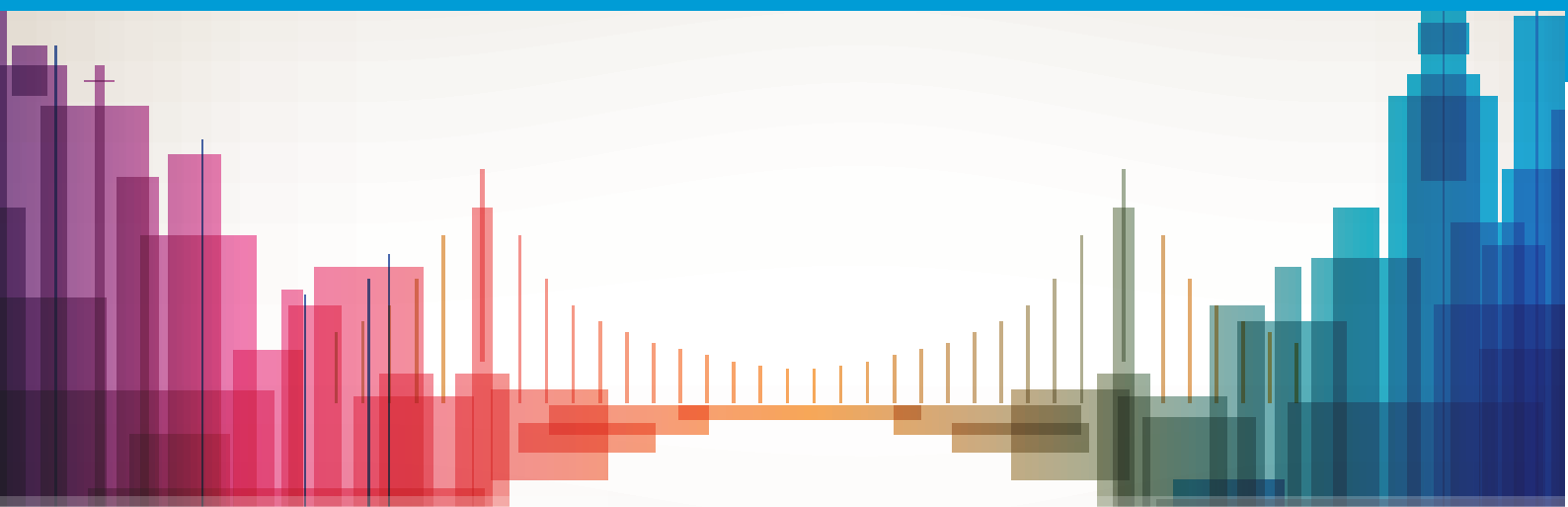




Zaozhuang High-tech Industrial Development Zone, Shandong, China (People's Republic of)

Case study of the U4SSC Guide to autonomous cities and AI: The next frontier of urban transformation



Convention on Biological Diversity



Food and Agriculture Organization of the United Nations



United Nations Economic Commission for Africa



UNECE



United Nations Educational, Scientific and Cultural Organization



FINANCE UNEP INITIATIVE



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United Nations Institute for Training and Research

UN HABITAT FOR A BETTER URBAN FUTURE



United Nations

Department of Economic and Social Affairs



UN 4 PARTNERSHIPS OFFICE



UNU EGOV



UN Tourism



UN WOMEN



WORLD METEOROLOGICAL ORGANIZATION



856.49

641.52



641.52



45.91



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**Case study of the U4SSC
Guide to autonomous cities
and AI: The next frontier of
urban transformation**



Foreword

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Disclaimer

The opinions expressed in this publication are those of the authors and do not necessarily represent the views of their respective organizations or U4SSC members. In line with the U4SSC principles, this report does not promote the adoption and use of Smart City technology. It advocates for policies encouraging responsible use of information and communications technologies (ICTs) that contribute to the economic, environmental and social sustainability as well as the advancement of the 2030 Agenda for Sustainable Development and the Pact for the Future and its Global Digital Compact.

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Abbreviations and acronyms

Abbreviation	Full form
5G	Fifth-generation mobile network
AI	Artificial intelligence
ICT	Information and communication technology
ICTs	Information and communication technologies
IoT	Internet of Things
LED	Light-emitting diode
PM2.5	Particulate matter with a diameter of 2.5 micrometres or less
PM10	Particulate matter with a diameter of 10 micrometres or less
U4SSC	United for Smart Sustainable Cities
UAV	Unmanned aerial vehicle



Executive Summary

This case study examines the implementation of the deep forest fire prevention system, the urban flood control system and the construction environmental monitoring system in the smart city of the Zaozhuang High-tech Zone. As part of the smart city initiative, the three systems aim to enhance urban safety, strengthen resilience and improve citizens' environmental quality of life. The study analyses the design, deployment and outcomes of the three systems, all of which use the AI capabilities of the City Brain platform to improve efficiency and reduce costs, assessing their contribution to natural disaster prevention, including forest fire and flood management, as well as environmental monitoring at construction sites. The case study discusses the challenges of deploying autonomous systems in complex systems of the smart city. By deploying AI-enabled applications on the City Brain platform, the Zaozhuang High-tech Zone Smart City has become one of the model projects of the Shandong Province's smart city.



1 Introduction

The Zaozhuang High-tech Industrial Development Zone (short form Zaozhuang High-tech Zone) was founded in December 1988 and officially established in November 1990, with the approval of the People's Government of Shandong Province. In February 2015, it was elevated to the status of "national High-tech Zone", with the approval of the State Council. It is the political, economic and cultural centre of Zaozhuang City, a hub for the development of high-tech industries in southern of Shandong Province, and a pilot area for national strategic emerging industries.

The Zaozhuang High-tech Zone is strategically located in the middle of the Beijing-Shanghai metropolitan area and is bordered by the scenic Nansi Lake to the west, and has four distinct seasons. It covers an area of 120 square kilometers and has three sub-district offices: Xingren County, Xingcheng and Zhang Fan, 34 villages and four neighbourhood committees, with a total population of 150 000.

2 Background and context

The Zaozhuang High-tech Zone proposes building a people-oriented, technologically innovative smart city with prosperous industries in an eco-friendly environment. Supported by extensive 5G network coverage, the initiative uses artificial intelligence technology to automate the monitoring and management of forest fire prevention, flood control and construction-site environmental conditions. This would ensure that the Zaozhuang High-tech Zone can look forward to a very bright future, and would promote the sustainable development of the Zaozhuang High-tech Zone.

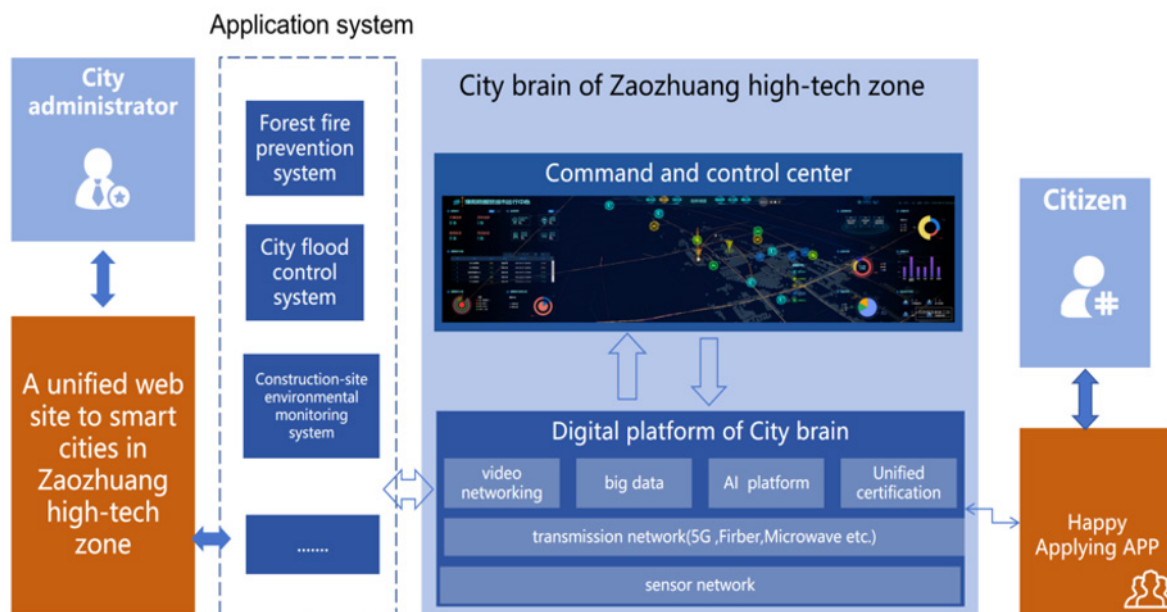
3 AI strategy approach in the city

In the "Zaozhuang City's 14th Five-Year Plan (2021-2025 for National Economic and Social Development and Outline of Long-Term Goals for 2035)", it is proposed to promote the upgrade of smart cities and accelerate the development of smart cities that are people oriented, demand driven, data driven and characteristic. It is also proposed to promote artificial intelligence, Internet of Things and other technologies in urban infrastructure, the environment, and to build dynamic monitoring, thereby improving the level of digital urban management.

Zaozhuang's urban areas have extensive 5G network coverage. With the high bandwidth and low latency of the 5G network, urban environment monitoring can be deployed remotely and information can be sent back in real time, and a closed-loop management process, covering environmental sensing, monitoring, early warning and emergency response, can be established by real-time analysis of the information with artificial intelligence technology.

4 Autonomous system adopted by the city

Figure 1 - Smart city framework of the Zaozhuang High-tech Zone (Source: Author)



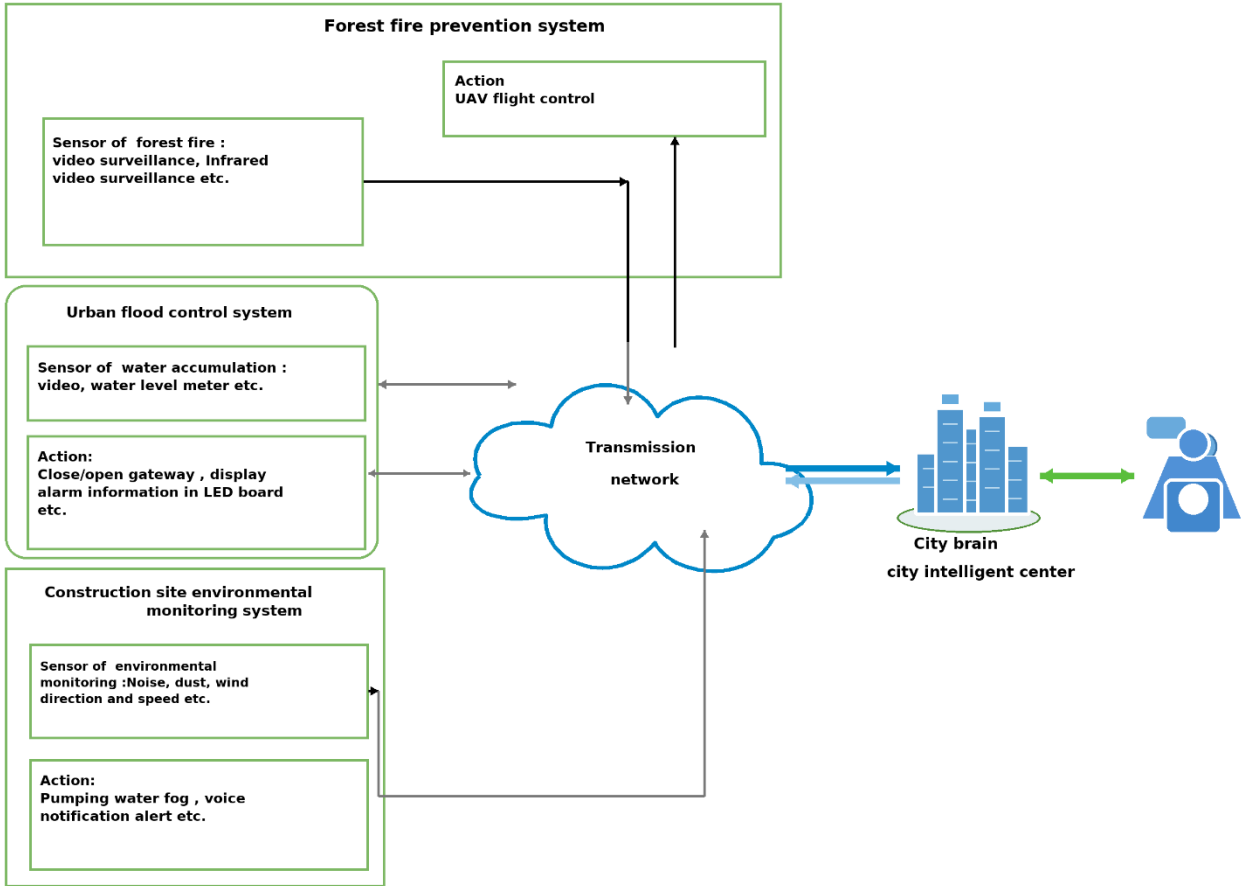
Forest fire prevention system initiative: Forest fires can spread rapidly and cause significant damage, making prevention, detection and response highly challenging. In addition, it will do great harm to life and property and is a threat to public safety.

Urban flood control system initiative: In heavy rainfall, water accumulation in water culverts and low-lying roads and so on, will have a serious impact on the safety of passing vehicles and people, and can easily lead to road traffic accidents or drowning.

Construction site environmental monitoring system initiative: Dust and noise pollution during construction can not only lead to major disputes between the construction site and nearby residents, but can also be of concern to the environmental regulatory authorities.

The City Brain (City Intelligence Centre), as shown in Figure 1, integrates artificial intelligence, cloud computing, big data, the Internet of Things and other technologies to conduct the closed-loop, full-cycle management of the urban environment (e.g., forest fires, urban water accumulation, construction site dust and noise), including monitoring, early warning and emergency response, all of which constitute autonomous systems. Please refer to Figure 2 for details.

Figure 2 - Autonomous system with decisions by people (Source: Author)

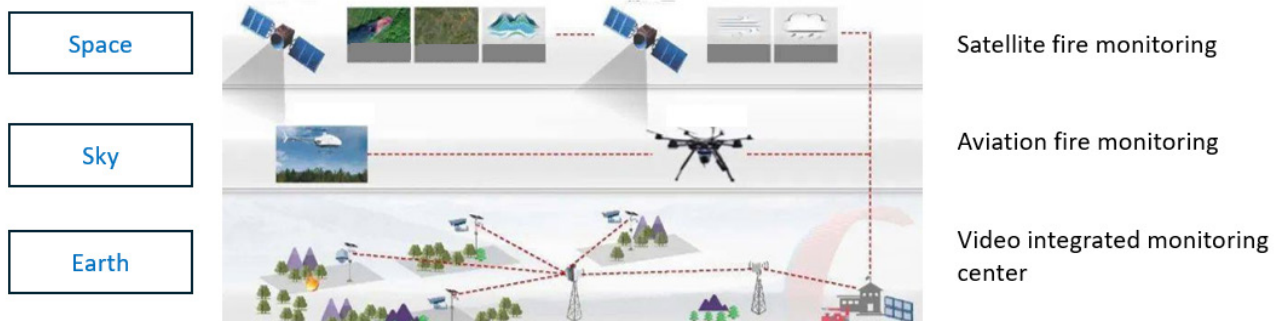


5 Implementation of the Autonomous System

- Forest fire prevention system

The forest fire prevention system is mainly composed of a front-end sensing system, a transmission network and a forest fire prevention monitoring centre. Please refer to Figure 3.

Figure 3 - Forest fire prevention system (Source: Author)



The front-end sensing system is mainly composed of a ground forest fire monitoring system, a UAV (Unmanned Aerial Vehicle) monitoring system, a man-vehicle management system in forested areas, and a satellite monitoring data access system.

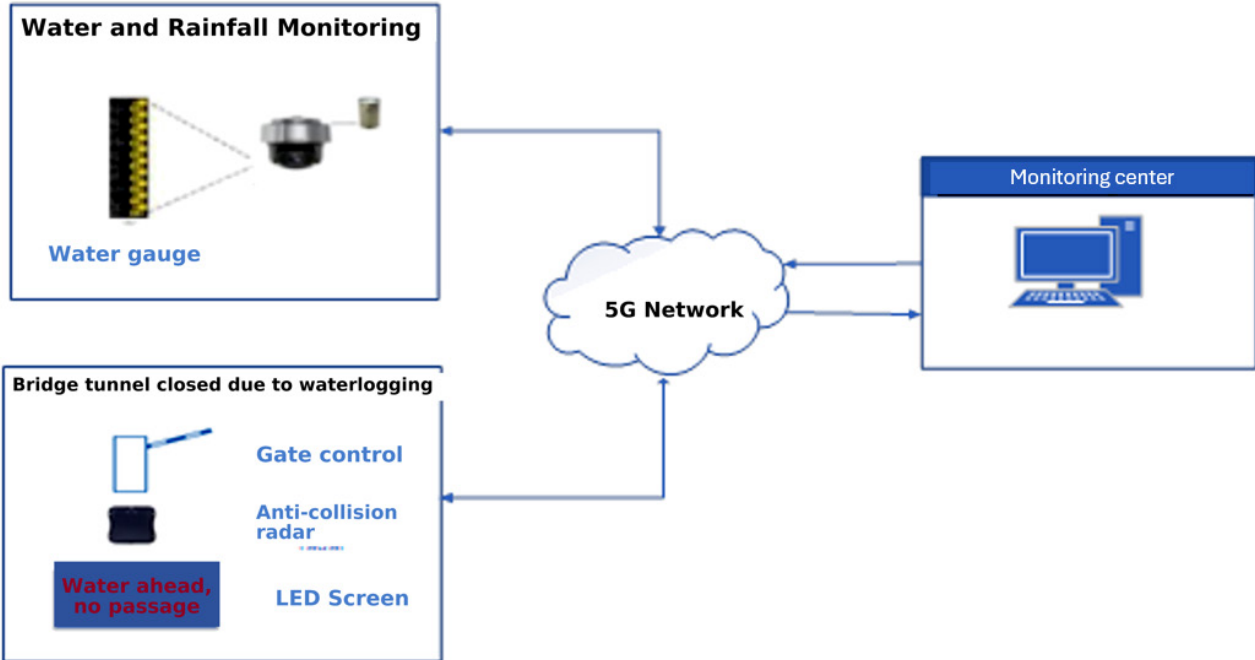
The transmission network includes, inter alia, 5G, fibre-optic and microwave networks. The 5G network may be the best choice for the Unmanned Aerial Vehicle (UAV) scenario and remote sensor information transmission.

A forest fire monitoring centre, based on the monitoring of video information, carries out image analysis using artificial intelligence technology, identifies potential fires and, after human confirmation, issues warning messages based on the fire situation, surrounding environment and staff availability. It collaborates with the relevant departments to dispatch the resources necessary to put out the fire.

- Urban flood control system

The urban flood control system consists of a road water monitoring sub-system and a flood monitoring sub-system of culverts. Please refer to Figure 4.

Figure 4 - Culvert flood control sub-system (Source: Author)



Road water monitoring sub-system: When water pools in the lowest-lying part of the road during heavy rainfall, using AI technology, the ball camera detects that the water has reached the warning depth and immediately sends text messages through a 5G network to notify the duty personnel. The front-end LED display and audio system provide real-time information on water depth.

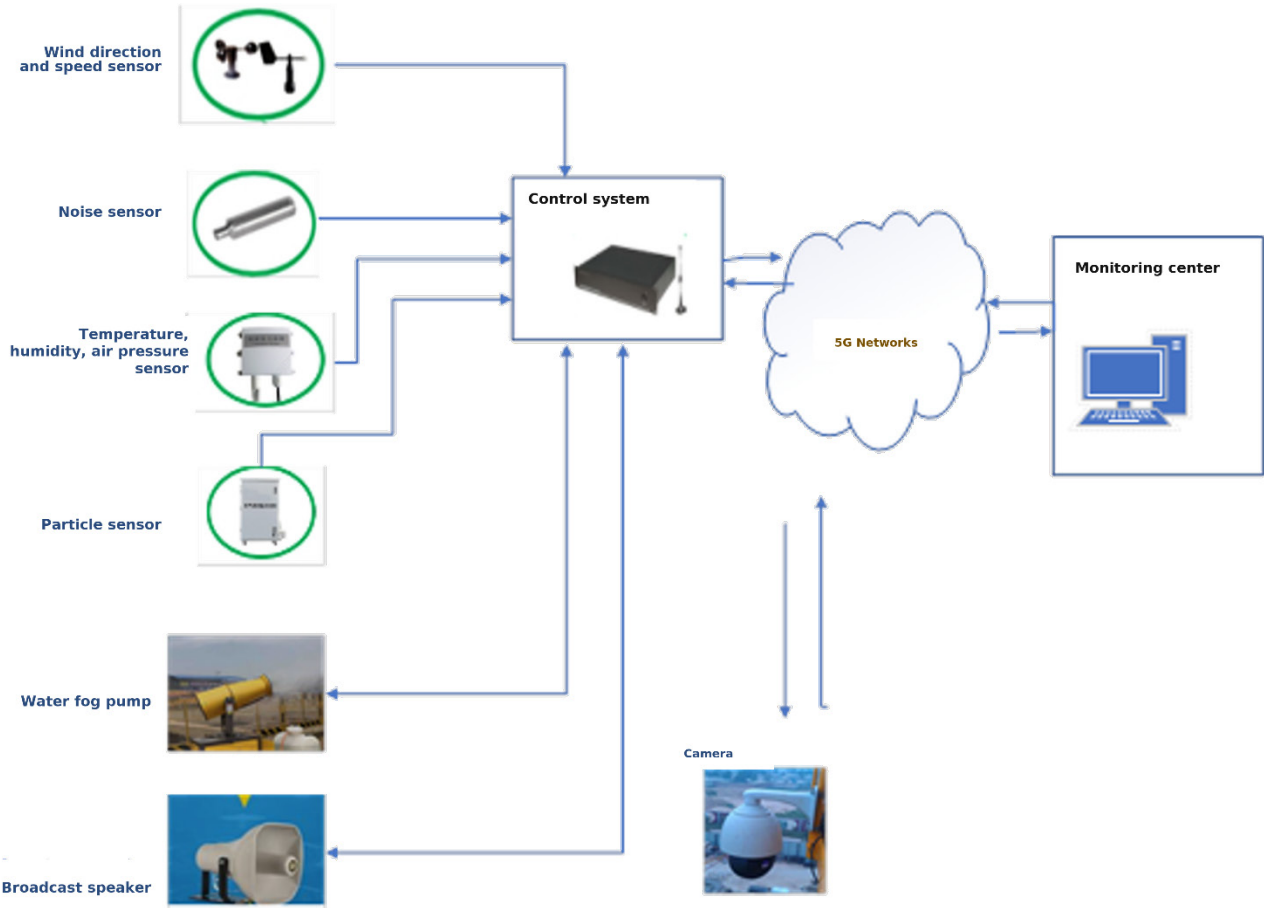
Flood monitoring sub-system of culverts: By using AI technology and a ball camera, this provides a real-time detection of water height in water culverts and low-lying roads, during rainfall. When the warning depth is reached or exceeded, the system can trigger a pop-up live monitoring screen in the monitoring centre, and at the same time can send text messages to the staff on duty. A warning message is also displayed on the LED screen on site.

Monitoring centre: For flooded culverts, using real-time video monitoring, on-duty staff can confirm that there are no pedestrians and vehicles in the area, and can then close the two side gates remotely, and stop any vehicles and people in time. Once the water has been removed, the road gates are opened remotely and the vehicles and people are allowed to pass through.

- Construction environmental monitoring system

The system is composed of a noise monitoring system, a dust monitoring system, a video surveillance system, an alarm and control system, a control system, a monitoring platform and customer terminals. Please refer to Figure 5.

Figure 5 - Construction environment monitoring system (Source: Author)



Automatic environmental noise monitoring system: Continuous monitoring of environmental noise generally requires the deployment of one or more noise monitoring stations on the site.

Automatic monitoring system of environmental dust: Continuous automatic monitoring of environmental dust, including PM10 and PM2.5 parameters.

Alarm and control system: When noise or dust levels reach or exceed permitted limits, the system can activate warning and mitigation equipment according to predefined procedures; Warning equipment, such as loudspeakers, can issue audible alerts, mitigation equipment, such as fog cannons, can spray water to suppress dust.

Video system: Regulators also need to view videos, in order to learn about pollution so that they can take the appropriate measures to control dust emissions on site, and understand the sources of these emissions.



6 Results and outcomes

By establishing a unified City Brain platform (City Intelligent Centre), we can make full use of artificial intelligence, the Internet of Things, cloud computing, big data and other technologies to monitor, provide early warning and emergency response in a closed-loop full-cycle management, and achieve the following outcomes:

- 1) Urban management units can more accurately grasp the situation of natural disasters in the city and improve the city's ability to deal with them.
- 2) The city becomes safer and more liveable, providing a good production environment for enterprises and a better living environment for citizens.
- 3) The city mobilizes stakeholders across the region to participate actively in urban services and city development, and provide better services for enterprises and residents.
- 4) The city greatly reduces the human resources required for public-service management through unified analysis, decision-making and scheduling, promoting cooperation and coordination among the High-tech Zone committees, offices and bureaus, and improve work efficiency.

7 Assessment of the autonomous system

By developing the City Brain as a unified platform, using artificial intelligence technology to uniformly process city information and emergency handling, we can not only reduce the total investment, but also improve the efficiency of the city operation. Using City Brain, a smart city can achieve real-time monitoring, early warning and emergency response processes that remain subject to human decision-making to deal with urban natural disasters throughout the day, together, these functions form AI-assisted autonomous systems. The implementation is described below:

- The forest fire prevention system enables automatic monitoring, early warning and centralized resource dispatch for forest fires, improving response times and reducing disaster-related losses.
- The urban flood control system enables automatic monitoring, warning and management of roads and culverts during rainfall, thereby helping protect people from the risks associated with heavy rainfall.
- The construction site environmental monitoring system implements automatic monitoring of noise and dust at construction sites, timely warnings and necessary response actions, which improve the livable environment of the city.

Ultimately, the above autonomous systems enable certain city services to operate continuously with AI-assisted monitoring and response, which is difficult for human beings to do, although important situations still require human beings to make final decision.



8 Conclusion

The Zaozhuang High-tech Zone has successfully developed a City Brain platform to centralize AI computing and data analysis; it has implemented applications including a forest fire prevention monitoring system, an urban flood prevention system, and a construction site monitoring system. It has established an autonomous processing loop covering monitoring, early warning and emergency response.

A key success factor is the identification of application scenarios that respond to local city conditions, combined with the active participation and cooperation of stakeholders under the leadership of the responsible department.

The problems and challenges faced are the evolution and updating of AI algorithms, which require continuous investment. It is difficult for public service applications to find a reasonable business model to support the long-term operation of application projects.

Because AI computing centres and related infrastructure are costly and a single application is difficult to bear, centralized development and shared access across different applications can help distribute investment costs, while the efficiency of the use of intelligent computing centres can be improved, which can be used as a reference for other cities.



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