Case Study

Intel® Celeron® processor
Intel® Core™ processor
Intel® Distribution of OpenVINO™ Toolkit
Intel® Video AI Box

Smart Park Solution Based on XiaoGu Technology's AI-Box Helps Create One-Stop Innovation Parks

"XiaoGu Technology and Intel have cooperated extensively in 3D vision algorithms, biological identification, security and other fields, improving security, performance, and agility. In the future, the two parties will ensure further in-depth cooperation in areas such as edge computing and IoT to continue implementing innovative technologies and provide users with a smarter life experience. "

– Chen Junyi
Chairman of XiaoGu Technology

Overview

Park owners are generally increasing investment in AI, cloud computing, Big Data, IoT, 5G and other digital innovation technologies to build smart parks and thus provide enterprises and individuals with more convenient, safe, efficient and stable services while promoting the optimal allocation of resources. Edge computing is one of the important directions for the construction of smart parks. By integrating applications such as computer vision and data analysis into the edge terminals in the park, the park can reduce construction costs and data transmission delay and also achieve higher service and network stability to meet the requirements of smart parks.

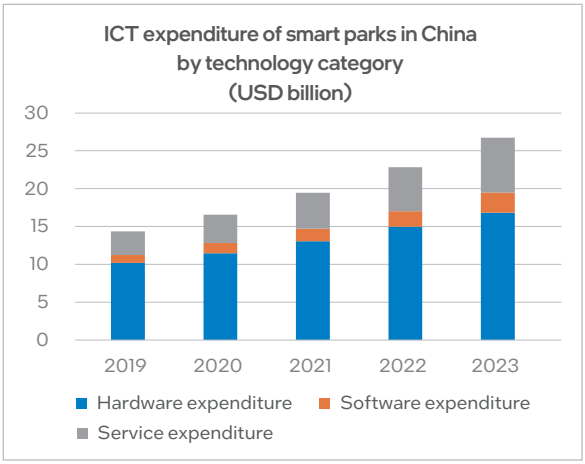
In cooperation with Intel, XiaoGu Technology has launched a smart park solution based on edge computing that provides parks with multiple functions such as gateway routing, wireless coverage, private cloud storage, media center, and smart hub to accelerate the construction of smart parks. The solution uses an edge computing terminal smart AI-Box equipped with Intel® Celeron® processor, Intel® Core™ processor, and Intel® Movidius™ Myriad™ X Vision Processing Unit (VPU), which integrate various AI algorithms such as target detection and target classification. Moreover, the deep learning inference performance is optimized through Intel Distribution of OpenVINO™ toolkit, which meets the stringent performance requirements of various AI workloads in smart parks.

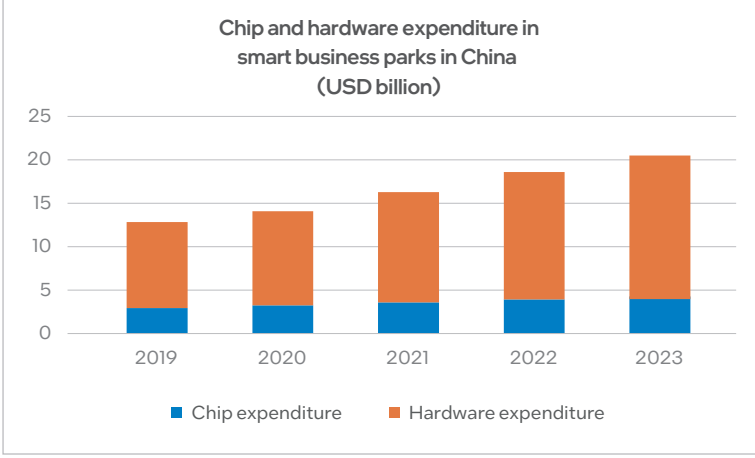
Background: rapidly developing smart parks

Development overview and trends of China's smart parks

Smart parks can be considered as an aggregation of intelligence, which is also an important part of smart cities. It not only promotes the intelligentization of applications such as security management, energy allocation, enterprise services, logistics and transportation in the park, but also attracts more and more enterprises to settle in. Parks in various regions of China are transforming according to the requirements of smart parks, and newly built smart parks generally strengthen the investment in information and communication technology (ICT). IDC data shows that from 2019 to 2023, the overall spending on ICT in China's smart parks will grow at an average annual rate of 17.4%, and by 2023, the overall spending will reach USD 29 billion[1].

[1] Computer-assisted telephone interviewing (CATI), in-depth interview, IDC analysis.





USD billion	2019	2020	2021	2022	2023	CAGR
Hardware expenditure	10.18	11.47	13.05	14.97	16.81	13.3%
Software expenditure	1.04	1.35	1.66	2.05	2.66	25.4%
Service expenditure	3.14	3.74	4.74	5.80	7.25	24.0%
Overall ICT expenditure	13.0	15.3	17.9	20.9	24.9	17.4%

USD billion	2019	2020	2021	2022	2023	CAGR
Chip expenditure	2.47	2.75	3.04	3.32	3.60	9.9%
Hardware expenditure	10.18	11.47	13.05	14.97	16.81	13.3%
Chip/hardware (%)	24.2%	24.0%	23.3%	22.2%	21.4%	/

Figure 1. 2019-2023 total expenditure on ICT and proportion of hardware and software expenditure in smart business parks in China

For park service providers, offering excellent smart park services can not only enhance the working experience and quality of life in parks, but also create safe and convenient public environments while providing competitive value-added services and enjoying greater commercial benefits.

From the perspective of ICT application, the construction of smart parks in China currently presents the following trends:

Rapid innovation and expansion of AI applications

AI is playing an increasingly important role in the current smart park system. In particular, the integration of computer vision and deep learning is giving smart parks the ability to discover, respond to and understand their dynamic environment automatically. This integration also provides park managers with efficient technical means to improve key systems such as safety management while reducing costs.

In-depth customization for smart park application scenarios

The construction needs of smart parks are expanding from large parks to small- and medium-sized parks, and even individual commercial buildings. The deployment of mature, one-stop smart park solutions can better meet the efficiency and economic needs of these users. Therefore, it is necessary for smart park solution providers to customize different solutions and meet the needs of different parks through the optimal combination of software and hardware.

Heterogeneous infrastructure

Smart parks are constantly integrating new workloads such as AI to meet application requirements in different scenarios, which leads to a rapid increase in their complexity. Under this trend, it is difficult for any single-architecture chip to meet the demand, so the heterogeneous processing capability of CPU, iGPU, VPU and other architectures will become an important requirement. Also, the infrastructure of smart parks also needs to be defined by software to dynamically change the resource allocation according to different computing requirements. This way, the infrastructure flexibly supports more scenarios while reducing deployment costs.

Cloud-edge-end realizes in-depth collaborative applications

Smart parks are characterized by the wide application of 5G, AI, and cloud-network-edge-end synergy. Based on the cloud architecture, smart parks transfer some data to the edge for processing through 5G and edge computing to shorten the data processing path, reduce the response delay of digital applications, and cut costs. This way, automatic control and decision-making of park operations are made through AI and deep learning.

Construction of smart parks empowered by edge computing

Edge computing plays an important role in the overall technical architecture of smart parks. Edge computing terminals deployed in smart parks collect and process data nearby, reduce network costs and delays caused during uploading data to the cloud, reduce data security risks caused by terminal-cloud interactions, and diminish the negative impact of network outages. At the same time, the deployment of various applications in edge nodes reduces the costs of storage, network, and transportation, among others.

Through the edge computing system, smart parks can transfer application workloads such as computer vision and AI for operation on the edge, where they can directly collect, forward, clean, aggregate, and filter data to meet the management needs of smart parks in terms of real-time response and data security. For example, a smart park can converge visual data collected by cameras into an AI box and perform AI inference through algorithms integrated in the AI box. The AI box will provided functions such as automatic security incident discovery and early warning, crowd statistics, and body temperature measurement.

Divided based on size and function, the current edge computing terminals that meet the application requirements of different scenarios include edge servers, AI boxes, and edge gateways, among others. At the same time, these edge terminals generally face the following challenges:

How to meet the huge performance demands of various workloads in smart parks

As more workloads are shifted from traditional data centers or clouds to the edge, edge terminals will face enormous performance pressure. In particular, the algorithmic models of various AI applications are becoming more and more complex, and the scale of data is growing rapidly. It will be difficult for traditional edge terminals to meet the performance requirements brought by those algorithmic models. This challenge requires edge terminals to strengthen support for innovative hardware and conduct performance optimization for AI workloads.

How to implement workload consolidation and reduce the complexity and cost of edge systems

To provide different functions, smart parks usually deploy 4G/5G routers, switches, AI boxes, IoT gateways, Network Attached Storage (NAS), and Network Video Recorders (NVR), among other devices. However, these devices add complexity to edge systems and increase the total cost of ownership/TCO. How to simplify the construction of edge systems through workload consolidation has become an important issue for parks, especially small- and medium-sized ones.

How to achieve flexible and efficient deployment

Small- and medium-sized parks also need to consider the technical efforts and time cost of edge computing system deployment. Integrating software, hardware, and AI algorithms into an all-in-one platform for unified deployment will help reduce the cost of integrating edge systems while enabling more flexible and efficient deployment.

How to ensure system stability and availability

The need to run key applications such as security management makes the stability and availability of the edge system an important requirement for smart parks. This requires the solution to cope with abnormal events, such as network interruption and network congestion, and provide services uninterruptedly.

Solution: smart park solution based on XiaoGu Technology's AI-Box

Solution overview

To help parks transform into smart parks through edge computing in an agile, efficient and inexpensive way, XiaoGu Technology has cooperated with Intel to launch a one-stop smart park solution based on XiaoGu Technology's edge computing terminal smart AI-Box. The scheme implements AI technology and products in the form of "AI algorithm + IoT smart hardware + application software + data platform", and uses 3D visualization technology to build a new smart park for IoT management and control.

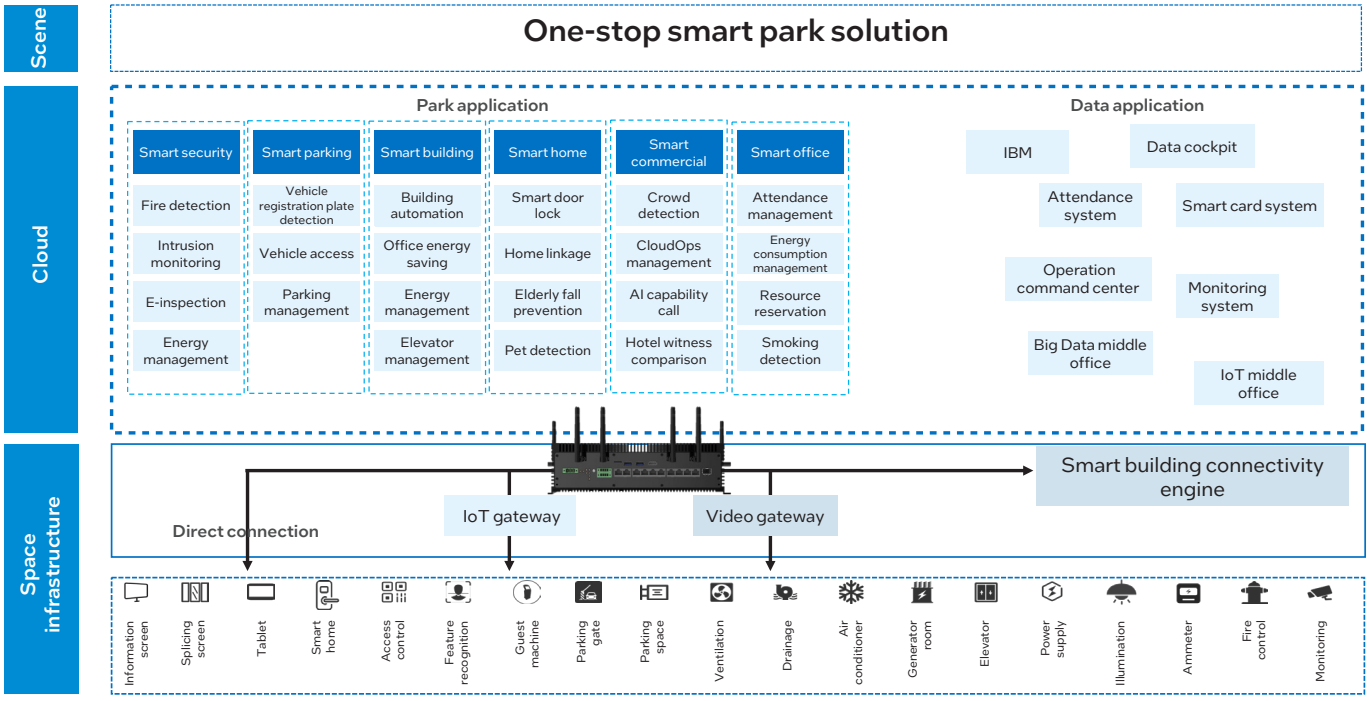


Figure 2. Architecture of XiaoGu Technology's one-stop smart park solution

With the support of this solution, users can fully access subsystems such as environmental monitoring, lighting, elevators, fire control, access control, water supply and drainage, power supply and distribution, as well as IoT equipment and facilities. Also, users can incorporate these subsystems into a unified management system and collect data from them and equipment to achieve data-driven services. After processing and analyzing the data, the solution also helps users build a unified data operation management center; provides a unified entrance; displays the core system operation indicators and alarm fault information that managers are concerned about; and provides a quick overview of each system and quick function entry together with its visualization.

Specifically, the solution covers the following subsystems to meet the different needs of smart parks:

- **Environmental monitoring system:** Taking the IoT as the network, it comprehensively captures environmental protection data and monitors environmental factors such as temperature, humidity, air quality, light, and rainfall in parks. Also, the system strengthens the environmental perception ability, expands the capacity of information resource sharing, and provides other systems in the parks with data support.
- **Video security management system:** It supports functions such as access security management, smart access control management, and key area situation management. Moreover, the system offers alarm linkage, improves the emergency response capability of park managers, and increases the overall security level of parks.
- **Smart fire control system:** It can cover key areas such as fire escapes with video coverage. When a fire emergency arises, the system automatically triggers a variety of early warnings to improve the fire control effect and reduce the investment of human and other resources.
- **Smart pedestrian system:** It provides a one-code access solution that aggregates access permissions. Park residents can pass automatically after obtaining authorization, which boosts traffic efficiency.

- **Smart car system:** It manages multiple parking companies in a unified way. Linked to the one-stop platform, it realizes the intelligent transformation and automation of the entry and exit of vehicles.
- **Energy management system:** It centrally displays the overview of energy use and flow in the area, showing comprehensive energy usage, energy efficiency, cost composition, etc. The system can also manage the key energy infrastructure in the area, including various power distribution rooms, transformer substations, water and gas. When an abnormal event occurs, the energy management system activates the alarm and work tickets mechanism to track processing. Also, it offers prepaid and centralized meter reading management applications and performs energy efficiency analysis.
- **Elevator management system:** It conducts real-time management of elevators, reminds automatically of maintenance time, and triggers an automatic alarm when a fault occurs.
- **Smart charging station system:** It provides a smart, safe and stable group charging and group control charging mode, and provides reliable technical support for efficient charging services.

XiaoGu Technology's one-stop smart park solution also provides smart linkage between different systems and equipment, and builds a novel experience in smart energy saving, smart security, smart fire control, smart traffic, and smart environment.

XiaoGu Technology's edge computing terminal smart AI-Box

As the core carrier of the smart park solution, XiaoGu Technology's edge computing terminal smart AI-Box is a smart gateway product for multi-functional and multi-scenario applications such as video surveillance analysis, commercial display access, and wireless network coverage. The smart gateway integrates functions such as gateway routing, wireless coverage, private cloud storage, media center, and smart hub to create the core brain of future smart AI scenarios.

XiaoGu Technology's edge computing terminal smart AI-Box supports WiFi 6, BLE5.0, Zigbee3.0 multiple protocol with wireless coverage, HDMI output, 802.11at POE power supply, data storage, and encryption. AI-Box integrates the video codec and control processing capabilities of Intel® Movidius™ Myriad™ X VPU, Intel® Celeron® processor, and Intel® Core™ processor, and uses self-developed AI algorithms for target detection and classification for urban, community, and industrial parks. The detection and identification of people, vehicles and objects effectively improves the price performance and analysis efficiency of video surveillance and enhances the flexibility and diversity of algorithm transplantation. The access capability of a variety of wireless communications provides complex network environments with the best networking solution. Also, it effectively reduces the difficulty and cost of wireless networking.

Taking into account the different performance and functions requirements of smart parks, XiaoGu provides two product options, namely AI-Box Basic and AI-Box Pro:

- **AI-Box Basic**

  The AI box is equipped with an Intel® Celeron® N3450 processor and Intel® Movidius™ Myriad™ X CPU MA2485. Moreover, the memory is integrated on the chip, and the box supports HDMI, SD card expansion, RS232 serial port, WiFi, LTE, power supply, RJ45, and other interfaces. The AI-Box Basic acts as an edge server to connect multiple IP cameras through a router and then sends the processed structured data to the monitoring and analysis platform.

  Overall, the advantages of the AI-Box Basic include: small size, rich interface, easy to use, multi-architecture mode, high performance, powerful AI inference performance, multi-platform support, and flexible deployment. In actual networking, the AI-Box Basic can be used in conjunction with the router to accept the visual data collected by the camera and forwarded by the router, and process the data. These data can also be transmitted to the monitoring and analysis platform in the cloud for further analysis to build a cloud-edge-end converged application architecture.

Figure 3. XiaoGu Technology's edge computing terminal smart AI-Box Basic

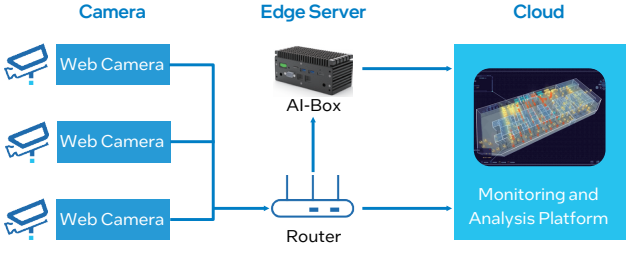


Figure 4. Typical deployment pattern of XiaoGu Technology's edge computing terminal smart AI-Box Basic

AI-Box Pro

Equipped with an Intel® Core™ i5 processor and Intel® Vision Accelerator Design based on Intel® Movidius™ Myriad™ X VPU MA2485, the AI-Box Pro can replace many different types of equipment required in traditional solutions, such as 4G/5G routers, switches, AI boxes, IoT gateways, Network Attached Storage (NAS), Network Video Recorders (NVR), etc. The AI-Box Pro helps customers reduce total cost of ownership/TCO and long-term maintenance costs. As an edge server, the AI-Box Pro also provides a variety of wireless network coverage capabilities, supports HDMI connection to commercial displays, and supports POE to power peripheral devices. In the event of abnormal Internet connection, it automatically switches to a mobile communication network.

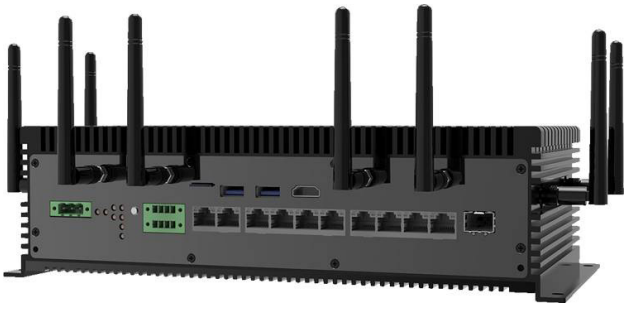


Figure 5. XiaoGu Technology's edge computing terminal smart AI-Box Pro

The advantages of the AI-Box Pro include:

- **Fanless design:** It adopts high-density cooling teeth for fanless cooling, and the reinforced aluminum metal casing has stronger advantages against corrosion, rust and interference, and avoids noise and dust pollution;
- **Full on-board components:** They include better compatibility, better stability, and strong industrial-grade seismic resistance;
- **Cableless design:** The whole machine is connected without cables, which improves the manufacturing quality and ensures product integrity and reliability;
- **Easy layout:** The whole machine is small in size, not limited by space, safe and easy to maintain.

XiaoGu Technology's edge computing terminal smart AI-Box integrates routing, gateway, management, and various AI algorithms such as target detection and target classification to meet different management needs. For example, XiaoGu's edge computing terminal smart AI-Box can integrate a fall detection algorithm and will automatically issue an alarm after a fall is detected so that relevant personnel can deal with it in a timely manner and thus protect the life and health of users.

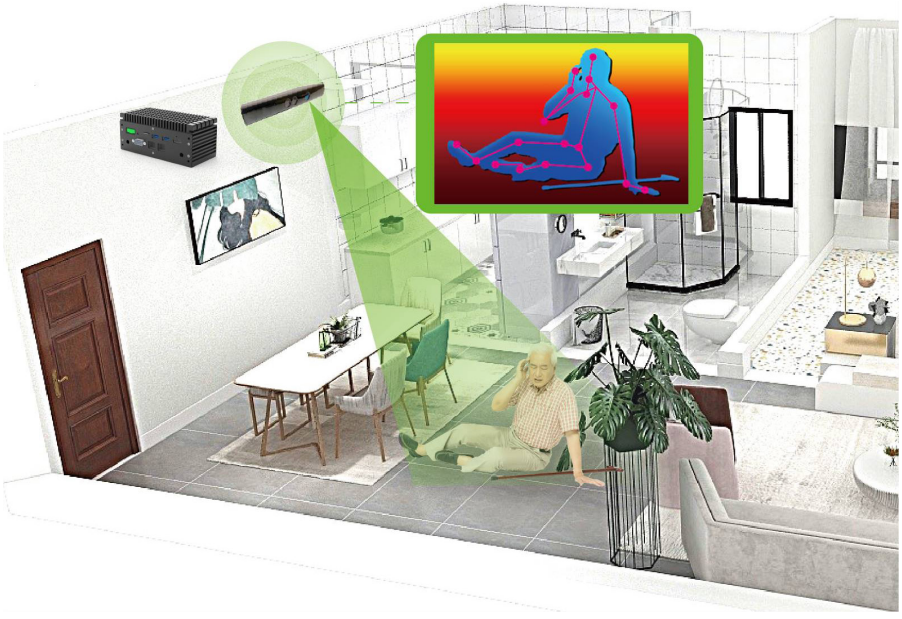


Figure 6. XiaoGu Technology's edge computing terminal smart AI-Box Basic integrates a fall detection algorithm

Integrated Intel technology for higher performance and flexibility

The Intel® Celeron® processor and Intel® Core™ processor integrated in XiaoGu Technology's AI-Box Basic and AI-Box Pro support different operating system platforms and a wide range of workload requirements, providing users with a wide range of product performance options. These processors not only have powerful computing power and good price performance, but they are also cost-effective, safe and reliable. Based on these processors, XiaoGu Technology's AI-Box Basic and AI-Box Pro can fully perform the functions of computing, storage and forwarding of large amounts of data under the constraints of edge scenarios. In addition, they support the reliable and stable operation of edge systems.

Intel® Movidius™ Myriad™ X VPUs feature a neural computing engine designed to run neural networks based on deep learning rapidly and efficiently without sacrificing accuracy. While ensuring low power consumption, VPUs provide a powerful SHAVE DSP, multi-core heterogeneous/homogeneous on-chip memory, and fixed-function imaging and vision accelerators to realize high-speed neural network operations and powerful image processing capabilities.

XiaoGu Technology's test data shows that after using the Intel chip, the Ethernet port transmission speed of XiaoGu Technology's edge computing terminal smart AI-Box reached 950MB/s, the overall score of the processor performance was as high as 39985, and the USB3.0 read and write speeds reached 111.2 (MB/s) and 113.7 (MB/s), respectively[2].

XiaoGu Technology also uses the OpenVINO™ toolkit for model conversion and optimization of the models trained on the PC side. Moreover, XiaoGu deploys the toolkit on the edge through its edge computing terminal smart AI-Box. Based on the latest generation of artificial neural networks, including convolutional neural networks (CNN), recurrent networks, and attention-based networks, OpenVINO™ toolkit is capable of scaling computer vision and non-visual workloads across Intel hardware to maximize performance. Also, it speeds up applications through the high-performance deep learning inference deployed from the edge to the cloud.

XiaoGu Technology's performance testing on a variety of AI models shows that the OpenVINO™ toolkit ensures a one-fold performance acceleration of Intel platforms. Combined with innovative hardware, AI-Box can reach a 19-fold performance improvement in computer vision-related deep learning[3].

In addition, for the design requirements of AI-Box, Intel also provides Intel® Video AI Box and a series of development and tuning tools including Intel® Media SDK and Intel® System Studio, which help developers and customers to choose flexibly, optimize deployment, reduce development time and cost, and support diversified computing needs and application scenarios. Intel® Video AI Box can effectively carry the high-density computing workload required for applications such as intelligent video analytics and thus provide edge AI with more outstanding computing power.

Figure 7. Intel® Video AI Box

[2,3] Data from internal test results of XiaoGu Technology.

Applied practice: efficiently meet a variety of workload requirements

XiaoGu Technology's edge computing terminal smart AI-Box has already been used in many parks for multi-person thermal imaging temperature measurement systems, data access and analysis management, among other applications. The AI-Box plays an important role in the construction of smart parks.

Smart temperature measurement at Intel Tech House exhibition hall

The exhibition hall uses XiaoGu Technology's edge computing terminal smart AI-Box to carry the multi-person thermal imaging temperature measurement system, which is deployed in the access gate. The deep neural network inference algorithm integrated into the AI-Box can replace the manual hand-held thermometer and effectively measure body temperature in a "contactless" way. The measurement system supports a self-defined alarm for abnormal body temperature, second-level detection speed, real-time uploading of temperature measurement data, and centralized management to strengthen the venue's pandemic prevention.

Figure 8. XiaoGu's multi-person thermal imaging temperature measurement system deployed at the Intel Tech House exhibition hall during an international sporting event

3D visual center platform for smart park projects

Smart parks carry the building information model (BIM) through the edge computing terminal smart AI-Box and integrate visitor information, vehicle and parking space information, work order information, electronic fence information and other data into the unified management platform based on AI-Box. The data is instantly analyzed in the edge platform and displayed on the big screen through the data visualization system, which plays an important role as a "management center."

Figure 9. 3D visual center platform

In general, XiaoGu Technology's edge computing terminal smart AI-Box brings the following benefits to smart parks:

- AI algorithms such as target detection and target classification ensure rapid AI analysis of multi-channel videos and timely alarms.
- Integration of functions such as AI analysis and networking reduces the infrastructure construction and transformation requirements for reduced TCO.
- High reliability in industrial scenarios; fully on-board components; cable-free design and simplified layout; wide temperature ranges; high corrosion, rusting, and interference resistance; and noise and dust pollution prevention, all provide systems with improved stability and availability.

Outlook: helping build one-stop smart parks

Smart park development is an ongoing process that is critical to future economic growth, civic engagement and service delivery. Driven by digital innovation technologies, more and more industrial parks are evolving into smart parks, which can be achieved through the deployment of intelligent equipment; implementation of intelligent applications and intelligent-driven strategies; and allocation of space, energy, data, human resources and other resources. In addition, the construction, management and operation mode of parks is reshaped for the sake of the interconnection and open sharing of their different modules.

At present, XiaoGu Technology is committed to integrating more and more advanced AI algorithms in its smart park solution for the application of smart parks in multiple scenarios. For example, XiaoGu Technology's AI-Box integrates the algorithm for the detection of battery-powered vehicles entering elevators; accesses the image data of elevator network cameras for AI analysis; accurately detects battery-powered vehicles that are prohibited from entering elevators; and excludes bicycles, strollers, wheelchairs, and other objects to better meet compliance requirements and reduce the safety hazards brought by battery-powered vehicles. The AI-Box also provides camera occlusion alarm, voice intercom, and sound and light warning functions to make elevators safer.

XiaoGu Technology will deepen cooperation with Intel-related ecosystem partners and deeply research 3D vision technology and edge computing capabilities based on Intel chips; realize the implementation of AI technology and products in the way of "AI algorithm + IoT smart hardware + application software + data platform"; and use 3D visualization technology to build a new smart park for IoT management and control.

Through close cooperation with ecosystem partner XiaoGu Technology, Intel is helping to build a future-oriented smart park core service and infrastructure for builders and operators to conduct strategic design. Intel also offers an edge-to-cloud framework with options for infrastructure. By sharing best practices and driving innovation in IoT, networking and communications, applications, data management, computing, analytics and security in smart cities, Intel technology fully meets the economic, social, and environmental needs of cities and parks.

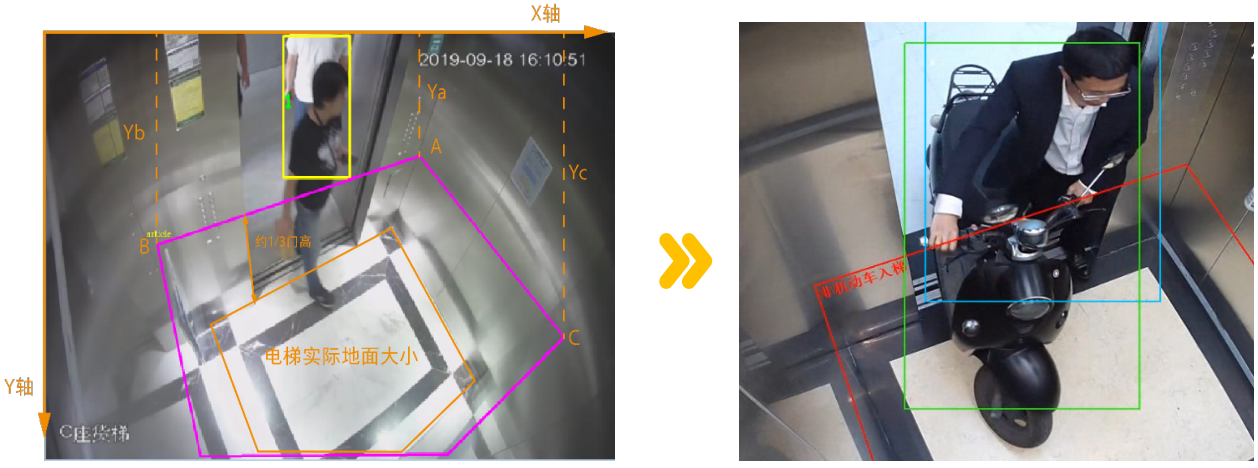


Figure 10. Detection algorithm of battery-powered vehicles entering elevators

About XiaoGu Technology

XiaoGu Technology is an AIoT service provider that provides AI edge computing solutions. Focusing on the research, development, and application of computer vision and embedded AI, XiaoGu Technology is committed to delivering performant, low-cost, energy efficient, and small-size embedded AI software and hardware solutions to realize the integration of visual perception and computing.

XiaoGu Technology digs deep into 3D vision technology and focuses on cutting-edge 3D vision algorithms such as 3D biometric spoofing, 3D feature recognition, 3D gesture recognition, 3D feature attribute analysis, and 3D head detection. To meet the needs of smart parks, smart communities, smart security, smart hotels, smart retail, vehicle security and other scenarios, XiaoGu Technology will create smart products for human-computer interaction based on 3D vision technology.

About Intel

Intel (NASDAQ: INTC) is an industry leader that focuses on developing technologies that change the world, drive global progress, and enrich human lives. Driven by Moore's Law, Intel is dedicated to the continuous innovation of semiconductor design and manufacturing to provide customers with solutions to major challenges. By integrating intelligence with the cloud, network, edge, and various computing devices, Intel unlocks the potential of data and helps improve both business and society. For more information on Intel innovation, refer to our China News Center at newsroom.intel.com and our official website at intel.com.