Case Study

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

Shentu Zhian Smart Community Solution by TruthVision Technology Based on Intel® Architecture

"Smart communities strongly demand for AI for large-scale development and strong reproducibility. Aiming at the huge potential of smart communities, TruthVision Technology uses a large resource-intensive and technologically profound platform like Intel and integrates software and hardware products including CPU and OpenVINO™ toolkit to provide users with high performance, high scalability, high and stability, and excellent price performance of AI analysis products. Also, TruthVision Technology is committed to introducing AI technology and its efficiency to every enterprise and individual around the world."

– Xu Biao
CEO of TruthVision Technology

Overview

Traditional communities are transforming into smart communities driven by digital innovation technologies such as artificial intelligence (AI), IoT, Big Data, and computer vision. Relying on the collection, processing and analysis of data, smart communities can generate a visualized view of the community environment and quickly react to situations. While providing efficient and intelligent management methods for community managers, smart communities also provide residents with a safe, comfortable and convenient living environment.

Video analytics plays an important role as a basic technology for the construction of smart communities. Intelligent video analytics systems can collect visual data of management objects such as people, cars, and public facilities in a community through cameras and other equipment. Then, those systems perform automated and intelligent transformation analysis through servers and gateways to generate intelligent data insights. In the long run, intelligent video analytics systems have proven to effectively assist in the creation of excellent communities and park environments and meet the needs of users in perimeter intrusion detection, parking violation detection, garbage management, and public facility management.

Shanghai TruthVision Information Technology Co., Ltd. (hereinafter referred to as "TruthVision Technology") has launched the Shentu Zhian Smart Community Solution based on Intel® architecture. This solution includes an intelligent video analytics system equipped with an Intel® Xeon® Scalable processor/Intel® Core™ processor. It can be connected to a network camera for video surveillance, motion analysis and feature classification of abnormal events in a single or multiple video surveillance areas. Also, it can store alarm information and images for a long time to realize intelligent transformation, automated event discovery and push processing.

Video Analytics Accelerates the Transformation of Smart Communities

Community management is the basic unit of city management and is also known as the "last mile" of urban refined governance. It is of great significance for improving management efficiency and residents' well-being, and also promoting industrial transformation. Traditional communities are accelerating their transformation into smart communities thanks to technological innovations and rapid economic development.

The smart community is a model of community construction and development characterized by the extensive use of Information and Communications Technology (ICT). ICT is used to improve the organization and deployment of space, energy, data, and human resources, and reshape the construction, management, and operation models of communities. Realizing the interconnection and open sharing of different modules in the community and driving the implementation of smart applications in the community is of great significance for promoting

social transformation. Smart communities improve the intelligent transformation of community management and provide their residents with safer and more convenient services.

Statistics show that China's urban population is growing continuously along with the number of communities. The vast majority of these communities are traditional, and a considerable part of these traditional communities are, or are planning to transform into smart communities. This tendency is pushing the construction of China's smart communities into a new era. Data shows that the scale of China's smart community market reached RMB 500 billion[1] in 2020 and it is expected to grow into a trillion-scale market.

An AI-based intelligent video analytics system represented by "AI + Smart Management" plays an important role in the construction and operation of smart communities. By means of the ResNet framework, Fast R-CNN, YoloV3, VGG, AlexNet, FaceNet, and other models for training, video service providers can integrate biometrics detection, abnormal behavior detection, vehicle detection, vehicle registration plate detection, high-altitude parabola detection, among other algorithms into their video analytics platforms to provide timely and effective insights and help achieve efficient community management.

Intelligent video analytics helps communities solve problems such as poor management, high human resource costs, and low response speed. For example, in traditional video management scenarios, staff on duty cannot guarantee an extensive inspection and may miss a large amount of screen content after some time. Therefore, simple video management can only be used for retrospective evidence collection and cannot be retrieved in real time.

Driven by policies such as "Opinions on Strengthening and Improving Urban and Rural Community Governance" and "Guiding Opinions on Comprehensively Promoting the Reconstruction of Old Urban Communities," AI + video analytics has achieved rapid development in the construction of smart communities. The "2021 China AI + Security and Protection Industry Report" released by iResearch Consulting Group shows that in 2020, the AI + security software and hardware market scale in the community building sector exceeded RMB 5 billion. Also, AI security is expected to maintain rapid and stable development in the community building sector in the next few years, reaching RMB 16.4 billion in 2025[2].

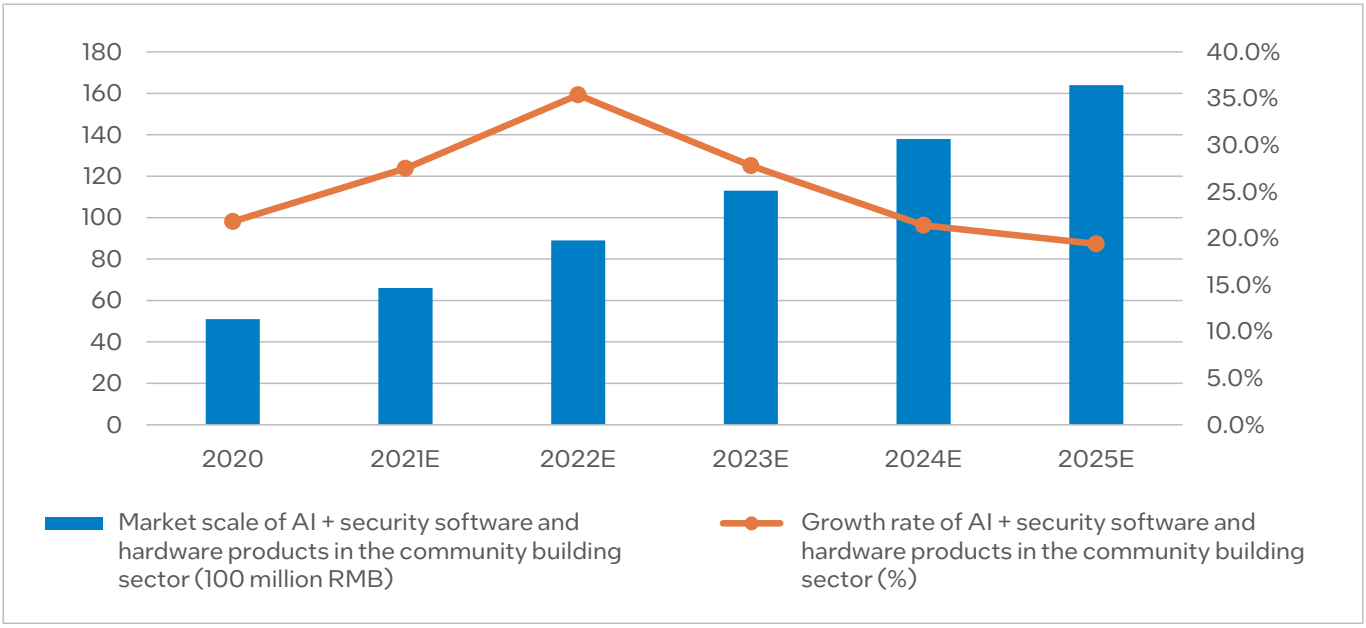


Figure 1. 2020-2025 market scale of AI + security software and hardware in China's community building sector

[1] Data from: "AIoT Drive Technology Real Estate Industry Report".

[2] Data from the "2021 China AI + Security and Protection Industry Report".

Important Trends in the Development of Smart Community Video Analytics Systems

Along with the rapid development of the market, intelligent video analytics systems for smart communities show the following trends:

Achievement of Cloud-Edge-End Convergence

Video analytics applications deployed at the edge can assist smart communities in deploying lightweight applications to clean, preprocess, aggregate, and filter data directly at the edge. This way, these video analytics applications reduce data processing pressure in the cloud and data centers, save network bandwidth, and increase application response speed in specific environments. At the same time, the preprocessed data at the edge can be transmitted to the cloud for further analysis. The cloud can train the model and send the trained version directly to the edge for inference.

The cloud-edge-end converged architecture realizes the uniformity of hardware platform and cross-architecture orchestration of resources, as well as introduces optimized software systems. These features will give the infrastructure enormous flexibility and realize the automatic elastic scaling of resources so that the cloud can empower the network and the edge side and ultimately accelerate business innovation and value realization.

High Integrated and Lightweight Design

Video analytics application scenarios in smart communities determine that their power consumption, space occupation and cost are restricted. Through a highly integrated design, these applications help communities to meet the needs of end users in terms of power consumption and space, while also reducing deployment and tuning barriers and saving time. Moreover, thanks to the continuous improvement of hardware computing power and the optimization of deep learning models, even lightweight terminals such as edge computing boxes could also undertake more complex AI inference tasks.

Traditional Visual Load and AI Load Integration

Users mainly expect video analytics systems to reduce costs and the complexity of operation, maintenance, and deployment. With the improvement of hardware performance and architecture, video analytics systems are expected to reduce the high costs of infrastructure deployment by integrating video capture, video decoding, access control and building intercom, license plate detection barriers and other applications at the edge. At the same time, due to the complexity of workloads, video service providers need to implement cross-architecture development and deployment to gain greater agility and flexibility.

Challenges Faced by Smart Community Video Analytics Systems

For new smart communities or traditional communities that are transforming into smart communities, the deployment of intelligent video analytics systems cannot be accomplished overnight and the process faces the following challenges:

- Replacing a large number of non-smart cameras already deployed in the community with smart cameras would result in a waste of old resources and money.
- Using traditional solutions imposes a heavy burden on the cloud and networks for AI inference workload like image detection, which may result in service instability or interruption.
- Applying traditional solutions brings obstacles and restrictions in terms of flexibility, cost, and scalability of smart video systems.

Shentu Zhian Smart Community Solution by TruthVision Technology based on Intel® Architecture

The core products of TruthVision Technology's Shentu Zhian Smart Community Solution are the video analytics terminals deployed at the edge, which include the TIVS6500-TR0 Intelligent Analyzer for large communities and the TIVS6500-PG8I Intelligent Analyzer for small and medium-sized communities. The solutions include the Shentu Zhian Cloud Service Platform and Shentu Zhian App, which can perform video positioning, motion analysis, feature classification, and accurate monitoring of abnormal events in a single or multiple areas. The solutions also save event information and images for a long time to provide managers with accurate and comprehensive information support.

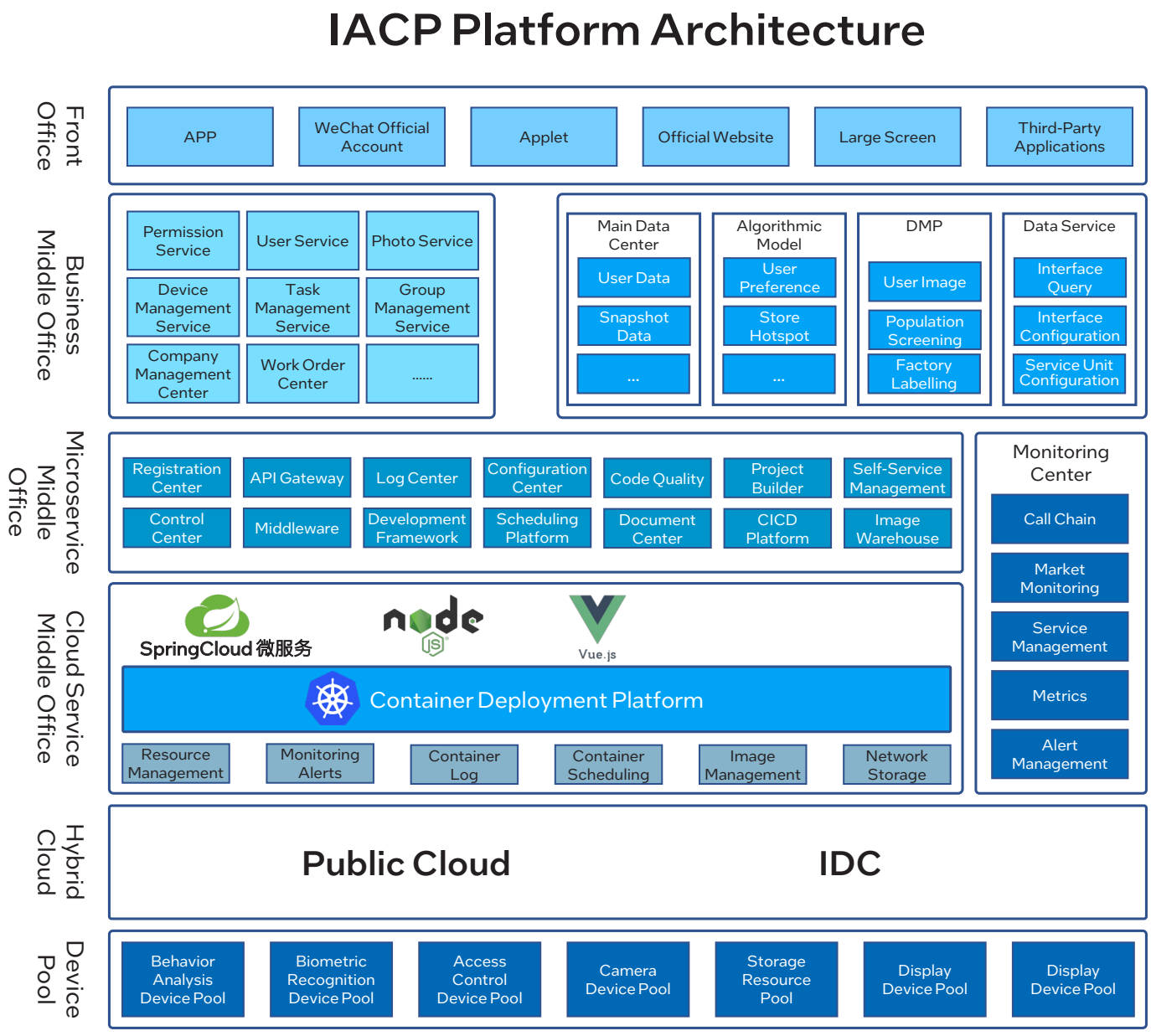


Figure 2. Architecture of TruthVision Technology's Shentu Zhian Smart Community Solution

- Shentu Zhian TIVS6500-TR0 Intelligent Analyzer

The Shentu Zhian TIVS6500-TR0 Intelligent Analyzer adopts an edge server architecture, which is compatible with 99% of the camera video access in the market and can support up to 48 channels of deep-learning-based video analytics to help users deal with various unfavorable situations in actual large-scale applications. It covers algorithms such as perimeter intrusion detection, detention area detection, high climbing detection, parking violation detection, bicycle/electric vehicle parking violation detection, customized vehicle detection, road violation detection, littering detection, high-altitude parabola detection, etc.

Figure 3. Shentu Zhian TIVS6500-TR0 Intelligent Analyzer

The Shentu Zhian TIVS6500-TR0 Intelligent Analyzer is equipped with Intel® Xeon® Scalable processors that deliver cutting-edge performance, memory bandwidth, and built-in AI acceleration capability for high-performance computing, AI applications, and high-density computing. Intel® Deep Learning Boost (Intel® DL Boost) with vector neural network instructions (VNNI) significantly improves AI inference, making it an excellent infrastructure for deep learning applications.

- Shentu Zhian TIVS6500-PG8I Intelligent Analyzer

The Shentu Zhian TIVS6500-PG8I Intelligent Analyzer is mainly used for smaller-scale smart community application scenarios. It is compatible with 99% of the camera video access in the market and can support up to 8 channels of deep-learning-based video analytics. It covers algorithms such as perimeter intrusion detection, detention area detection, high climbing detection, and parking violation detection. Compared with the TIVS6500-TR0, the TIVS6500-PG8I Intelligent Analyzer adopts an edge computing box architecture with lower cost, size, and power consumption to better meet the needs of smaller scale users.

Figure 4. Shentu Zhian TIVS6500-PG8I Intelligent Analyzer

The TIVS6500-PG8I Intelligent Analyzer is based on the Intel® Video AI Box reference design, which fully integrates leading Intel® hardware, software, and AI algorithms to help both partners and end customers at all levels to accelerate the development and design of edge AI applications through mature platform-level functionality.

The TIVS6500-PG8I Intelligent Analyzer is equipped with the 11th generation Intel® Core™ mobile processor and Intel® Iris® Xe graphics. The processor uses Intel's sophisticated processing technology and redesigned core architecture. Also, it has built-in AI functions to achieve high execution performance. The Intel® Iris® Xe graphics card is equipped with Intel® DL Boost technology, which can provide reliable support for the AI engine, effectively shorten the workload processing time, and improve the system's computing capability. This processor has a powerful and flexible architecture that can provide rich data type support including floating-point 32-bit, floating-point 16-bit, integer 32-bit, integer 16-bit, and integer 8-bit, as well as multiply-accumulate (MAC) operation with the help of single instruction and multiple data (SIMD) instruction set.

Device Model	TIVS6500-PG8I	TIVS6500-TR
CPU	Intel® Tiger lake UP3	Intel® Xeon® Silver 4216
RAM	8 GB	64 GB
Deep Learning Frameworks and Models	Darknet/Yolo v3	Darknet/Yolo v3
Actual Inference Device	CPU	CPU
Performance Goal (FPS)	25	25
Actual Performance (FPS)	10-25	25
Inference Delay (Latency)	1.2ms	0.2ms
Video Channels	8	48

Table 1. Configuration and Performance of Shentu Zhian Video Intelligent Analyzers[3]

Software Innovation and Optimization

As early as 2016, TruthVision Technology launched a new generation of self-developed intelligent video analytics engines TAIP (training and assessment in practice) to automate internal deep learning calculations, data resource management, and algorithm training processes. At present, TruthVision Technology has five core technologies: original and independent expert system and deep learning fusion technology, 2D image to 3D scene modeling, complex scene multi-target tracking, expert system body model, and complex scene anti-jamming learning. These original AI technologies are applied in smart analytics systems so that they can eventually serve platform-based products and improve product experience and quality.

TruthVision Technology's Smart Community Solutions can be extended to 30+ algorithms, including:

- **Perimeter Intrusion Detection:** detects illegal entry to and exit from the perimeter of a designated area and gives warnings or reminders.
- **Water Intrusion Detection:** detects illegal entry to and exit from the perimeter of an area with water and gives warnings or reminders.
- **Parking Violation Detection:** monitors motor vehicles/non-motor vehicles staying illegally in a designated area and gives warnings or reminders.
- **Specific Vehicle Detection:** performs target detection of construction trucks and gives signals or reminders to attract attention.
- **Vehicle Registration Plate Detection:** performs identity authentication for import and export vehicles, cooperates with access control management systems, and authorizes access of vehicles.
- **Stacking on Road Detection:** detects items stacked in a designated area exceeding a certain time and gives signals or reminders to attract attention.
- **Litter Detection:** detects littering behavior in a designated area and gives signals or reminders to attract attention.

[3] Test data from internal test results of TruthVision Technology.

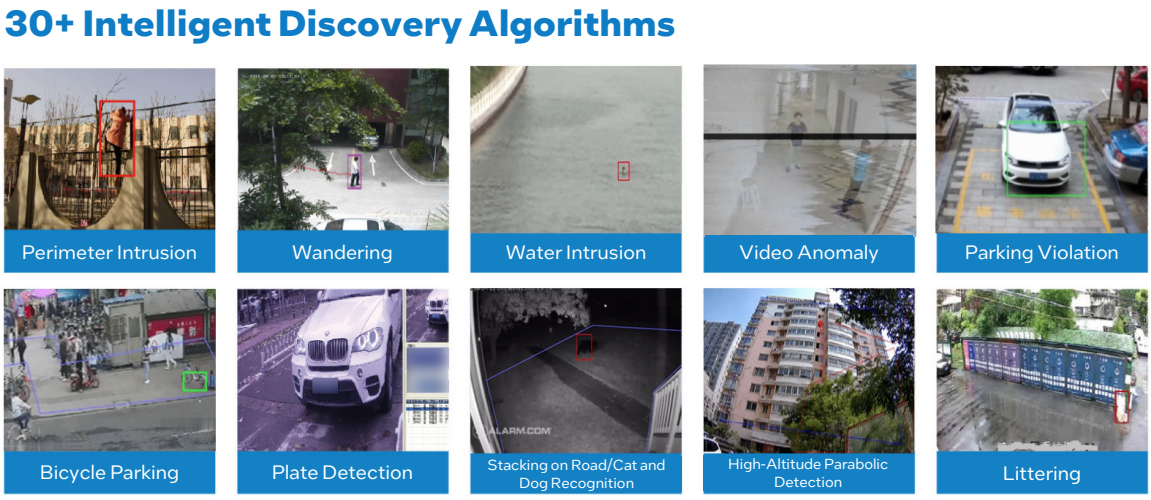


Figure 5. TruthVision Technology's Deep Learning Algorithm for Smart Communities

Based on self-innovated intelligent video analytics engines, TruthVision Technology also optimizes its performance and performs inference deployment through OpenVINO™ toolkit. OpenVINO™ toolkit is a comprehensive toolkit for the fast development of various deep learning applications (including human visual simulation, automatic speech detection, natural language processing, recommendation systems, etc.). The toolkit is suitable for different artificial neural networks, including convolutional neural networks (CNN), recurrent network and attention-based networks, and is capable of scaling computer vision and non-visual workloads across Intel® hardware to maximize performance. It speeds up applications through the high-performance, AI and deep learning inference deployed from the edge to the cloud.

OpenVINO™ toolkit supports industry-standard AI frameworks along with standard or custom layers to seamlessly integrate deep learning inference into applications, and scale/optimize workloads across Intel® hardware (including accelerators). Through the built-in Model Optimizer (MO) for pre-inference models and the Inference Engine (IE) for dedicated hardware acceleration, OpenVINO™ toolkit supports neural network acceleration and deployment across Intel® platforms, significantly increasing the speed of image inference without sacrificing accuracy. To significantly improve the performance of deep learning algorithms, OpenVINO™ toolkit supports model compression technology for complex networks, cross-platform heterogeneous acceleration technology for multi-task scenarios, CNN acceleration engines based on x86 kernel instruction sets, and quantization and model retraining strategies for low-bit mixed precision.

Test data shows that after optimization with OpenVINO™ toolkit, the AI inference comprehensive performance of Shentu Zhian Video Intelligent Analyzers has greatly improved to support up to 48 channels of intelligent video analytics[4].

In addition to OpenVINO™ toolkit, TruthVision Technology's Shentu Zhian Smart Community Solution uses Intel® Math Kernel Library for the algorithm expert system, and Intel® C ++ compiler for recompilation to make full use of the hyper-threading and other built-in technologies of Intel® processors.

Based on the powerful computing power of Intel® processors, as well as the optimization of OpenVINO™ toolkit, Intel® Math Kernel Library and other software, Shentu Zhian Smart Solution can provide excellent performance, and its algorithmic analysis frame rate can reach 25 frames[5].

Realize Full-Process Governance through Cloud-Edge-End Architecture

The Shentu Zhian Smart Community Solution includes intelligent analyzers at the edge, the Shentu Zhian Cloud Service Platform in the cloud, and the Shentu Zhian App on the terminal. The mobile phone terminal obtains the geographic location of the community field staff in real time and when patrolling, it automatically pushes the surrounding event information to the service staff mobile terminal and ranks response time, attendance, attendance time, and attendance mileage.

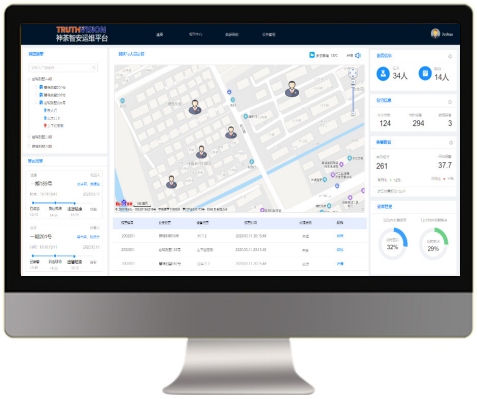
[4,5] Test data from internal test results of TruthVision Technology.

	Traditional Community	Shentu Zhian Smart Community
Video Surveillance	Rely on People's View	Machine Vision Intelligent Discovery
Problem Discovery	Patrol Personnel Commonly Overlook	Machine Looked at 24 Hours
Intercom Device	Analog Intercom	Digital Video Intercom
Personnel Patrol	Patrol Flashlight	Internet Patrol Tracking and Positioning
Visitors Management	Staff Inquiries	Cloud Appointment
Property Repair	Phone, Paper and Pen	Digital Cloud Repair Report
Staff Management	Communication via WeChat group	Digital Cloud Management
Performance Evaluation	Rely on Evaluation	Digital Performance Evaluation
Comprehensive TCO	Sufficient Manpower, Low Efficiency and High Cost of Management	Manpower Saving, Efficient Management and Low Cost
Owner Experience	Chaotic Management, Low Security and Poor Experience	Efficient Management, High Security and Wide Experience

Figure 6. Comparison of Shentu Zhian Smart Community Solution with Traditional Solutions

| Front-End Duty

| Security Management Center



| Performance Evaluation System

| Applet to View Whole Picture

Figure 7. Shentu Zhian Cloud Service Platform + App Provide Efficient Management Capabilities

The solution builds a cloud-edge-end video analytics process that realizes the full-process governance of "intelligent discovery, push events, assignment, cloud attendance, and disposal" violations and provides managers with accurate and comprehensive information support. Also, the solution can be easily integrated with other products to help system integrators provide overall smart management solutions.

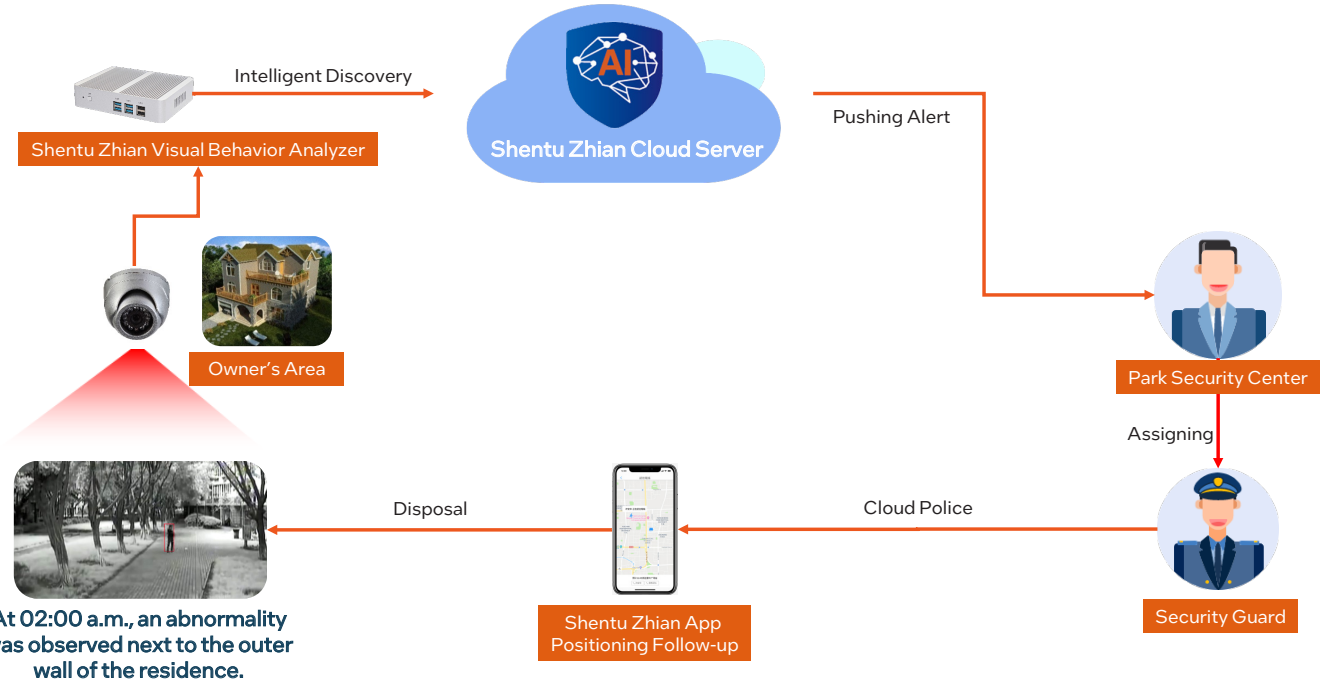


Figure 8. Shentu Zhian Cloud Smart Community Solution Supports Full-Process Smart Management

Shentu Zhian Smart Community Solution has the following advantages over traditional solutions:

- The realization of cloud-edge-end integrated processing can not only improve stability and immediacy through edge AI inference, but also solve chaotic aspects of the entire governance process through cloud management.
- There is no need to completely change the existing video surveillance system. Old camera equipment can be used and thus save time and money.
- After an incident, the system can determine whether it was due to a violation of regulations through the AI application within 3 seconds and complete the treatment within 5 minutes, which greatly improves management efficiency[6].
- The cloud management platform assists the community in building a dual assessment system for community staff workload and work efficiency to refine the attendance team and service personnel.

[6] Test data from internal test results of TruthVision Technology.

Application Practice: Solve Problems and Accelerate Transformation into Smart Communities

The Shentu Zhian Smart Community Solution has been successfully applied in multiple smart communities to help users solve the problems of insufficient management personnel, difficulty in real-time supervision, and superficial video analytics, significantly improving their management capabilities and accelerating their transformation.

Street in Pudong, Shanghai

The street has more than 250,000 permanent residents and only 65 management personnel. Frequent community problems include parking violation, driving violation of construction trucks, temporary stalls by unlicensed vendors, commercial shops occupying roads, and garbage dumping. Community management teams lacking personnel face untimely problem discovery, assault management, unclear department responsibilities, high coordination cost, and lack of data support for management.

Figure 9. Smart Street Application Scenarios of TruthVision Technology

TruthVision Technology uses advanced intelligent video behavior analysis technology to install AI brains on every camera to analyze street conditions in real time and automatically report chaotic behavior. When the system detects violations in a designated area (parking violations, high-altitude parabola detection, randomly placed shared bikes, garbage dumping, etc.), it will automatically generate a warning signal and push it to the managers' portable devices to handle community issues in a timely manner. Relying on rich algorithm application, strong application pertinence, and strong anti-interference, TruthVision Technology's Shentu Zhian Smart Community Solution combines AI with modern urban governance to provide the community with a better living environment.

Shanghai Zizhu National Hi-Tech Industrial Development Zone

Shanghai Zizhu National Hi-Tech Industrial Development Zone has attracted more than 5,200 companies among Fortune 500 companies, including Intel, and other well-known companies around the world to set up R&D Centers and regional headquarters. The Development Zone has deployed the Shentu Zhian Smart Community Solution to improve its smart management level and prevent parking violation, random placement of electric vehicles/shared bicycles, and littering.

This solution can collect data from cameras deployed at different points in the Development Zone and analyze the image data. When the system detects violations such as parking violations and littering, it will automatically generate an alarm signal and send the picture to the nearest manager's device to handle the issue in a timely manner. This method helps maintain a clean and orderly environment and provide enterprises in the Development Zone with better services.

Conclusion

Smart communities are of great significance for improving living environments and urban management. As they have been vigorously promoted by policies, the number of communities transforming into smart communities has increased enormously. In the overall development of smart communities, AI provides managers with vital visual insights to respond to abnormal events and violations in a timely manner and thus maintain an orderly community environment.

With the help of end-to-end technical capabilities, Intel is able to provide sufficient momentum for the construction and transformation of smart communities. Also, it supports the high performance and high availability of the system to quickly recover from errors by means of scalable core functions such as AI, Big Data, and storage; it supports simplified application development so developers can use multiple programming languages to integrate and expand functions; it supports functions to simplify deployment and maintenance to facilitate remote installation and upgrade; and it supports cloud-side collaboration to achieve unified management and load balancing from the edge gateway to the cloud.

Under the framework of ecological programs such as the "Intel® AI Top 100 Innovation Incentive Program," Intel is extensively cooperating with partners such as TruthVision Technology. By means of ubiquitous computing, ubiquitous connectivity, infrastructure from the cloud to the edge, and AI, Intel helps partner's solutions to integrate data resources such as people, things, places, objects, feelings, and organizations in the community scenario. With the smart community public service management platform as the carrier, Intel provides community management and service applications for organizations, properties, residents, and enterprises to enhance their scientific and intelligent transformation level community management and services.

About TruthVision Technology

Shanghai TruthVision Information Technology Co., Ltd. is an innovative high-tech enterprise that was officially established in Shanghai Zizhu Science-Based Industrial Park in September 2013. It focuses on AI core technology and product research and development.

"AI perceives the world in the service of society" is the vision of the enterprise. TruthVision Technology applies AI video analytics technology to many fields such as personal consumer goods, mobile Internet, and enterprise security. Moreover, it is committed to introducing AI technology and its efficiency to every enterprise and individual around the world.

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.