IPC Intelligent Video Surveillance (IVS) Technology White Paper

White Paper by Dahua Technology

Release 1.0

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1 Foreword

With rapid development of video surveillance and fast increase in monitoring sites in recent years, massive video data brings challenges to real-time surveillance alarms and to the effective use of video data. A large video surveillance system often has hundreds or even thousands of channels for videos and the corresponding digital video data. It has become extremely difficult for operators to detect abnormalities through observing each channel of videos. An effective solution to solve these issue is to automatically and intelligently analyze videos, and extract and record the events that users are interested with, thus realizing timely alarm or efficient analysis after the event, and enhancing security efficiency.

In terms of traditional perimeter protection functions, the major problem is there are too many false alarms. With increase in labor costs nowadays, cameras are expected to be smarter to reduce false alarm rate, and decrease the frequency and time needed to manually confirm alarms. The development of AI makes it possible. Through deep learning, cameras can intelligently detect moving objects in surveillance images and recognize their types. Moving objects or trajectories that are not of interest to users are filtered out Alarms are only sent out when the objects and behaviors that users are interested with are detected.

Dahua developed Intelligent Video Surveillance (IVS) technology in the context of AI technology. Based on the algorithm of Intelligent Defense System (IDS), it realizes dynamic detection and recognition of types and trajectories of moving targets in the monitored scene.

2 Principle of IVS Technology

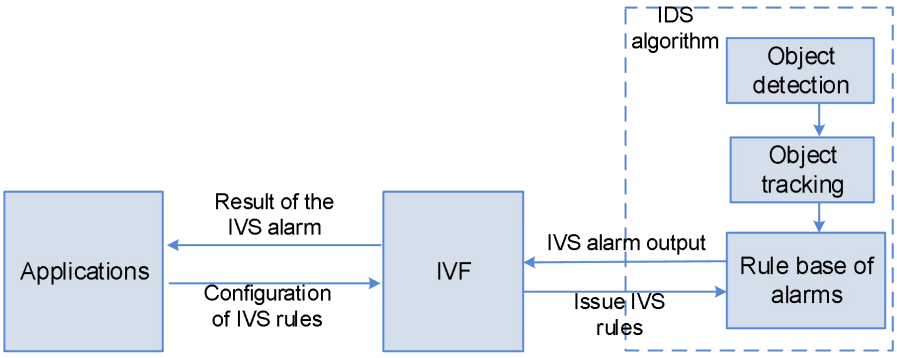
2.1 IVS Technology Introduction

Based on sophisticated deep learning algorithms of IDS and massive training data accumulated over the years, Dahua IVS technology can detect and classify the objects of interest collected from the videos and track them to get continuous tracks. Then, the technology analyzes these tracks, compares them with the preset rules, and exports alarms that are of interest to users.

Currently, IVS technology can mainly distinguish humans and motor vehicles, and set multiple preventive rules according to the needs of users. The effective object types for alarms can be set as human, vehicle, or human and vehicle.

2.2 Principle of IVS Technology

The overall IVS technology solution involves information exchange and data traffic of modules such as application configuration, Intelligence Video Frame (IVF), and IDS algorithm module. For the framework of IVS technology solution, see the figure below.



Framework of IVS technology solution

- Application configuration module

  The related parameters include rule type (8 rules supported by the rules library of IDS algorithm, which corresponds to 8 events types), supported target type (human, vehicle, or human and vehicle), sensitivity, and the information needed for the scene calibration.

- IVF module

  IVF module functions as a bridge in the whole IVS process. By adding rules that are of interest to users to the module, IVS alarm types and targets can be provided through algorithms, and can be reported to the application after the locations of the targets are acquired.

- IDS algorithm module

  The IDS algorithm module mainly includes 3 modules: Object Detection (OD), Object Tracking (OT) and the Trajectory Base Alarm (TBA).

Based on deep learning algorithm, and long-term training with massive data, OD module can detect humans and motor vehicles in various conditions such as visible light, infrared light at night or thermal images, thus minimizing omitted and false alarms.

When the object detection model detects the object, the OT module can employ a series of logic algorithms (such as recognize properties, mark IDs, predict movements) to ensure the correctness associated with the same object in different video frames, track location of the object in subsequent frames, and draw motion trajectories. Then, it judges whether the alarm rules set by the user are triggered.

For alarm events that are of interest to users, the TBA module can set rules based on the motion tracks of the objects. Currently, there are mainly 8 types of events –tripwire, intrusion, loitering detection, fast moving, people gathering, parking detection, abandoned object and missing object – which are respectively analyzed and processed by the corresponding IDS algorithm.

2.3 Intelligent Business of IVS

As mentioned above, the Dahua IVS technology is based on the rules database of IDS algorithms. The 8 intelligent rules can be respectively used to process 8 types of alarm events, which comprehensively cover business scenarios and requirements of users for intelligent protection and the intelligent analysis of behaviors.

2.3.1 Tripwire Detection

The user is required to draw a warning line in surveillance images (straight line segment or a polygon curve formed by several straight line segments) and set the crossing direction that can trigger the alarm. When the target that is of interest to users is detected in the video image, the camera starts to track and record its trajectory. If the target crosses the warning line and the moving direction is the same as the rule direction set by the users, the camera will provide alarms by immediately sending on-site snapshot and time of the event to the users, or

by linking siren and light alarm. This function is used to detect human, vehicle, or human and vehicle. The monitoring scenarios generally include narrow and long passages or entrance/exit, or roads where the target have clear moving directions. For sites like plazas where the target's moving direction is random, this function is not suitable.

Since it takes time and space for the camera to detect and confirm the target after it appears in the image, the user shall leave a certain amount of space on both sides when setting a warning line, and should not set the line near an obstacle.

2.3.2 Intrusion Detection

If there is a completely sensitive area or a place that needs special attention in the surveillance image, the user can use intrusion detection. The user is required to set an enclosed polygon area (a rectangle or an irregular shape) in the surveillance image to cover the entire sensitive area or place.

The intrusion detection can be used to handle two types of events that the user are concerned with. One type is when the target enters or leaves the area. The other one is when the target directly appears in the area. This function is used to detect humans and/or vehicle. The application scenarios include fenced areas, lawns, entrance/exit, and prohibited driving areas. Apart from basic safety protection, the user can also use this function for other purposes.

The appearance in the area supplements the event that involves entering or leaving of targets in an area. It can be used to solve the missed alarms issue when the boundary of the area defined by the users is too close to the boundary of the surveillance image, and the

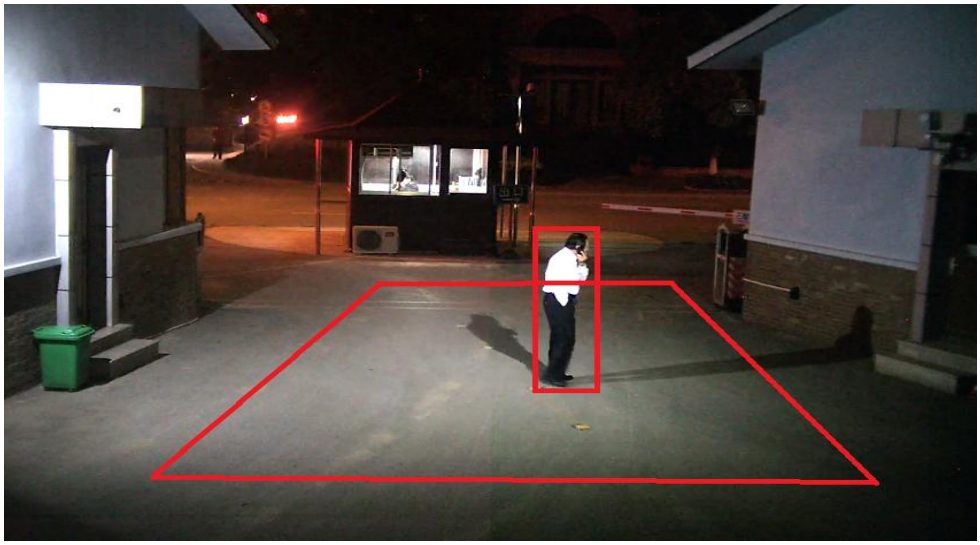
crossing rule cannot be completed by the target. Similar to the warning line, to detect an entry/exit event, a certain space of target movement shall be reserved at the perimeter of the area line.

2.3.3 Loitering Detection

In some special scenarios, such as a house gate or a bank and in some places where people are not allowed to linger for a long time, the loitering detection can be used. Similar to the detection rules of intrusion, the user is required to set an enclosed polygon area (a rectangle or an irregular shape) in the surveillance image to cover the entire sensitive area or place.

This function is mainly used to detect humans. The camera starts to record the duration of stay of the target after the camera detects the target and tracks it in the defined area. When the duration exceeds the minimum alarm time that has been set and the locations detected vary each time (for example, the shift in the target's movement in the last 2 seconds exceeds at least the width of the target), the alarms or the combined siren and light alarms will be triggered. After the target enters the area, if it does not move or the distance of every movement is short (such as shaking at the original place), the target will be considered as stationary by the camera and will not trigger alarms.

Aside from this, after the target triggers an alarm, if within the interval of alarms the target is still loitering in the area, the alarm will be triggered again.



2.3.4 Fast Moving Detection

For security cameras, it is crucial to instantly detect abnormalities in surveillance images. The camera can detect the suspected target immediately, and send the time of event timely to the user. In this way, cases can be detected and solved early. The fast moving function is designed to detect persons who run suddenly in surveillance images (for example, the suspect tries to get rid of the tracking and quickly leaves the scene). Similar to the detection rules of intrusion, the user is required to set an enclosed polygon area (a rectangle or an irregular shape) in the surveillance image to enable the camera to detect the moving status of the object.

Since monitoring scenarios vary, the mounting angles of the camera and the distance from the camera to the target area also vary. To ensure the accuracy of the algorithm and the alarms, the user is required to set the depth of field (the 3D information needed for rebuilding the environment) before using this function. Based on configuration, IDS algorithm calculates the actual speed of the target. If the actual speed of the target exceeds the speed set by the user, the alarm will be triggered (the camera has a sensitive interface for the adjustment of the alarm's speed limit.)

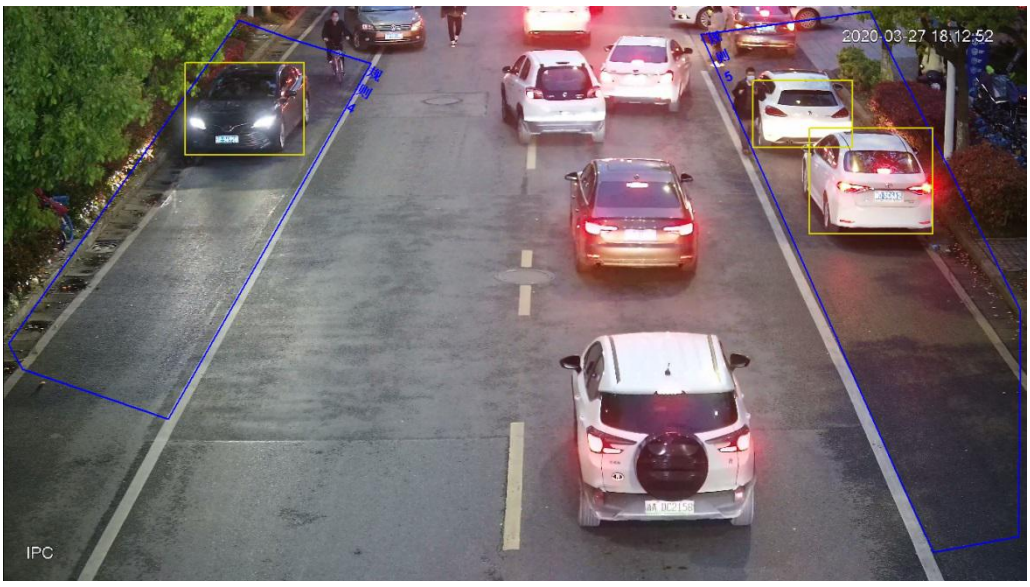
2.3.5 Illegal Parking Detection

Obviously, this function is mainly used to detect motor vehicles, and to judge whether

motor vehicles are parked in a prohibited area. Similar to the detection rules of intrusion, the user is required to set an enclosed polygon (which can be a rectangle or an irregular shape) in the monitoring screen to cover the entire prohibited area.

This function's major application scenarios include emergency exits, fire truck lanes, lanes for non-motor vehicles, and important road entrances and exits. When an illegal parking event occurs, the camera immediately takes on-site snapshot and sends the alarm information to the use. The siren and light alarm can also be linked to warn the vehicles, thus addressing the issue of long-time waiting in the traditional ways of law enforcement.

The principle of this function is similar to that of loitering detection. After the camera detects and tracks the motor vehicle in the defined area, the camera judges whether the object is stationary or not, and the duration of stay is calculated. When the duration exceeds the time threshold set by the user, the alarm will be triggered.



2.3.6 People Gathering Detection

This function is mainly used to detect humans. Based on deep learning algorithm for the detection of human faces and bodies, the alarm is triggered when people gathering or high crowd density is detected in outdoor plazas, at the gate of government buildings, at the entrance/exit of stations, or in other sensitive monitoring areas. This function is developed to monitor abnormalities in scenarios with dense crowd, such as riot, stampede, traffic jams,

spread of epidemic and more. Once an abnormality has been detected, alarms will be triggered immediately to disperse the crowd.

Similarly, the user is required to set an enclosed polygon area (a rectangle or an irregular shape) in the surveillance image to cover the entire sensitive area or place.

Since the scenarios of users vary, the mounting angles of the camera, the distance from the camera to the target area, the number of targets and the crowd density defined by user also vary. Before using it, the user shall define the detection area and targets of the camera according to the actual purpose of the monitoring and configure parameters such as the smallest area for gathering, the duration of the gathering that can trigger the alarm, and the sensitivity of the alarm.

2.3.7 Abandoned Object and Missing Object

In a railway station, some passenger often forget their luggage behind while rushing to take trains, and station staff often cannot timely notice it. Once the train leaves, the passenger might not be able to retrieve their things in a short time, resulting in economic loss and other inconveniences. In other scenarios, items temporarily left in a place may be taken away by someone. Traditional tracking after the event is often time-consuming and toilsome. In order to provide early detection and solution to such problems and reduce unnecessary losses, Dahua developed a function that can detect abandoned and missing objects.

The principles for the detection of abandoned objects and missing objects are similar. The difference lies in their logic. Based on the principle of IDS algorithm for background modeling,

this function counts the stationary areas in the foreground of the video and judges whether the objects are abandoned or missing according to the similarity of the foreground and the background.

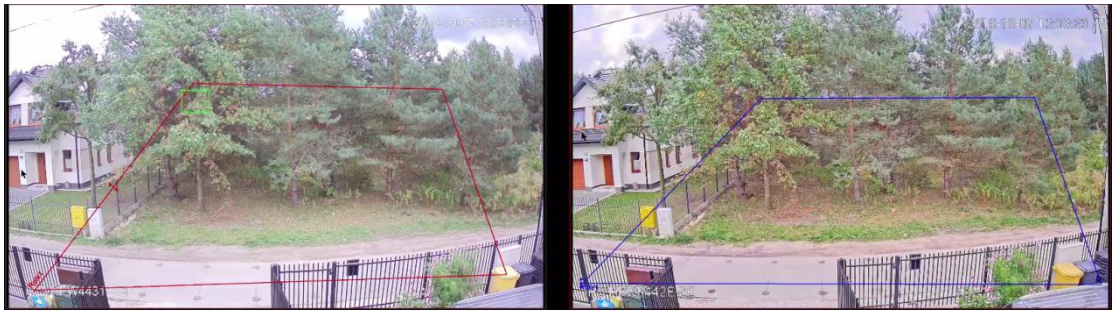
Considering that objects are stationary items that are smaller than humans and motor vehicles, humans and vehicles are filtered out by two functions. Abandoned objects mean that when the camera detected them in the monitoring scene, the duration of stay exceeded the time set by the user, which can then trigger the alarm. Missing objects refers to those detected in the previous scenarios that were taken away but not returned to its original place after the time threshold, thus triggering the alarm.

3 Advantages of Dahua IVS Technology

3.1 Advantages of Dahua IVS Technology

Based on deep learning algorithm and massive training data accumulated over the years, Dahua IVS technology can accurately recognize humans and motor vehicles, track their motion trajectories, and analyze their behaviors. False alarms triggered by light changes, swinging leaves, or flying birds and insects can be effectively filtered out. Dahua cameras only report human and motor vehicles or behavior rules generated by human and motor vehicles that are of interest to users to reduce efforts and costs of manual confirmation.

At the same time, supported by various intelligent rules and rigorous logical analysis capability, IVS technology can be widely applied even in complicated scenarios to meet business requirements of users.

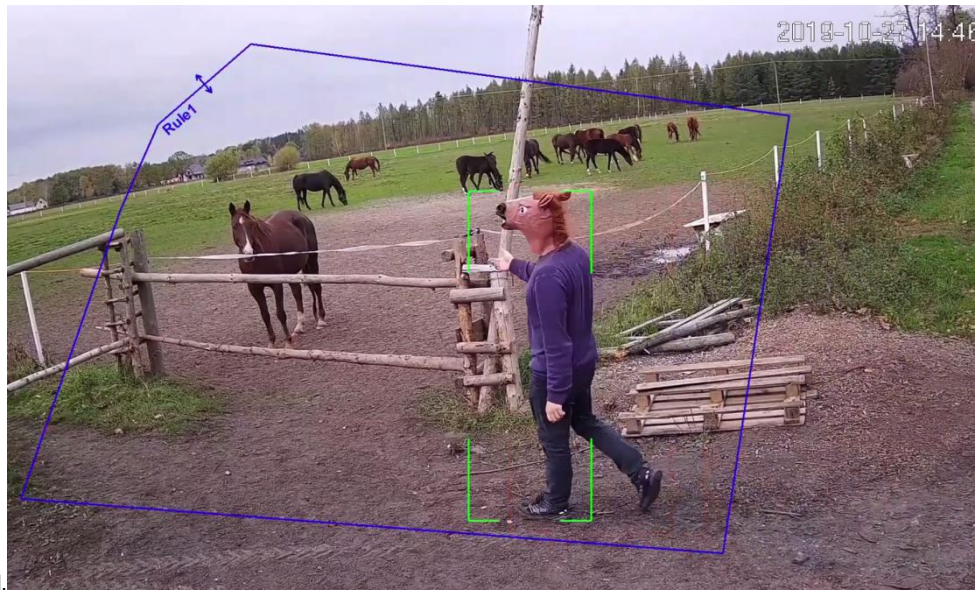


For traditional boundary surveillance, swinging leaves frequently trigger alarms

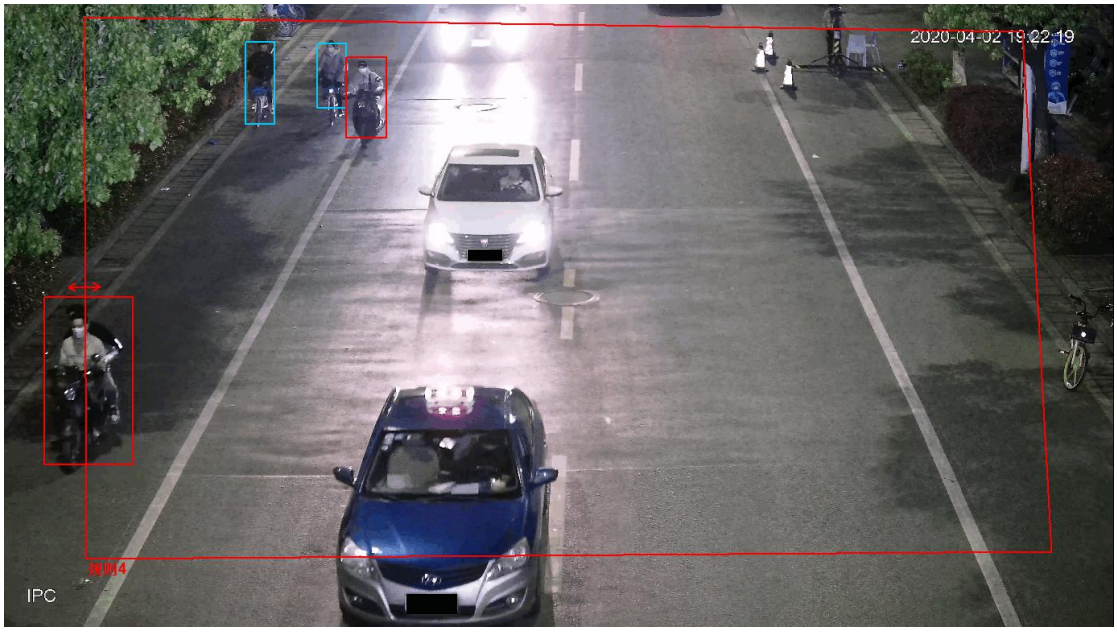
IVS technology can effectively filter out irrelevant moving objects

For human targets, besides standing and walking postures, crawling, rolling, creeping, jumping, hiding faces and other suspicious movements can also be accurately detected by Dahua AI algorithm (see the figure below).

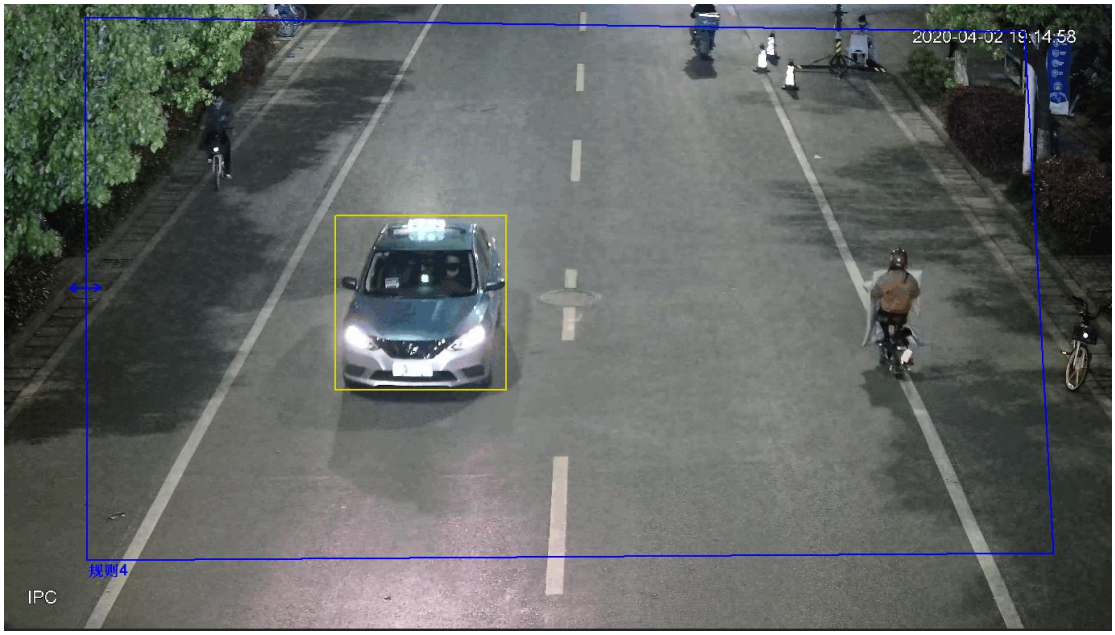
Suspicious human targets with various postures can still be detected.



Real horses cannot trigger the alarm, but a human wearing a horse head mask can trigger it.



When detecting humans, the cameras will not give alarms when motor vehicles and other objects trigger the rules.



When detecting motor vehicles, the cameras will not give alarms when humans and other objects trigger the rules.

3.2 Siren and Light Alarm Technology

Dahua siren and light alarm technology can be used to deter intruders. By adding a high-decibel speaker and a high-power lighting source to the camera, the warning signal can be sent to people through sound and warning light. All of these can be linked into a siren and light alarm function.

IVS supports accurate classification and detection of humans and vehicles and can

intelligently analyze multiple types of intrusions (humans or vehicles). Thus, different types of sounds and warning lights can be set in the camera in order to deter targets and realize effective prevention of incidents.

Moreover, the siren and light alarm technology also supports the configuration of different voice formats set by the user and warnings for different alarm rules. The sound volume can be adjusted so that the device can be flexibly applied in more scenarios. In the same scenario, alarms configured for different periods can reach different effects. For example, during business hours of a shop, the voice in the file can be mild and welcoming, while during off-hours, warning audio can be used. Thus, one camera can be used for multiple purposes, which is more economical.

4 Summary

Dahua IVS technology supports the detection and classification of humans and motor vehicles. Through the generation and analysis of continuous tracking of targets and combining alarm rules set by the users, intelligent protection can be realized. Cameras that support IVS technology generally can be applied in panoramic scenarios, such as borderlines, fences of residential communities, yards, lawns, and more. Even in complicated scenarios, the IVS technology can ensure the accuracy of alarms.

Fences of residential communities

Borderlines

Yards and lawns

Banks of rivers and lakes

Prohibited areas of museums

No-parking areas of fire truck lane

Financial establishments

Areas that are sensitive to people gathering