

# **User Manual**

**Wireless Magnetic Vehicle Detection**

**System: ClairGeo-S**

Version: 1.0

TraffiClair Technology Co., Ltd.

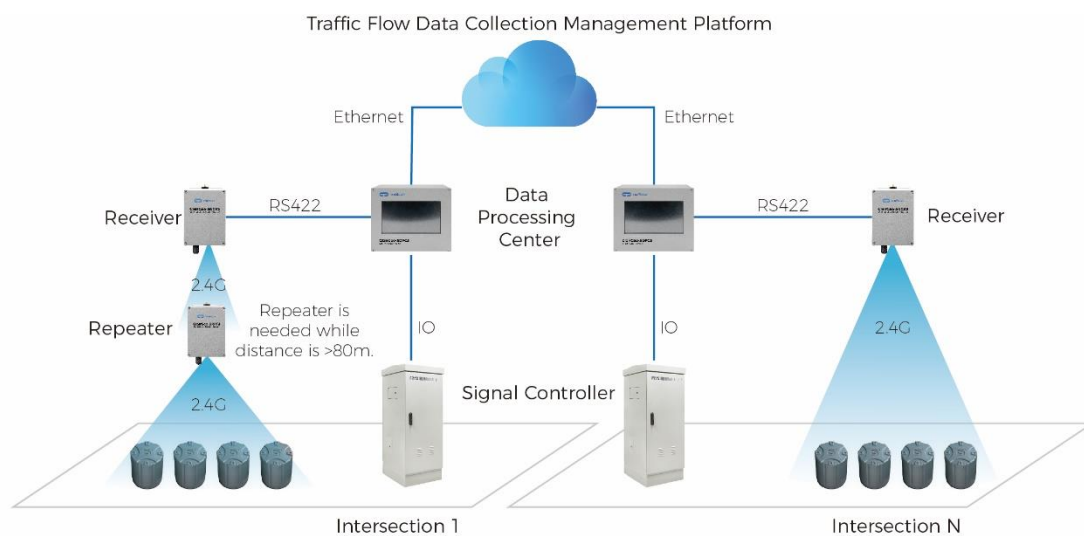
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# 1. Introduction

The "Urban Traffic Basic Data Collection System" mainly functions to report the urban road vehicle traffic conditions and status to the intersection signal control system and the central database. At the same time, following the concept of the Internet of Things (IoT) management, it accomplishes the management of its own devices. The system includes wireless geomagnetic vehicle detectors (SDET), receivers (SRCV), repeaters (SRPT), data processing center (SDPC), urban center server (including database server), and management client.



### Product Framework Diagram

- The overall structure is based on the latest IoT technology while considering the specific characteristics of this system to achieve remote maintenance and management functionalities.
- The entire system adopts a modular design and object-oriented development technology, providing interfaces for system functionality extension. The vehicle detector employs a modular structure design due to its limited resources and development environment constraints. This choice aims to reduce redundancy and facilitate maintenance effectively.
- Upper-level services and client application systems are developed using object-oriented programming techniques, establishing interfaces and inheritance relationships. While this approach may introduce some redundancy, it ensures logical clarity and minimizes maintenance efforts.
- Establishing a product development platform using mature technologies aims to improve

implementation speed, reduce implementation costs, and avoid wastage of resources caused by redundant development efforts. The vehicle detector utilizes the development kit provided by the processor manufacturer, making it easy to set up the development environment. The data processing center runs on embedded Linux, utilizing Fedora as the development platform. Fedora is an open, innovative, and forward-looking operating system and platform based on Linux. It allows anyone the freedom to use, modify, and redistribute it, both now and in the future. The OS porting work is done in collaboration with experienced domestic companies.

- Wireless communication employs existing, advanced, and mature technologies.
- The serialization and aesthetic improvement of the product can be achieved through collaboration with relevant enterprises to collectively complete the work. Currently, the product has not been serialized, but in the coming years, the goal is to expand the company's scale and establish cooperative relationships with other companies to develop various related products, such as parking lots, access control systems, etc. Any application that requires vehicle detection can be developed and applied, leading to the serialization of the product line.

## 2. Function and Characteristics

The "Urban Traffic Basic Data Collection System" is a product widely applied in the urban traffic vehicle management system. Its main principle involves a wireless geomagnetic vehicle detector capable of collecting various parameters of traffic vehicles, such as vehicle speed, traffic flow, headway time, occupancy time, etc. The system consists of a data collector, wireless transceiver, data processor, and a primary lithium battery. The data collector includes magnetic sensors, voltage amplifiers, and an AD converter. The wireless transceiver is a short-distance, low-power digital transmission module operating in the 2.4 GHz frequency band, compatible with the 802.15.4 protocol, capable of forming a mesh network where each module can function as a routing node, coordinator, or terminal node, with an internal protocol stack. The data processor comprises a microprocessor and data acquisition interfaces, among other components.

### 2.1 The wireless geomagnetic vehicle detector

The wireless geomagnetic vehicle detector is a well-known manufacturer's geomagnetic sensor developed based on the "Gauss Theory of Geomagnetic Field." It operates by detecting the continuous disturbance in the magnetic field intensity caused by the passage of a vehicle containing ferromagnetic material over a specific geographical coordinate point. The sensor samples and compares this data with the initial sampled data to calculate the impact of the vehicle's passage on the Earth's magnetic field at that point. The detector then processes this data in a microprocessor and converts it into binary, digital, or analog format as needed. The processed data is transmitted wirelessly to the on-site data processing center, where it is further processed using embedded microprocessors. Finally, the processed data is sent to the urban center server or on-site signal controllers, providing users with essential traffic data such as headway time, occupancy time, vehicle speed, and traffic flow based on the movement of vehicles.

The main design challenges of the wireless geomagnetic vehicle detector include volume, power consumption, communication distance, and algorithm.

Its key technical characteristics are as follows:

- Small Size
- Easy and Simple Installation: It requires no power lines, data cables, or road construction permits.
- Ultra-Low Power Consumption: It can operate continuously for up to 5 years.
- Use of Lithium Iron Phosphate Battery: The detector utilizes high-quality military-grade lithium iron phosphate batteries with stable high working voltage, high discharge voltage,

and low self-discharge rate (less than 1% when stored for one year at 25°C). It can operate within a wide temperature range of  $-45\pm 3^{\circ}\text{C}$  to  $+85\pm 2^{\circ}\text{C}$ .

- Long Communication Distance: It can achieve a communication distance of up to 150 meters from the receiver.
- Detection Capability in Various Vehicle States: It can detect vehicles moving at high speeds, at slow speeds, and even stationary vehicles.
- Strong Anti-Interference and Adaptability: The detector exhibits strong anti-interference capabilities and can adapt well to various environmental conditions.
- Minimal Maintenance: Generally, no maintenance is required under normal road conditions.
- Long Usage Life: Due to its extended operational time, it results in very low average annual costs.

## 2.2 Receiver

The receiver uses 2.4GHz wireless communication technology and adopts an existing short-range communication protocol. Its main function is to act as the data aggregation endpoint for wireless data and transmit the data to the data processing center via the RS422 interface. It can also allow a maximum of 16 wireless geomagnetic vehicle detectors to join the network. If there are more than 16 vehicle detectors, additional repeaters must be added. The receiver is powered through the data processing center, and at least one receiver is required for each data collection section or intersection.

## 2.3 Repeater

The repeater also uses 2.4GHz wireless communication technology and adopts an existing short-range communication protocol. Its main function is to extend the communication range between the receiver and the wireless geomagnetic vehicle detectors, while also increasing the capacity of the short-range wireless network terminals (wireless geomagnetic vehicle detectors). Each repeater allows up to 16 wireless geomagnetic vehicle detectors to join the network.

The repeater can be powered using various methods, including direct 220V AC power supply or solar power.

## 2.4 Data Processing Center

The data processing center receives and organizes the data on the passage of vehicles in the road. It is connected to the receiver and efficiently processes the data. The processed data is then transmitted to the urban center server or intersection signal controller using communication means such as optical fiber or other methods and utilizing the TCP/IP communication protocol.

The data processing center operates on an embedded Linux system platform with Cortex-A7 as the core processor, providing a stable and efficient local data transmission and processing device. Each data collection section or intersection requires at least one data processing center device and receiver. It serves as the network coordinator and processing center for that location, capable of managing and controlling over 65,000 wireless geomagnetic vehicle detectors theoretically. The data received by the receiver is processed by the data processing center and then sent to the signal controller or central server through Ethernet, serial port, or I/O port.

The main technical features of the data processing center are as follows:

- **Display of Communication Information:** The center can display communication messages, communication status information, wireless geomagnetic vehicle detector detection information, and status information. This includes the detector's operational status, power supply voltage, and communication status.
- **Wireless geomagnetic vehicle detector Information Browsing:** The center allows browsing of information related to the detectors, including their types (functionality), positions, and attributes.
- **System Time Modification:** The capability to modify the system time as needed.
- **Detector Parameter Modification:** The center enables the modification of detector parameters, including communication parameters, vehicle detector position information, vehicle detector-to-lane mappings, and operational parameters.
- **Versatile Output Options:** The data processing center supports various output options, including TTL high effective, TTL low effective, normally open contact, normally closed contact, RS485, RS232, Ethernet, and more. Customized output configurations can be tailored to specific requirements as needed.

In summary, the data processing center offers a range of features for information display, browsing, and modification, providing flexibility and adaptability to cater to different needs in the "Urban Traffic Basic Data Collection System."

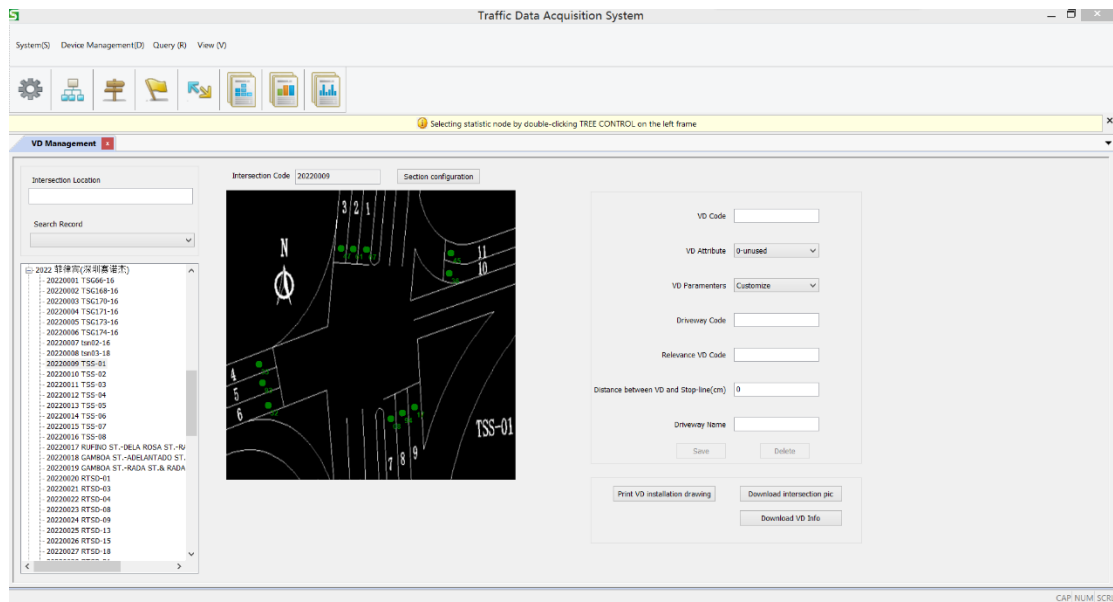
## **2.5 Urban Center Server**

The urban center server uses Socket programming technology and the TCP/IP communication protocol to receive business requests from data processing centers and management clients. Simultaneously, it utilizes Oracle or SQL Server databases for fast storage and organization of the vast amount of collected traffic data.

## **2.6 Management Client**

The management client controls and manages data processing centers and wireless geomagnetic vehicle detectors through the urban center server. It can access the operational

status of every intersection or road section device in the city.



*The main functions of the management client include:*

- Subzone Management: Managing and organizing different subzones within the city for efficient traffic management.
- Intersection or Road Section Management: Controlling and overseeing the operation of intersections or road sections equipped with wireless geomagnetic vehicle detectors.
- Vehicle Detector Installation Information: Managing the installation locations of vehicle detectors, corresponding lane relationships, and parameter settings.
- Data Processing Center Time Calibration: Ensuring accurate time synchronization for data processing centers.
- Traffic Statistics Data Query: Accessing and querying traffic-related statistical data for analysis and planning purposes.
- Vehicle Detector Status Query: Checking the status and operational conditions of individual vehicle detectors.
- Vehicle Detector Packet Loss Rate Query: Monitoring the packet loss rate of vehicle detectors over the last 24 hours.
- Vehicle Detector Fault Query: Identifying and investigating any issues or faults related to vehicle detectors.
- Data Synchronization between Server Database and Local Database: Ensuring seamless synchronization of data between the urban center server's database and the local database of the management client.

## 2.7 The System Design Features

Establishing an overall architecture based on the Internet of Things (IoT) reference, the system enables wireless connections between the wireless geomagnetic vehicle detectors, receivers, repeaters, and data processing center for unified management. When a vehicle moves or stops on the detector, it detects the vehicle's status and sends the headway time and occupancy time to the urban center server or intersection signal controller through the data processing center. The intersection signal controller adjusts its control strategy based on traffic flow, headway time, and occupancy time. The server handles data storage and provides fundamental data for other management and decision-making systems. The most crucial task of this system is to provide vehicle detection data to other systems while also performing self-management tasks, including detector parameter modification, battery monitoring, and operational status checks.

A user-friendly visual human-machine interface is crucial as it serves as the system's facade and reflects the convenience of maintenance and status monitoring. The system allows modification of each vehicle detector's parameters, monitors the status of each vehicle detector, and enables control and monitoring of intersection or road section devices. All these functionalities are presented in a user-friendly manner.

Regarding the relationship between the management client, urban center server, and database server:



Each intersection or road section must have one data processing center device and one receiver installed. The number of vehicle detectors installed at an intersection or road section is determined by the minimum number of repeaters required.:

$$N_r = INT\left(\frac{N_c + 1}{12}\right)$$

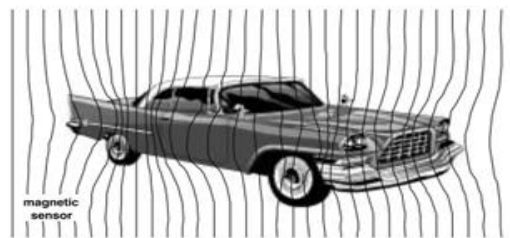
Where  $N_r$  means the number of vehicle detector routers,  $N_c$  means the number of vehicle detectors, and INT means integral number.

For example: If 24 vehicle detectors are required to be installed at one intersection, then,

according to the formula, 2 vehicle detector routers are needed.

### 3. Core Product - Wireless geomagnetic vehicle detector

The wireless geomagnetic vehicle detector achieves precise collection of geomagnetic signals, with comprehensive algorithms, high energy-saving mode, and a reliable wireless communication network. The core technology of this product lies in the collection of geomagnetic signals. When a vehicle moves or stops on the detector, it impacts the geomagnetic field as shown in the diagram below:



Vehicles in the Earth's magnetic field disturbances

The wireless geomagnetic vehicle detector first collects signals at regular intervals through geomagnetic sensors. The collected signals are then processed to generate waveform curves, which are then passed to the algorithm. The algorithm identifies the vehicle's status, such as presence, absence, movement, or stationary, and transmits this information wirelessly.

The algorithm used in the detector is a combination of dynamic and static algorithms. It primarily analyzes waveform characteristics, applying filtering, sampling curve analysis, and anti-interference techniques to achieve accurate detection. The wireless communication uses the IEEE 802.15.4 protocol, which incorporates collision and retransmission mechanisms, enabling long communication distances (over 150 meters) and reliable data transmission. Additionally, the system implements wireless security mechanisms, allowing registration to the network only with proper authentication through passwords.

## 4. Technical Specifications

The wireless geomagnetic vehicle detector is the core device of this system. The final design aims to achieve hardware stability, mature software, and precise algorithms, making it a new type of vehicle detector with promising market prospects. Through a reasonable architecture, the detector provides users with traffic flow, occupancy time, headway time, vehicle speed, and other data while also incorporating management functionalities for the vehicle detectors and data processing center equipment. The following technical specifications meet the requirements for functional implementation.

### 4.1 Technical specifications of the ClairGeo-SDET wireless geomagnetic vehicle detector include:

- Detector lifespan: 5 years
- Wireless communication distance: 150m
- Maximum detection height above ground: 60cm
- Dimensions: Diameter: 87mm, Height: 96mm
- Operating current:  $\leq 100\mu\text{A}$
- Wireless frequency band: 2.4GHz
- Wireless data rate: 250kbps
- Wireless power output: 18dBm
- Operating temperature:  $-45\pm 3^{\circ}\text{C}$  to  $+85\pm 2^{\circ}\text{C}$
- Storage temperature:  $-55^{\circ}\text{C}$  to  $+120^{\circ}\text{C}$

### 4.2 Technical specifications of the ClairGeo-SRCV wireless receiver include:

- Maximum capacity: Can accommodate up to 16 wireless geomagnetic vehicle detectors in the network.
- Dimensions: 200mm × 150mm × 75mm
- Power supply: Powered by the data processing center.
- Operating voltage: DC 5V
- Operating current: 50mA
- Wireless frequency band: 2.4GHz
- Wireless data rate: 250kbps

- Wireless power output: 18dBm
- Operating temperature:  $-45\pm3^{\circ}\text{C}$  to  $+85\pm2^{\circ}\text{C}$
- Storage temperature:  $-55^{\circ}\text{C}$  to  $+120^{\circ}\text{C}$
- Receiver sensitivity: -110dBm
- Relative humidity: 93%

### 4.3 Technical specifications of the ClairGeo-SRPT wireless repeater include:

- Maximum capacity: Can accommodate up to 16 wireless geomagnetic vehicle detectors in the network.
- Dimensions: 200mm × 150mm × 75mm
- Input voltage: AC 85V to 265V / Solar power / Lithium battery / DC 5V / DC 48V
- Operating voltage: DC 5V
- Operating current: 50mA
- Wireless frequency band: 2.4GHz
- Wireless data rate: 250kbps
- Wireless power output: 18dBm
- Operating temperature:  $-45\pm3^{\circ}\text{C}$  to  $+85\pm2^{\circ}\text{C}$
- Storage temperature:  $-55^{\circ}\text{C}$  to  $+120^{\circ}\text{C}$
- Receiver sensitivity: -110dBm
- Relative humidity: 93%
- Battery lifespan:  $\geq 3$  years

### 4.4 Technical specifications of the ClairGeo-SDPC data processing center include:

- Dimensions: Length 213mm, Width 173mm, Height 86mm
- Output interfaces: Dual Ethernet, RS232, RS485, IO
- Input voltage: AC 85V to 265V
- Operating voltage: DC 12V
- Operating current: 180mA (without LCD screen) / 400mA (with LCD screen)
- Wireless frequency band: 2.4GHz (only available for integrated model, not standard configuration)
- Wireless data rate: 250kbps (only available for integrated model, not standard configuration)
- Wireless power output: 18dBm (only available for integrated model, not standard configuration)

- Operating temperature:  $-45\pm 3^{\circ}\text{C}$  to  $+85\pm 2^{\circ}\text{C}$
- Storage temperature:  $-55^{\circ}\text{C}$  to  $+120^{\circ}\text{C}$
- Relative humidity: 93%

#### **4.5 System detection technical specifications include:**

- Vehicle flow accuracy: 97%
- Speed accuracy: 95%
- Occupancy time accuracy: 98%
- Headway time accuracy: 98%
- Time occupancy rate error: Less than  $\pm 2\%$

## 5. Comparison with other commonly used traffic vehicle detectors

### 5.1 Comparison with inductive loop detectors:

The inductive loop detector is a traditional traffic detector that works by burying induction loops in the road and connecting them to the vehicle detector. When a vehicle passes over the loop, the change in loop inductance caused by the vehicle's presence is detected, and the status signal is transmitted to the vehicle detector for data collection and analysis.

Advantages of inductive loop detectors over other detectors include low cost, high reliability, high detection accuracy, and all-weather operation, making them the most widely used vehicle detectors currently.

Disadvantages:

- During initial installation of the inductive loops, road cutting is required to embed them, which can lead to traffic congestion and disruptions on major urban roads during the construction period.
- The installation of loops can damage the road surface and shorten the lifespan of both the road and the loops. This is particularly problematic for asphalt roads, leading to increased maintenance and operational costs and affecting the system's availability.
- Inductive loops are susceptible to environmental influences such as road sinking, cracking, and freezing, leading to false detections.
- Due to their measurement principle, the detection accuracy of inductive loop detectors significantly decreases during congested traffic or when vehicles are closely spaced, making them less suitable for traffic flow detection at urban intersections.
- Once set, inductive loop detectors are fixed and difficult to adjust when road conditions change.

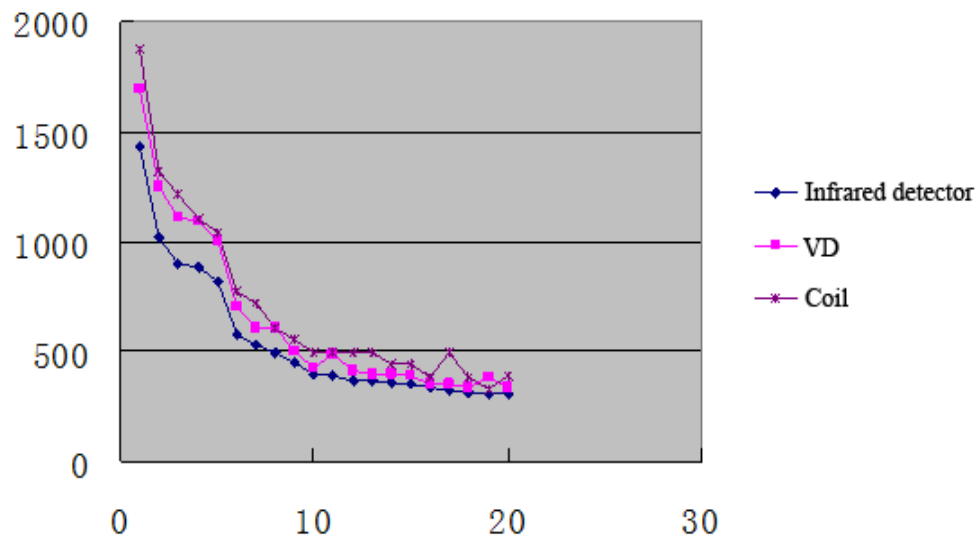
Overall, the wireless geomagnetic vehicle detector in this system provides advantages over inductive loop detectors in terms of installation convenience, maintenance, and adaptability to changing traffic conditions. It offers a reliable and efficient alternative for traffic data collection and management.

The following results are based on actual measured record.

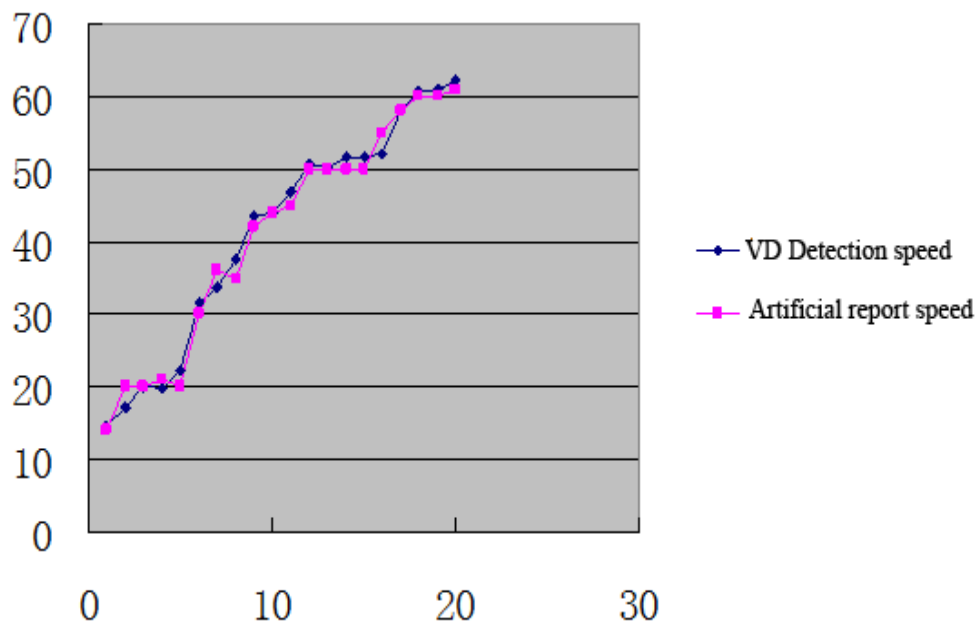
|                                                                    |
|--------------------------------------------------------------------|
| Record comparison between earth coil detector and vehicle detector |
|--------------------------------------------------------------------|

| Infrared occupancy | Coil occupancy | VD occupancy | VD speed | Reported speed | VD/ Infrared | Coil Infrared / |
|--------------------|----------------|--------------|----------|----------------|--------------|-----------------|
| 1430               | 1873           | 1690         | 14.5     | 14             | 1.182        | 1.310           |
| 1017               | 1321           | 1250         | 17.2     | 20             | 1.229        | 1.299           |
| 898                | 1212           | 1110         | 20.1     | 20             | 1.236        | 1.350           |
| 884                | 1101           | 1095         | 19.8     | 21             | 1.239        | 1.245           |
| 818                | 1040           | 1005         | 22.1     | 20             | 1.229        | 1.271           |
| 575                | 771            | 705          | 31.6     | 30             | 1.226        | 1.341           |
| 530                | 716            | 605          | 33.6     | 36             | 1.142        | 1.351           |
| 497                | 606            | 610          | 37.5     | 35             | 1.227        | 1.219           |
| 449                | 551            | 500          | 43.5     | 42             | 1.114        | 1.227           |
| 396                | 496            | 430          | 44       | 44             | 1.086        | 1.253           |
| 390                | 495            | 485          | 46.75    | 45             | 1.244        | 1.269           |
| 369                | 496            | 410          | 50.55    | 50             | 1.111        | 1.344           |
| 366                | 496            | 400          | 50.14    | 50             | 1.093        | 1.355           |
| 359                | 441            | 395          | 51.6     | 50             | 1.100        | 1.228           |
| 355                | 441            | 390          | 51.6     | 50             | 1.099        | 1.242           |
| 334                | 385            | 355          | 52.15    | 55             | 1.063        | 1.153           |
| 324                | 495            | 355          | 58.05    | 58             | 1.096        | 1.528           |
| 311                | 385            | 335          | 60.8     | 60             | 1.077        | 1.238           |
| 309                | 330            | 380          | 60.85    | 60             | 1.230        | 1.068           |
| 306                | 386            | 335          | 62.05    | 61             | 1.095        | 1.261           |

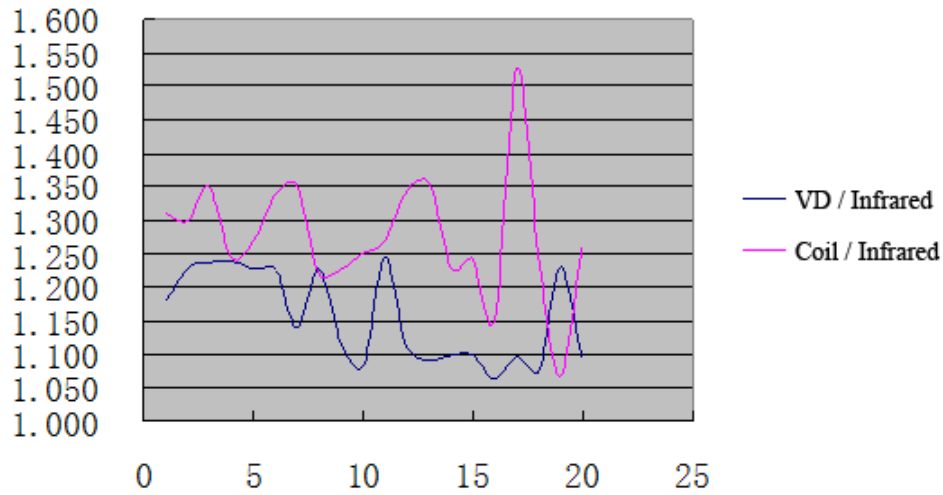
Contrast chart of occupancy:



Contrast chart of magnetic nail detection rate and reported rate:



Ratio contrast chart:



*Experiment conditions:*

Inductive Loop Detector: Following the installation requirements for the inductive loop detector, we created a 5-turn 1m x 1.2m loop and connected it to the receiver of the inductive loop detector. The receiver's contact was then connected to a microcontroller to calculate the occupancy time, and the data was displayed on a computer.

Infrared Detector: The occupancy time was calculated by using an infrared detector that detects the infrared light blocked by the vehicle's body.

Analysis: From the ratio comparison chart, it can be observed that the smaller the range of curve variation, the more ideal the situation, with a straight line being the most ideal scenario. Looking at the ratio comparison chart, the "VD/Infrared" ratio curve has a smaller range of variation, indicating better performance.

$$\text{"VD/ Infrared" variation range: } 1.05 < \frac{VD}{Infrared} < 1.25$$

$$\text{"Coil / infrared" variation range: } 1.05 < \frac{Coil}{Infrared} < 1.55$$

According to actual experiment, wireless geomagnetic vehicle detector (VD) is more accurate and more dependable, and the premise is that the detected results by infrared detector are the most reliable.

## 5.2 Comparison with video detectors:

Video detectors use video cameras as front-end sensors, and detection areas are set on the video images collected by the cameras. When a vehicle enters the virtual detection area, it causes a change in the background grayscale value of the image. The processor then processes the image to determine the presence of the vehicle and detect traffic parameters such as flow and speed.

Video detectors have the advantages of collecting large amounts of information, high accuracy, reliability, and ease of installation, debugging, and maintenance. They can flexibly set detection areas as needed and provide real-time video images for management purposes.

However, video detectors depend on the quality of the video footage, which can significantly impact detection results. Prominent factors affecting the performance include adverse weather conditions (rain, snow, fog), lighting, trees, and dynamic shadows caused by vehicles.

In comparison, the wireless geomagnetic vehicle detector (VD) has shown better accuracy and reliability in the previous testing, making it a preferable choice over video detectors in certain situations where environmental factors can affect the performance of video-based detection systems. The VD detector is not affected by adverse weather conditions or lighting, providing consistent and dependable vehicle detection data.

### **5.3 Comparison with microwave detectors:**

Microwave vehicle detectors operate based on the induction principle of emitting electromagnetic waves to detect vehicles. Taking RTMS microwave as an example, it hangs on the roadside and emits continuous low-power modulated microwaves within a fan-shaped area, leaving a long projection on the road surface. RTMS divides the projection into 32 layers, with each layer being 2 meters. Users can define the detection area as one or multiple layers. RTMS calculates the traffic information of target vehicles based on the echo returned by the detected vehicles and periodically sends this traffic information to the control center via RS232.

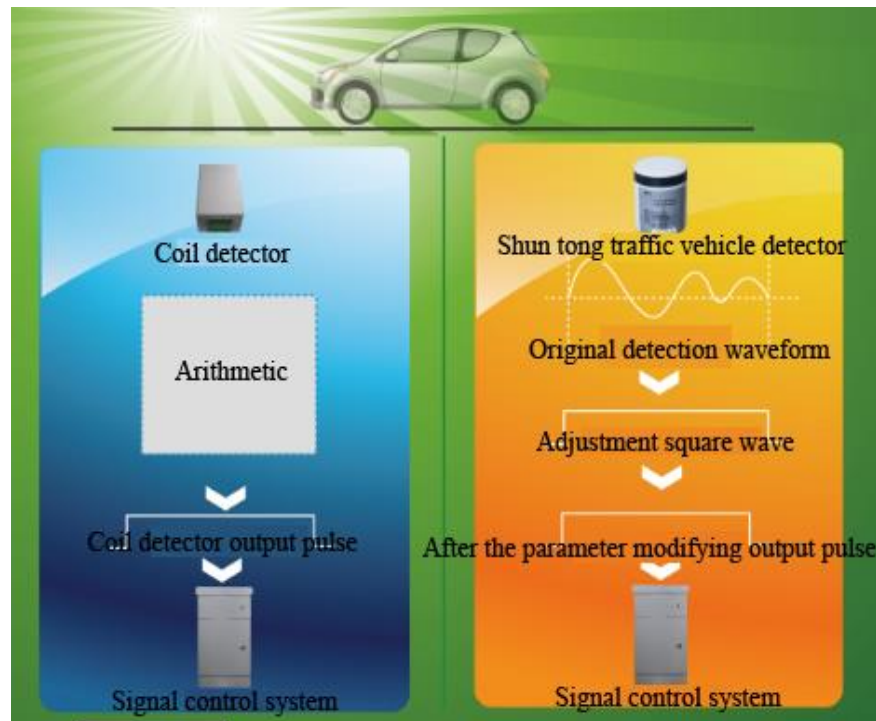
RTMS exhibits higher accuracy in detecting on high-speed highways with single vehicle types, stable traffic flow, and uniform vehicle speed distribution, and is not affected by weather conditions. However, in congested traffic conditions or areas with uneven distribution of vehicle types, especially where there are many large vehicles, the detection accuracy will dramatically decrease due to occlusion effects. Moreover, microwave vehicle detectors cannot detect stationary vehicles, making them unsuitable for installation on congested urban roads or intersections. Additionally, microwave vehicle detectors require a certain distance from the nearest lane to avoid blind spots.

### **5.4 Comparison with normal vehicle detectors**

| Comparison Item               | Video Detector              | Inductive Loop Detector     | Microwave Detector   | Magnetic Detector (VD)                        |
|-------------------------------|-----------------------------|-----------------------------|----------------------|-----------------------------------------------|
| Installation                  | Easy, quick                 | Difficult, slow             | Easy, quick          | Easy, quick                                   |
| Configuration                 | Medium                      | Easy, quick                 | Medium               | Easy                                          |
| Detection Accuracy            | Visual confirmation         | Assumed                     | Assumed              | Assumed                                       |
| Flexibility                   | Flexible                    | Not flexible                | Flexible             | Flexible                                      |
| Detection Area                | Up to 8 lanes               | 1 lane                      | Up to 8 lanes        | 1 lane                                        |
| Sensitivity                   | Moving and stopped vehicles | Moving and stopped vehicles | Only moving vehicles | Moving and stopped vehicles                   |
| Directionality                | 4 directions                | Not applicable              | 2 directions         | 1 direction                                   |
| Impact of Mixed Vehicle Types | Affected                    | Affected                    | Affected             | Not affected                                  |
| Maintenance Cost              | Low                         | Very high                   | Low                  | Low                                           |
| Lifespan                      | 7 years                     | Less than 5 years           | 7 years              | 6 years (battery replacement to continue use) |

## 6. Simulated loop detector output

Currently, some systems are designed to work with ground loop detectors. This requires our developed wireless magnetic vehicle detector (ClairGeo-SDET) to be able to output signals in a manner similar to ground loop detectors.



*Simulated Loop Detector*

The coil outputs generally include TTL high-active, TTL low-active, normally open, and normally closed. Ground loop detectors usually provide outputs in the form of pulses and dry contacts. The ClairGeo-SDET can fully simulate the output modes of ground loop detectors, achieving "presence" and "no vehicle" binary outputs. The occupied time can be determined based on the length and width of the ground loop installation, and the output function can be customized according to specific requirements.

The ClairGeo-SDET converts the waveform formed by the collected data into a square wave and sends it to the SDPC (Data Processing Center). The SDPC then transforms (using the output function) to generate the same square wave output as the ground loop detector.

# 7. Application

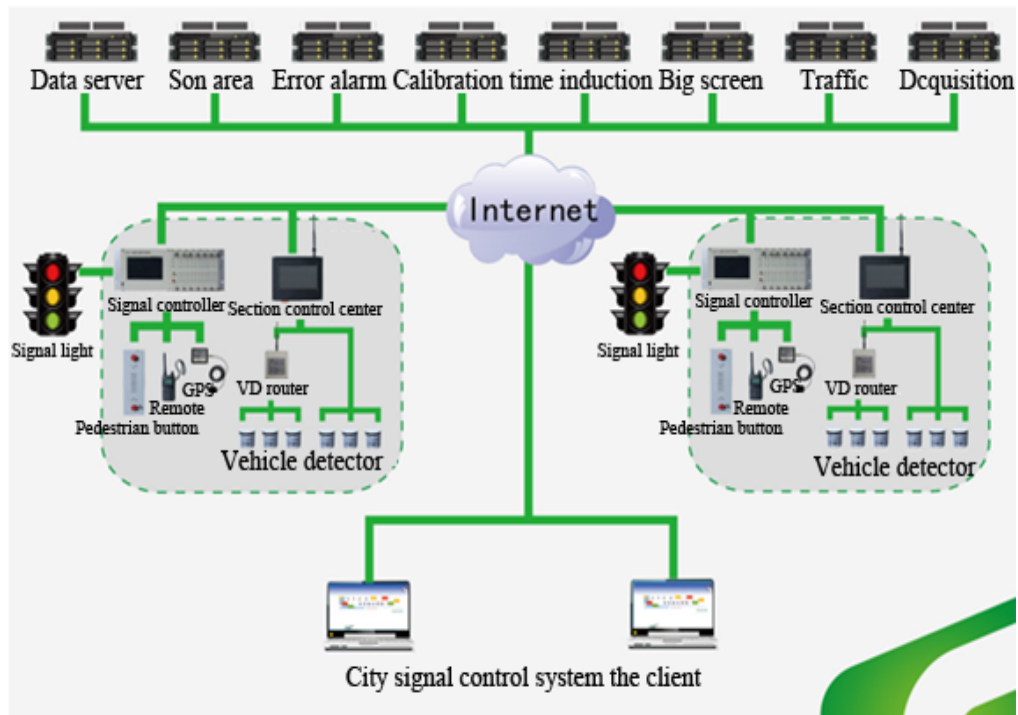
The traffic basic data collection system is widely used and can be applied in various scenarios, including:

- Inductive traffic signal control system
- Red-light violation capture system
- Speeding violation capture system
- Access control systems
- One-way street violation capture system
- No-entry violation capture system (no left turn, no right turn, restricted areas, etc.)
- No-parking zone (yellow grid) violation capture system
- Parking lot space guidance system
- Urban parking guidance system
- Urban tollgate automatic monitoring system
- Public security traffic command center system construction

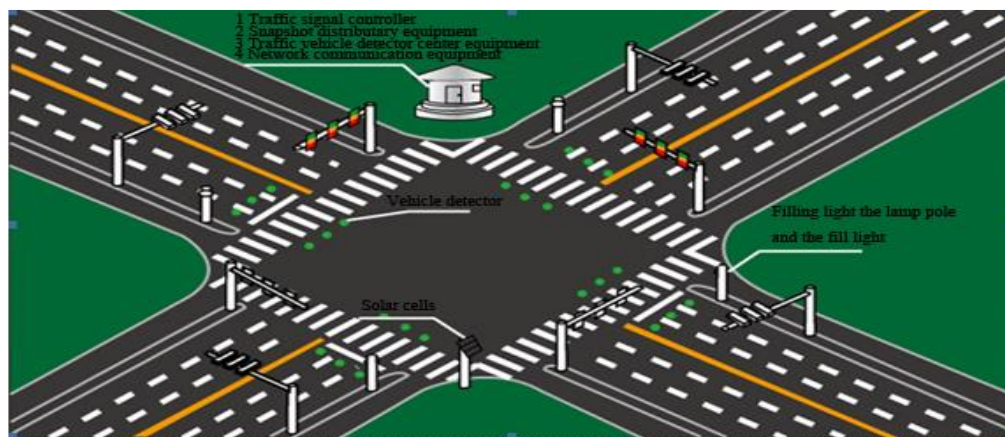
The list above is only a selection of commonly used applications. The traffic basic data collection system can be adapted and applied in various traffic management and surveillance scenarios to enhance traffic safety, efficiency, and overall management.

## 7.1 Application in Traffic Induction Algorithm

1. System structure:



2. Actual installment diagram:



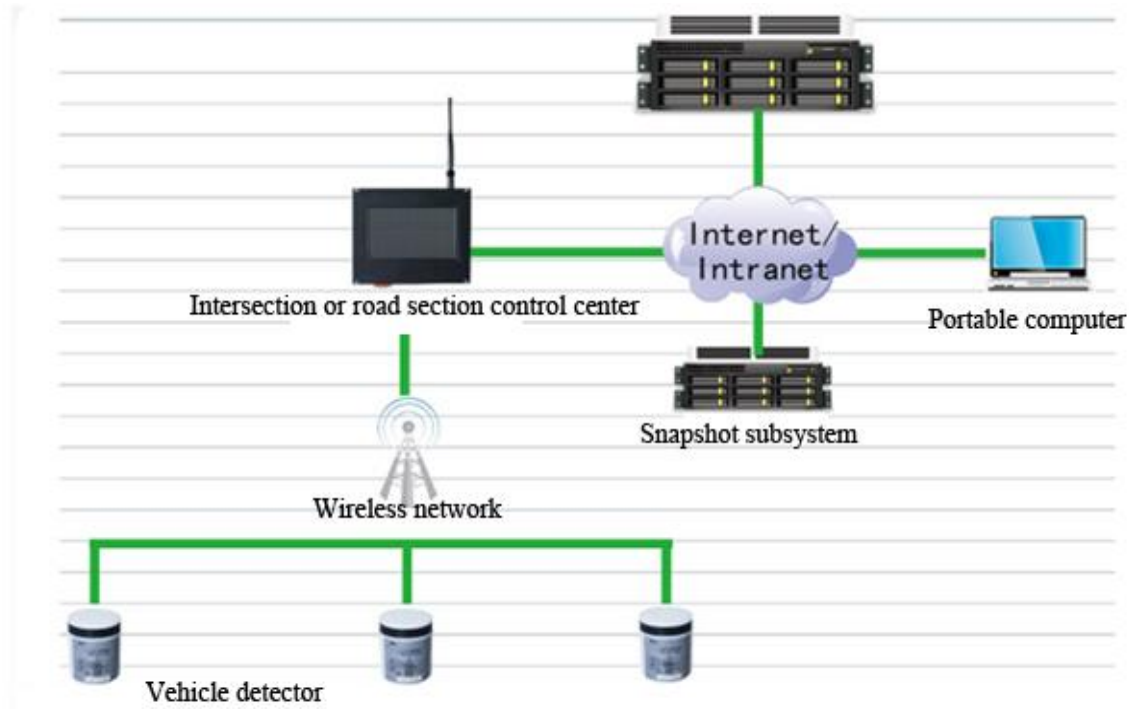
3. Explanation:

One or several detectors are installed for each lane, and the actual number and installation location are determined by traffic control algorithm.

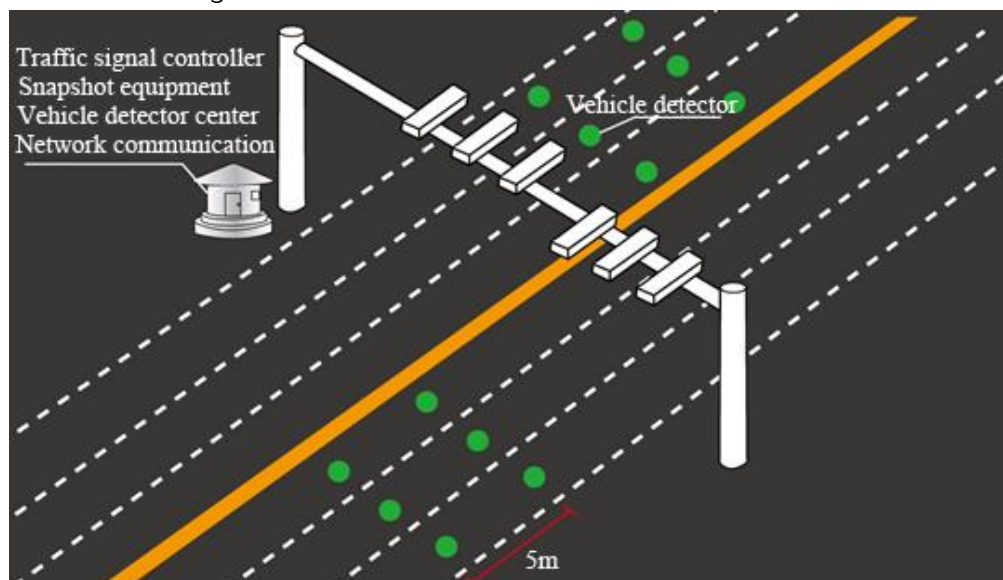
When detector cannot communicate with intersection or section acquisition center, or the number of installed detectors is over 10, detector routers must be installed.

## 7.2 Application in Speeding Snapshot System

### 1. System structure:



### 2. Actual installment diagram:



### 3. Explanation:

Detector processing center (intersection or section acquisition center) trigger signal through

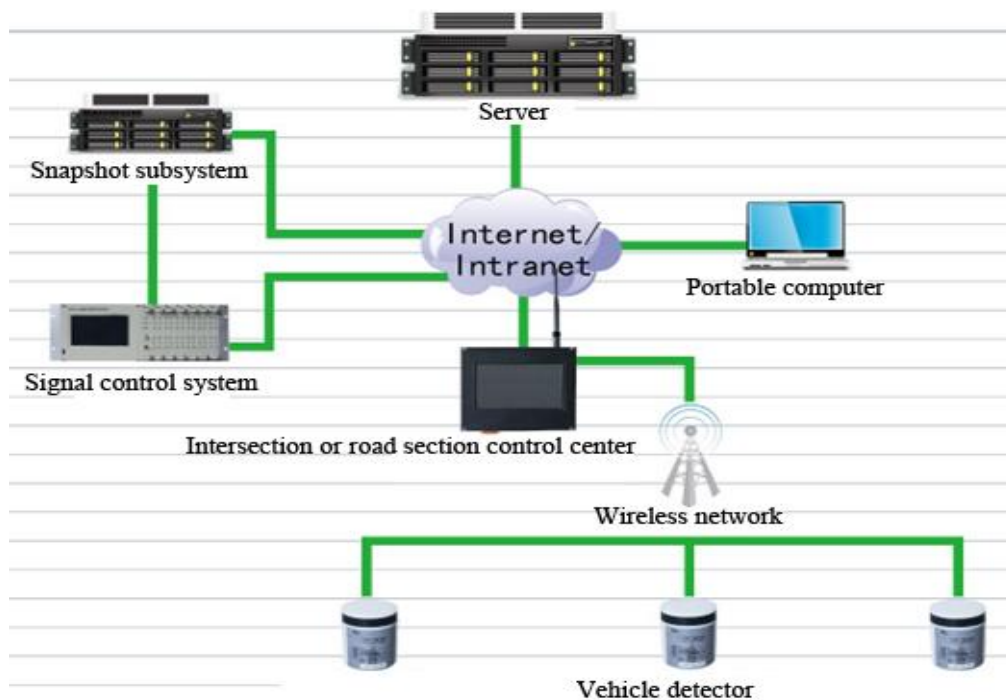
vehicle heads of 2 detectors installed for each lane. Speed is calculated using the formula of

$V = \frac{S}{t}$ , and then transmitted to vehicle identification system or urban center server.

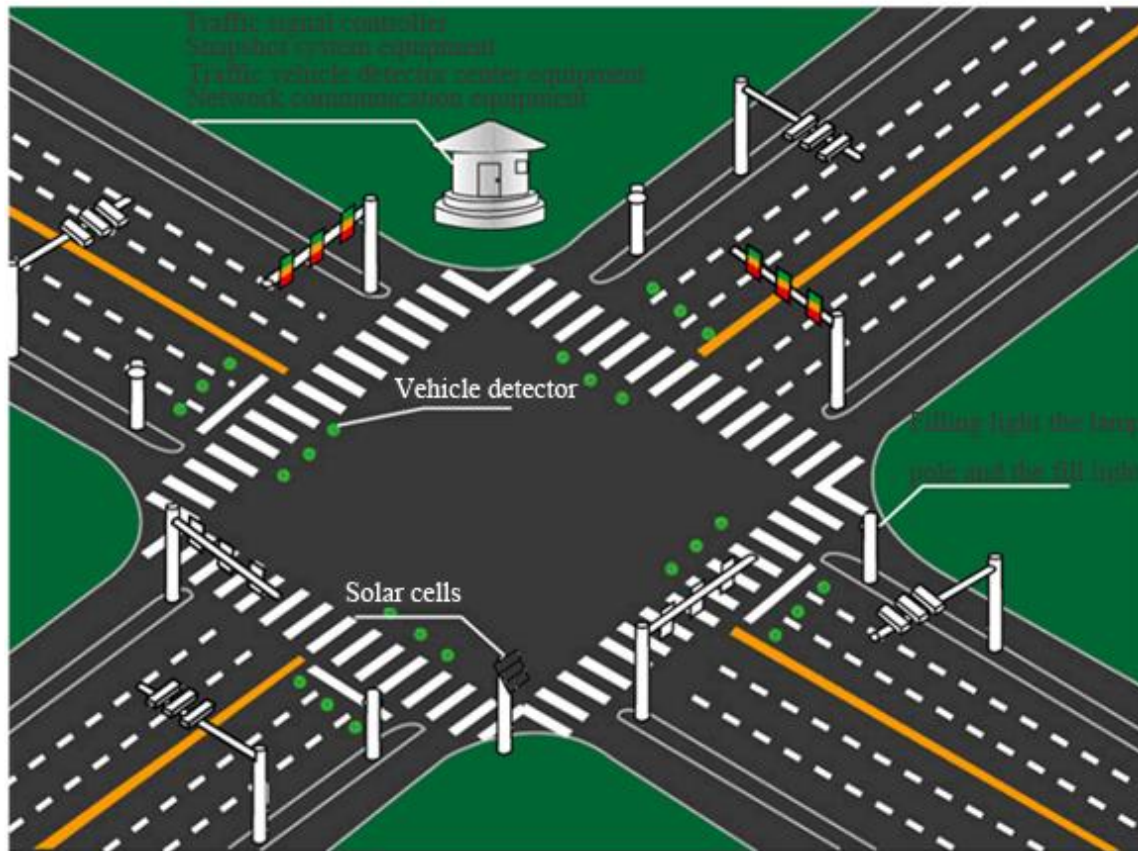
Identification system receives the speed value to judge whether there is speeding according to speedy-limiting threshold. If speeding is confirmed, the snapped images and vehicle identification information are then transmitted to urban center server.

## 7.3 Application in Traffic Light Violation Snapshot System

1. System structure:



2. Actual installment diagram:



### 3. Explanation:

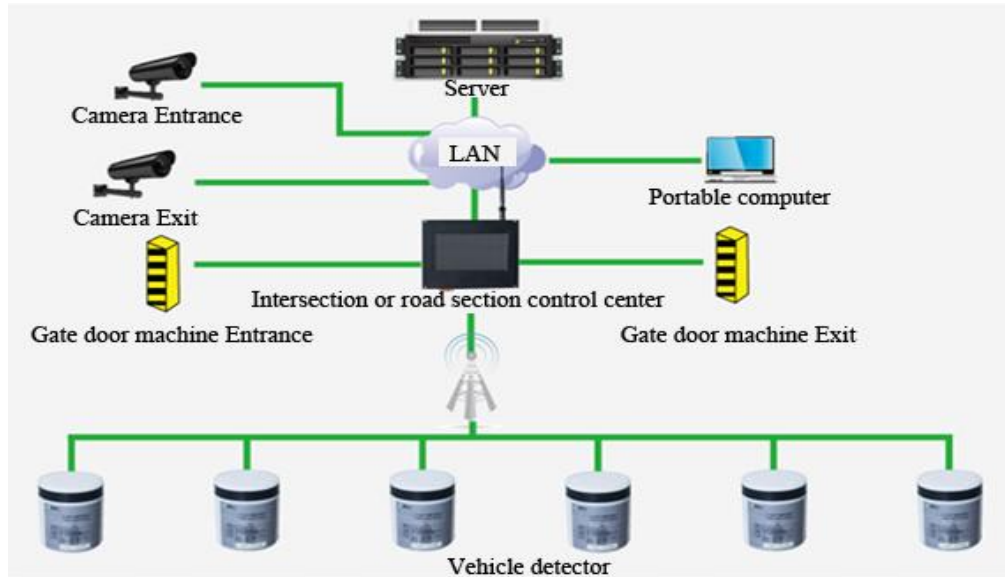
Detector processing center (intersection or section acquisition center) receives detection information from detectors in each lane, transmitting to signal controller, snapshot system, and urban center server.

When phase control is changed, signal controller informs the red light lane to snapshot system.

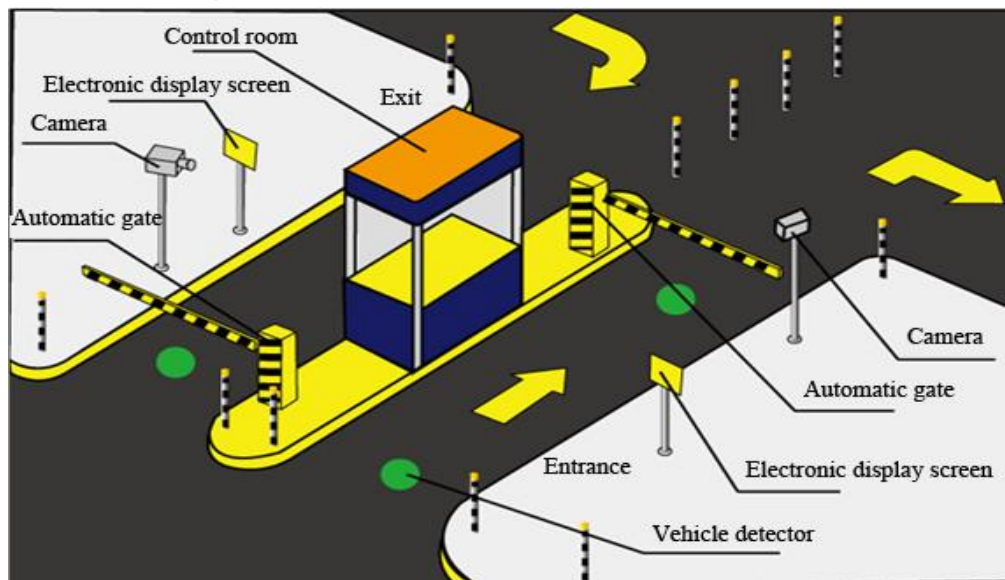
Snapshot system is triggered according to red light lane and the signal of “with vehicle” from run red light detector in the lane, the snapped image and identification information are transmitted to urban center server.

## 7.4 Application in Access Control System

### 1. System structure:



2. Actual installment diagram:

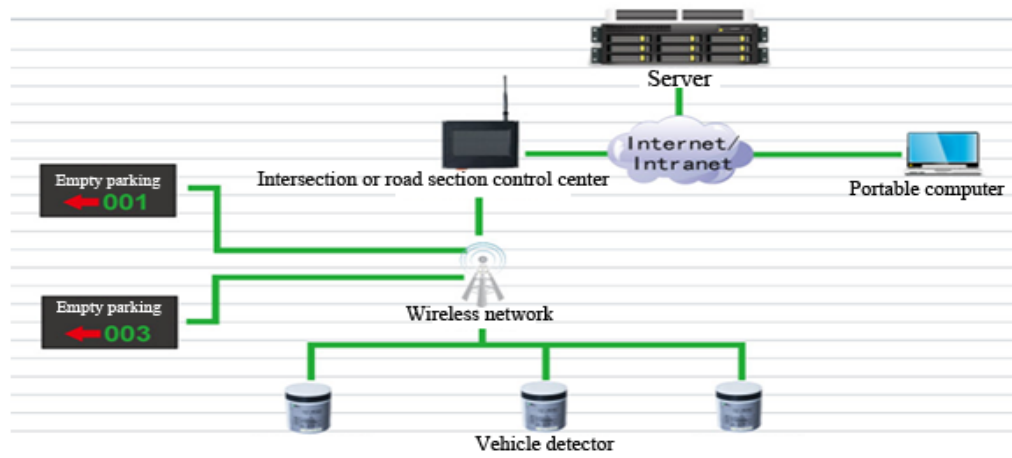


3. Explanation:

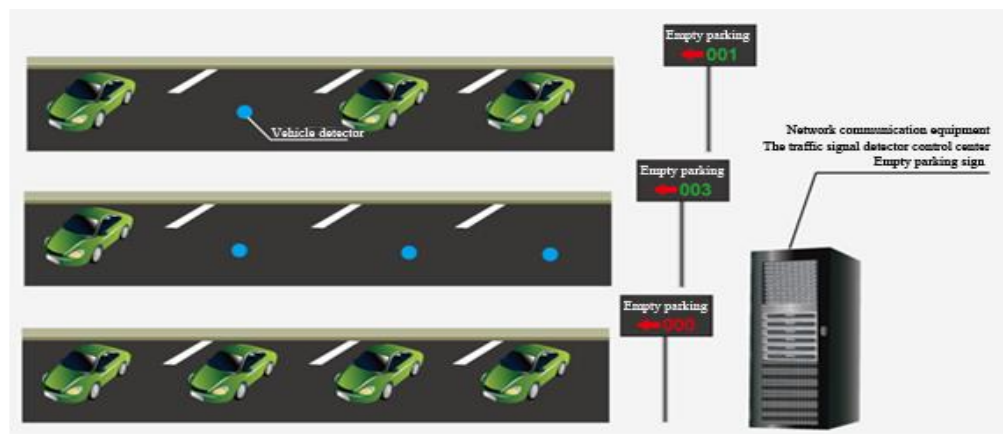
There are two processes for vehicle detector in access control system: the one is to trigger vehicle identification device to work, and the other is to control gate device up or down, and count entered/existed vehicle number.

## 7.5 Application in Urban Parking Inducible System:

1. System structure:



2. Actual installment diagram:



## 8. Transportation, storage, installation, use

### 8.1 Transportation and Storage:

The packaged products can be transported using conventional transportation tools. During transportation, avoid intense vibrations, exposure to rain or snow, direct sunlight, contact with corrosive gases, and mechanical damage. It is necessary to transport the vehicle detectors in an inverted position.

The products should be stored in a well-ventilated, dry, and storage area free from acidic, alkaline, or corrosive gases. The vehicle detectors should also be stored in an inverted position.

### 8.2 Preliminary Site Survey for Installation:

Before installation, a thorough site survey is necessary. This includes assessing the installation site, planning the positions for data processing centers, receivers, relays, vehicle detectors, and antennas based on the site conditions. Drawing a detailed layout on paper or electronically to mark the construction dimensions on the road surface is also part of the preparation process.

### 8.3 City Traffic Basic Data Collection System Installation

Each inspection point requires the following equipment:

- 1 Data Processing Center device
- 1 Receiver
- 1 Wireless Magnetic Vehicle Detector

If the number of installed detectors exceeds 16, it will be necessary to install a repeater to extend the wireless communication range and accommodate additional detectors in the network.

The number of repeaters:

$$N_r = INT(\frac{N_c + 1}{12})$$

Where  $N_r$  is the number of repeater,  $N_c$  is the number of vehicle detector, and INT means integral number.

For each intersection (site), the following equipment needs to be installed:

- Wireless Magnetic Vehicle Detector
- Data Processing Center
- Receiver
- Relay (if the number of detectors exceeds 16)

At the city management center or management department, the following equipment needs to be installed:

- City Center Server
- Management Client

## 8.4 Installation of Wireless Magnetic Vehicle Detector

### 8.4.1 Preparation of Equipment



*Wireless Magnetic Vehicle Detector*

### 8.4.2 Number of Installations

The number of wireless magnetic vehicle detectors to be installed depends on the application method and the specific requirements for each type of detector:

- Full-Function Detector: Install at least 1 unit per lane.
- Speed Detection Detector: Install 2 units per lane.
- Queue Length Detection Detector: The number of installations is not fixed. Generally, install

- 1 unit every 10 meters backward from the stop line.
- Red Light Trigger Detector: Install 1 unit per lane.
- Front Road Segment Full of Parked Vehicles Trigger Detector: Install 1 unit per lane.

### 8.4.3 Installation Tools

The following tools are required for the installation of the wireless magnetic vehicle detectors:

- Drilling Machine (Water Drilling)
- Drill Bit with an external diameter of  $\Phi 102\text{mm}$
- Water Bucket and Water
- Iron Hammer
- Rubber Mallet
- Iron Chisel
- Water Boots
- Screwdriver
- Epoxy Resin
- Fine Sand
- Measuring Tape
- Iron Shovel
- Water Pumping Tool
- Specialized Extrusion Tool



*Road Drilling Machine*

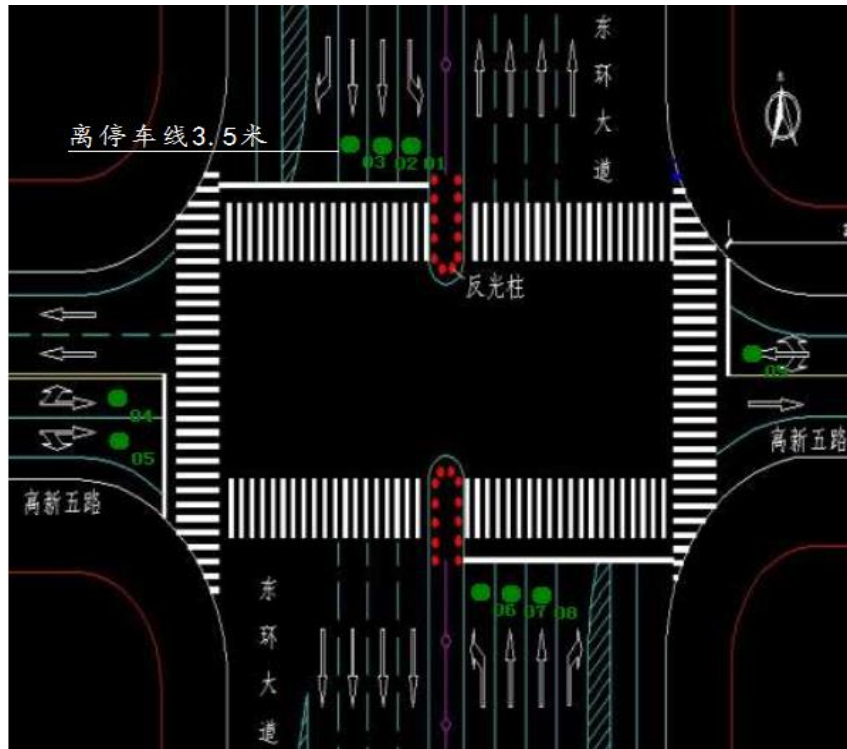
## 8.4.4 Installation of the Vehicle Detector

- Use a highway drilling machine to drill a hole with a depth of >130mm.
- Place the inverted vehicle detector into the hole in an upright position. If the top of the vehicle detector is below the road surface, add fine sand at the bottom. If it is above the road surface, it indicates that the depth of the hole is insufficient. After leveling it with the road surface, use a specialized extrusion tool to secure it.
- Other Notes: The wireless magnetic vehicle detector is inverted and in a power-off state for power-saving purposes during transportation. When installing it officially, place it in an upright position. Determine the installation position based on the function of the vehicle detector.
- Caution: The installation position should not be too close to high-voltage cables, as it may affect the normal operation of the wireless magnetic vehicle detector.

## 8.4.5 Installation position

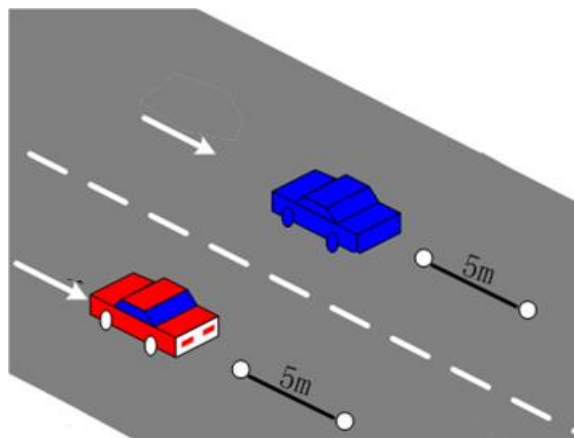
For each lane that requires detection, at least one vehicle detector should be installed. The specific installation quantity depends on the application method.

For SCATS (Sydney Coordinated Adaptive Traffic System) system, the vehicle detector should be installed 3.5 meters behind the stop line, on the centerline of the lane, as shown in the diagram below:



*The green dots represent the detectors.*

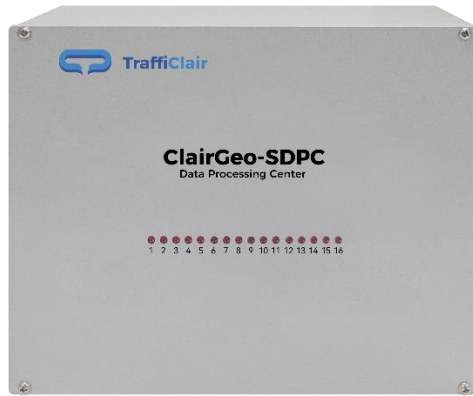
If detecting speed, one lane requires the installation of 2 detectors. The distance between each detector and the stop line can be set through the management software or data processing center. To ensure accuracy, the distance between the two detectors should be at least 3 meters and should not exceed 6 meters.



*Speeding Vehicle Detector Installation Position Diagram*

## 8.5 Installation of Data Processing Center

### 8.5.1 Preparation of the equipment



*Data Processing Center*

The data processing center equipment has the following peripheral interfaces:  
RS485, RS232, Ethernet, USB, I/O Ports

### 8.5.2 Installation Quantity:

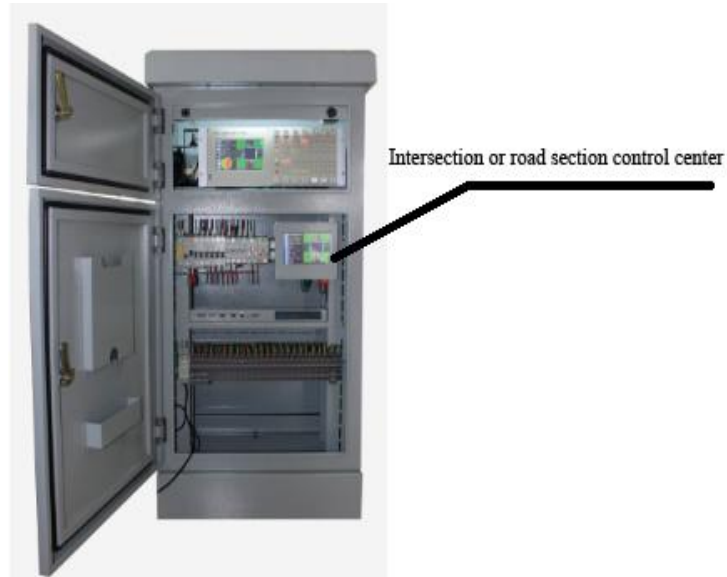
One data processing center is installed per intersection or road section.

### 8.5.3 Data Processing Center Installation:

- Place the data processing center inside the equipment rack and secure it.
- Connect the 220V AC power supply cables: ground (GND), live (L), and neutral (N).

### 8.5.4 Installation Position:

The data processing center can be installed in the intersection cabinet, road section cabinet, or other system cabinets.



*Installation location for data processing center*

The bracket for the data processing center is optional and can be selected based on the specific conditions of the equipment rack.

#### **8.5.5 Data Processing Center Connection with Other Equipment:**

- The data processing center equipment sends the collected basic data to the city data center through Ethernet, 3G, or other means. It requires ordinary twisted pair cables to connect with a hub, router, or 3G DTU (Data Terminal Unit).
- It is connected to SCATS through a 37-core cable using the SDPC type data processing center.



- For other signal controllers, serial cables, Ethernet cables, or IO cables can be used for output connections.

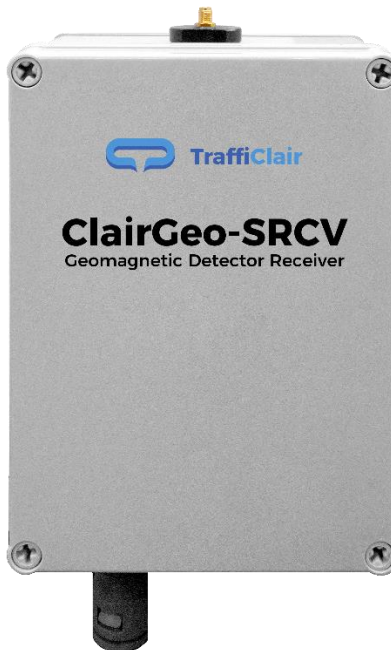
Once both the data processing center and the receiver are installed, perform actual communication tests to check the signal line connections. After powering on, if a green dot

appears in the middle of the interface, it indicates that the connection between the data processing center and the receiver is normal.

## 8.6 Receiver Installation

### 8.6.1 Equipment Preparation:

- Receiver



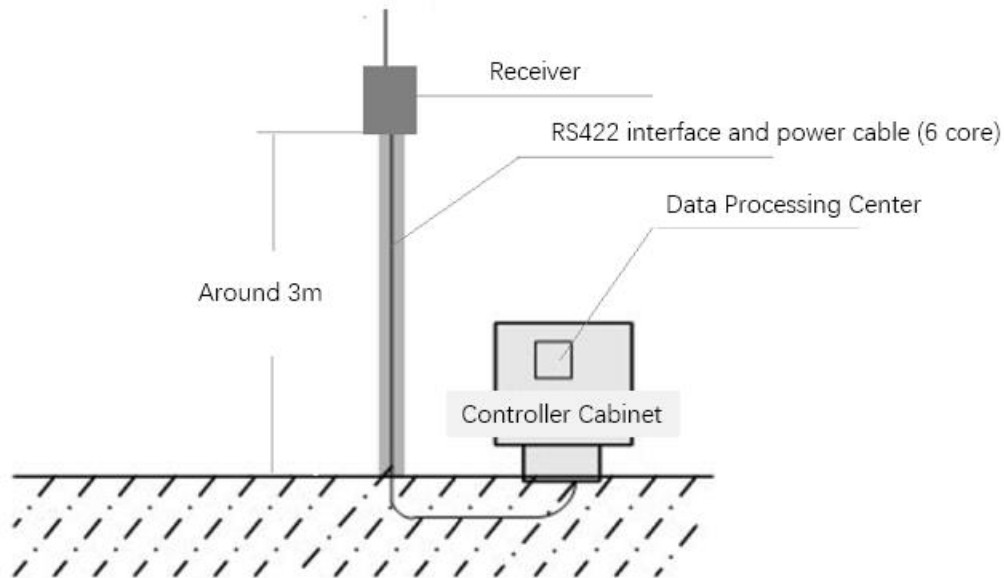
### 8.6.2 Installation Quantity:

- The number of receivers should be consistent with the number of data processing centers at the site.

### 8.6.3 Receiver Installation:

- Fix the receiver on a suitable pole near the data processing center.
- Connect the receiver to the data processing center using a six-core cable.

The connection between the data processing center and the receiver is shown in the diagram below: (Please refer to the provided diagram for details)



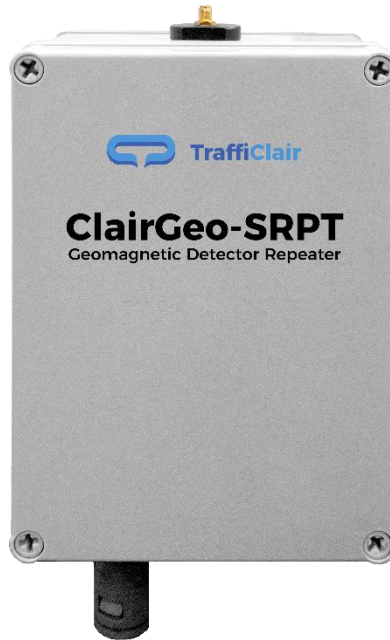
#### 8.6.4 Installation Location:

The receiver should be installed on a suitable pole near the data processing center, such as a traffic signal pole or a red-light camera pole. It is important to ensure that the six-core cable can pass through the pole and that there are no significant obstructions around the receiver that could block the signal.

### 8.7 Repeater Installation

#### 8.7.1 Equipment Preparation

Repeater



### 8.7.2 Number of Installations

The repeater should be installed under the following circumstances:

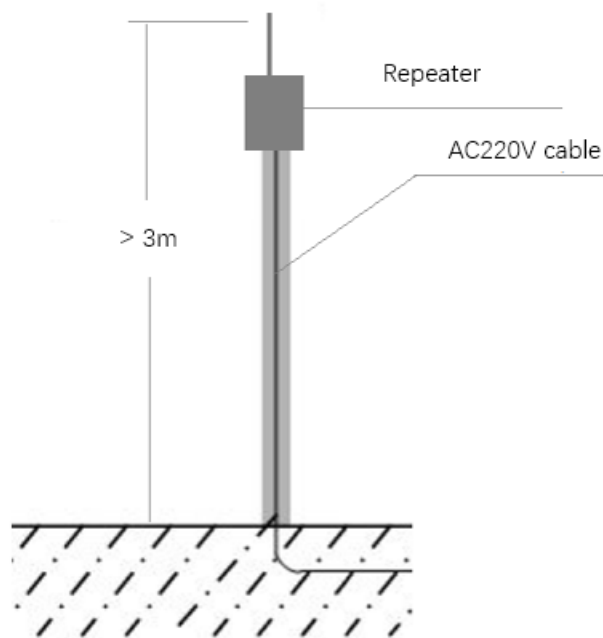
- When there are obstructions between the detector and the receiver, a repeater is needed.
- When the visible distance between the detector and the receiver exceeds 150 meters, a repeater is needed.
- If the number of detectors at an intersection exceeds 16, a repeater is needed. The number of repeaters required can be determined using the following formula:

$$N_r = INT\left(\frac{N_c - 1}{16}\right)$$

Where  $N_r$  is the number of repeater,  $N_c$  is the number of vehicle detector, and INT means integral number.

### 8.7.3 Repeater Installation

- repeater only needs to be powered.



#### 8.7.4 Installation Position

The repeater can be installed on signal poles, electronic police poles, or solar power poles.

- If installed on a signal pole or electronic police pole, connect the AC 220V power supply to the L and N terminals inside the repeater.
- If installed on a solar power pole, connect the solar panel output power line to the solar power input terminal inside the repeater.
- The repeater has installation holes at the back, which can be fixed to the pole using clamps or brackets.

### 8.8 Field Parameter Configuration

Field parameters are configured through the data processing center using the touchscreen. The main configurations include:

- Setting the wireless network ID for the intersection or section. Typically, it is set to the intersection code (numeric).
- Configuring SDPC communication parameters, including the intersection or section code, IP address, server IP address, etc.
- Configuring SDPC communication with the signal controller.

### Parameters of Communication

|                        |                |                                                                                                                             |               |                                             |              |
|------------------------|----------------|-----------------------------------------------------------------------------------------------------------------------------|---------------|---------------------------------------------|--------------|
| Intersection ID        | 20000024       |                                                                                                                             | Version       | V1.4910                                     |              |
| Local IP               | 192.168.1.47   | Mask                                                                                                                        | 255.255.255.0 | Gateway                                     | 192.168.1.1  |
| Server IP              | 192.168.1.254  | Port                                                                                                                        | 8630          | Debug IP                                    | 192.168.2.48 |
| Other IP               | 192.168.1.254  | Port                                                                                                                        | 2000          | I/O Setting                                 | 1            |
| Protocol of Ethernet   | 10             | Protocol of Serial                                                                                                          | 1             | Baud Rate                                   | 115200       |
| Coordinator            | Internal Port2 | Serial Select                                                                                                               | 232           | I/O Board                                   | Common       |
| Interval Time of Serve | 60             | <input type="checkbox"/> Send Data to Server                                                                                |               | <input type="checkbox"/> Send Data to Other |              |
| Interval Time of Other | 60             | Other Communication <input type="checkbox"/> Ethernet <input type="checkbox"/> Uart <input checked="" type="checkbox"/> I/O |               |                                             |              |

Save

Tab 1 2 3 Bksp  
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 Del 7 8 9

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- Configure the location information of the vehicle detectors.

### Location Information of VD

VD ID

X

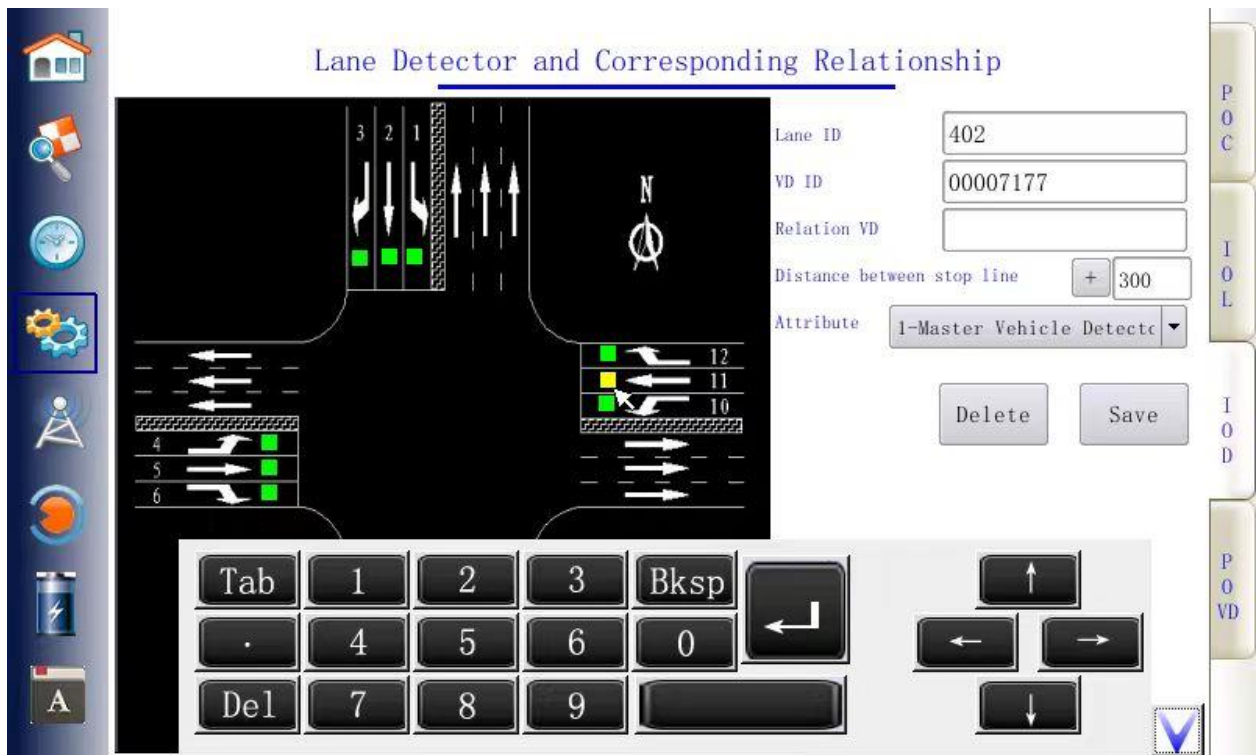
Y

Pic Delete Save

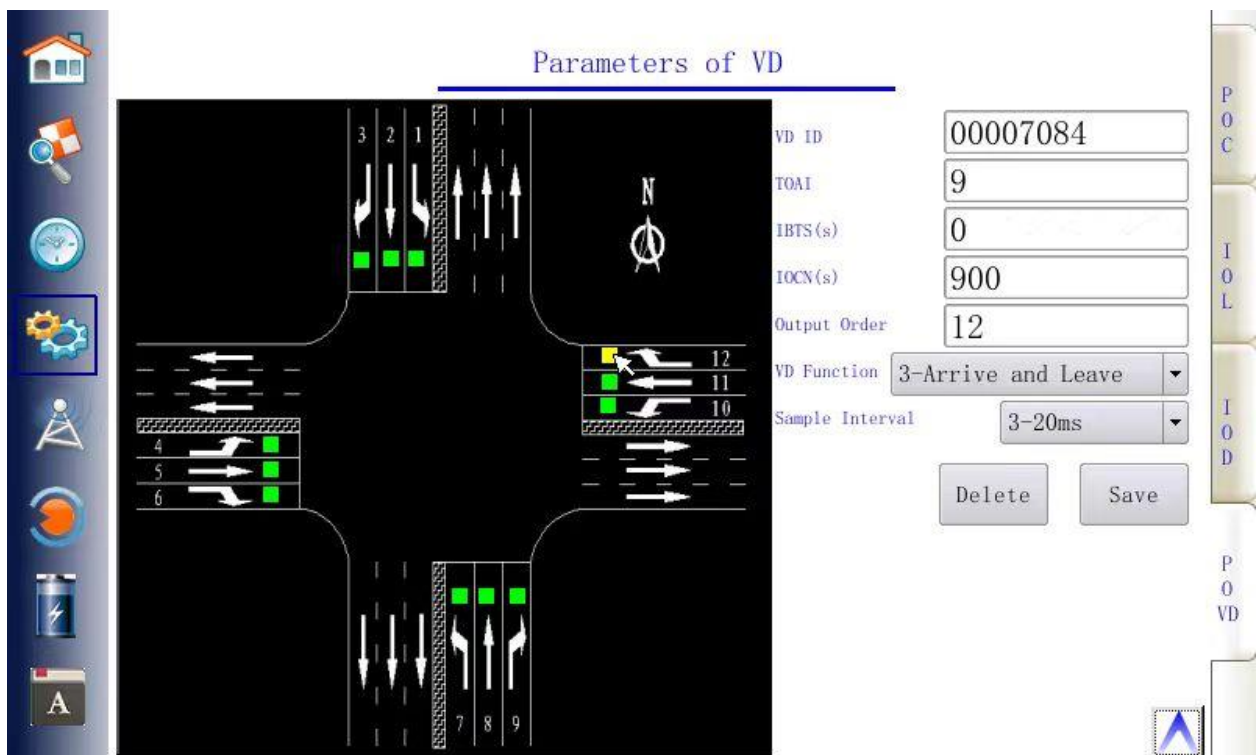
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- Configure the mapping between the vehicle detectors and the lanes.



- Configure the operating parameters of the vehicle detectors.



- Information browsing.





Note: The codes of the vehicle detectors are determined and set before leaving the factory.

## 8.9 City Center Server Installation

Server Configuration:

- CPU: At least 2.0GHz clock speed.
- Memory: At least 2.0GB RAM.
- Hard Drive: At least 140GB storage capacity.
- Network Card: 1000M (1Gbps) Ethernet.
- Internet Connection Speed: Broadband with at least 2Mbps bandwidth.
- Operating System: Windows 7 Service Pack 1.

Install Service Program:

- The installation files are included in the system distribution CD.
- Locate and run "VehicleDetectorServiceSetup.msi".
- Follow the default options during the installation process.
- After installation, you will find the "VehicleDetectorService" in Windows services.
- If using a server load balancing solution, additional configurations will be required.

## 8.10 Management Client Installation

Management Client Configuration:

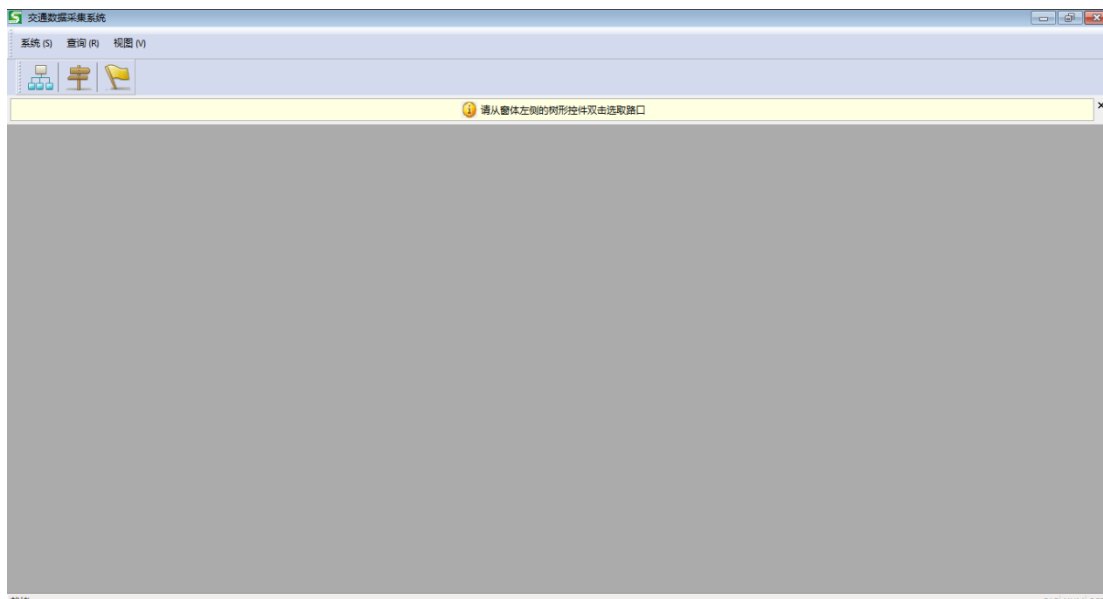
- CPU: At least 2.0GHz clock speed.
- Memory: At least 2.0GB RAM.
- Hard Drive: At least 140GB storage capacity.
- Network Card: 100M (100Mbps) Ethernet.
- Operating System: Windows 7 SP1 or Windows 2008 Server.

Install Management Client Program:

- The installation files are included in the system distribution CD.
- Locate and run "Traffic Data Collection System.msi".
- Follow the default options during the installation process.
- After installation, you will find the following icon on your desktop:

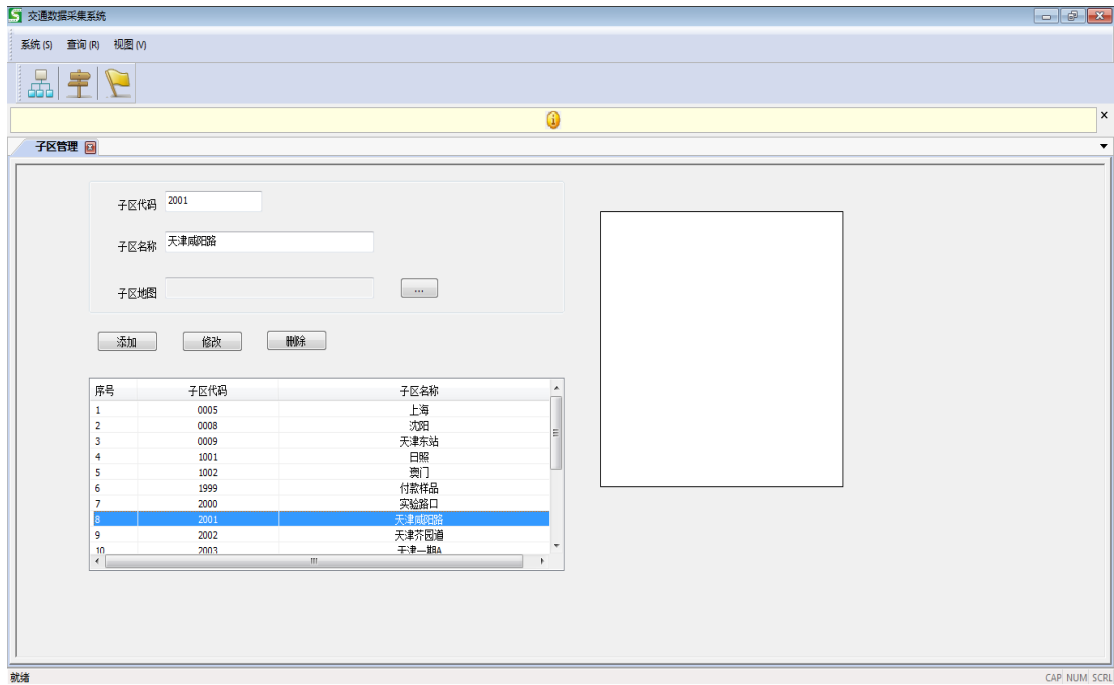


(Double-click to launch the Management Client)

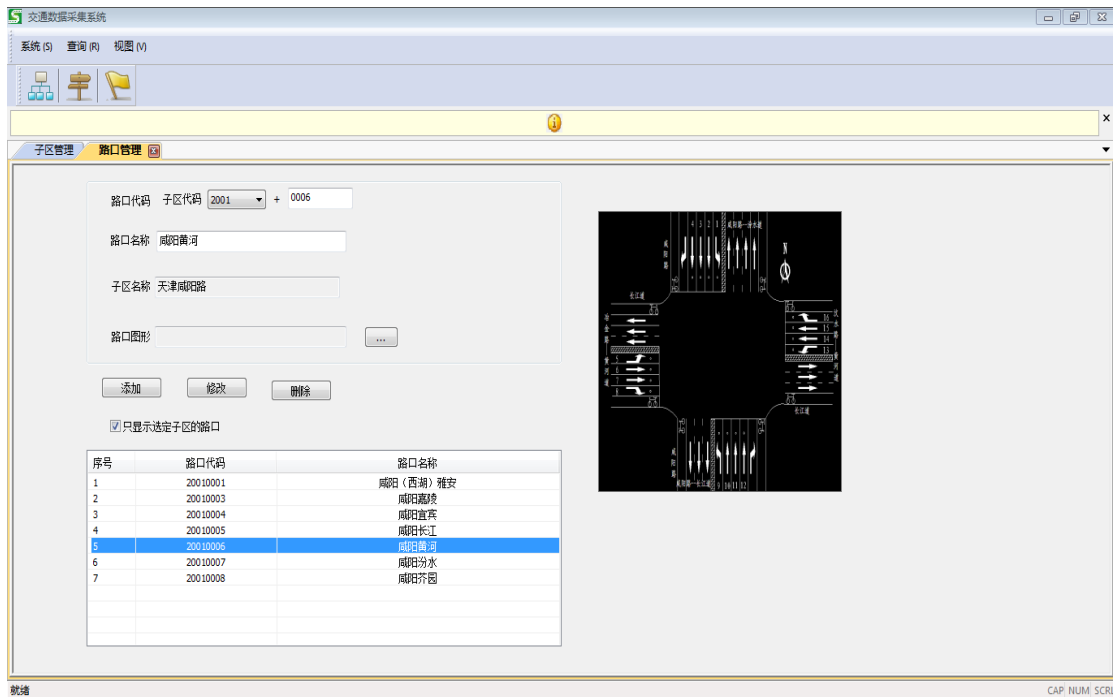


## 8.11 Client Functions

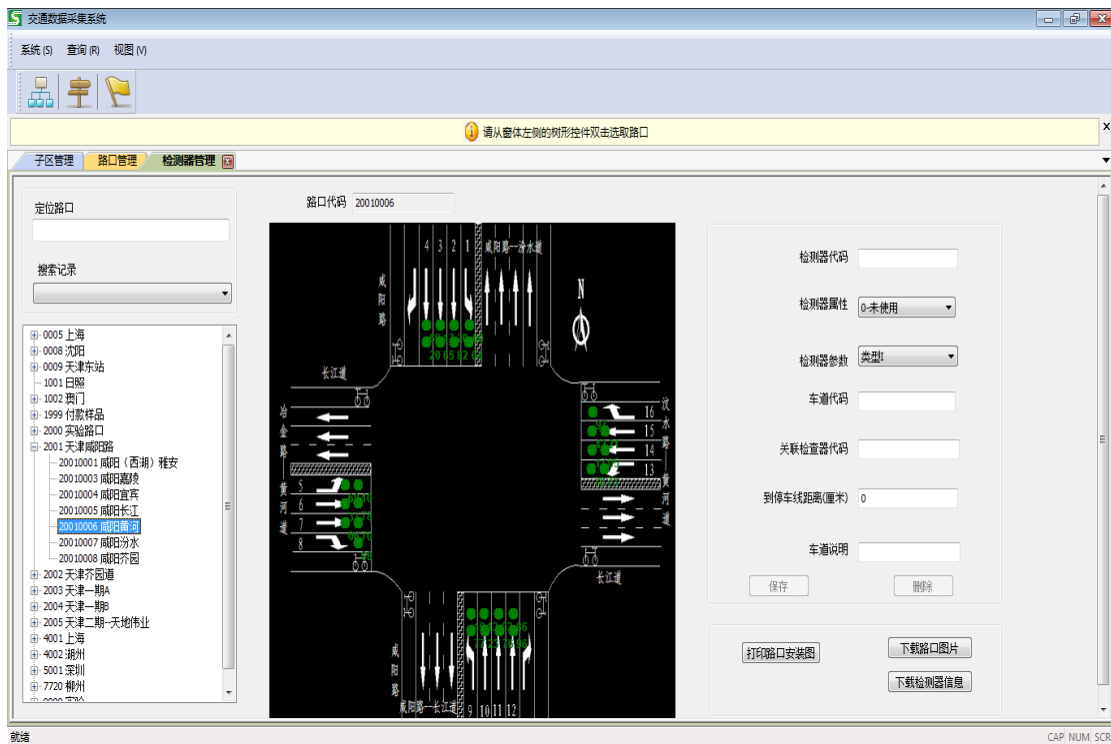
## 8.11.1 Subzone Management



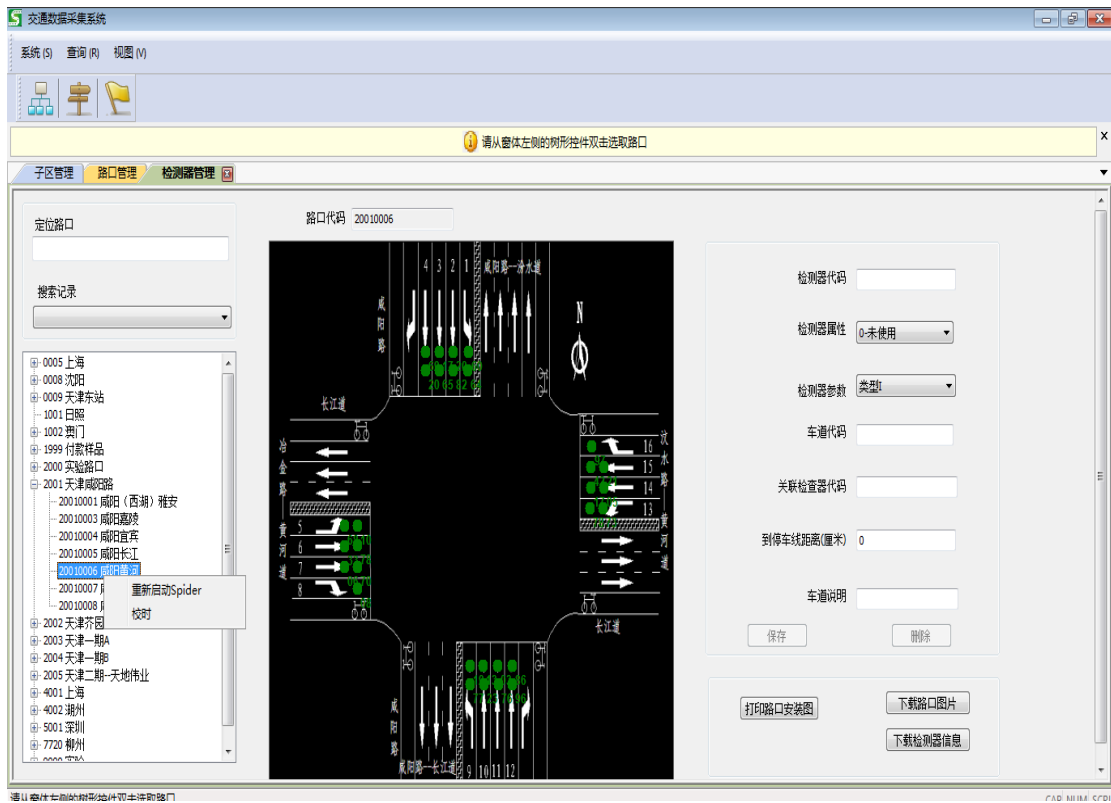
## 8.11.2 Intersection Management



### 8.11.3 Detector Management



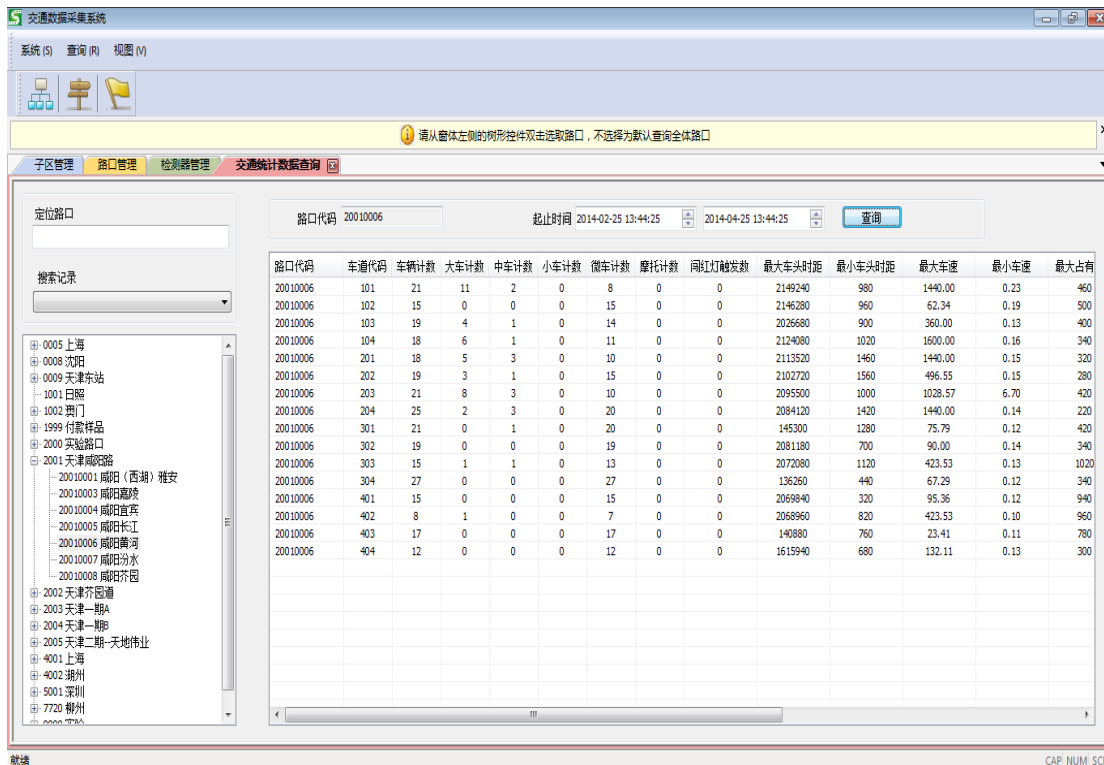
In the Detector Management interface, you can set the position, lane, and operating parameters of the vehicle detectors. Right-click on the corresponding intersection to adjust the time and restart the data processing center:



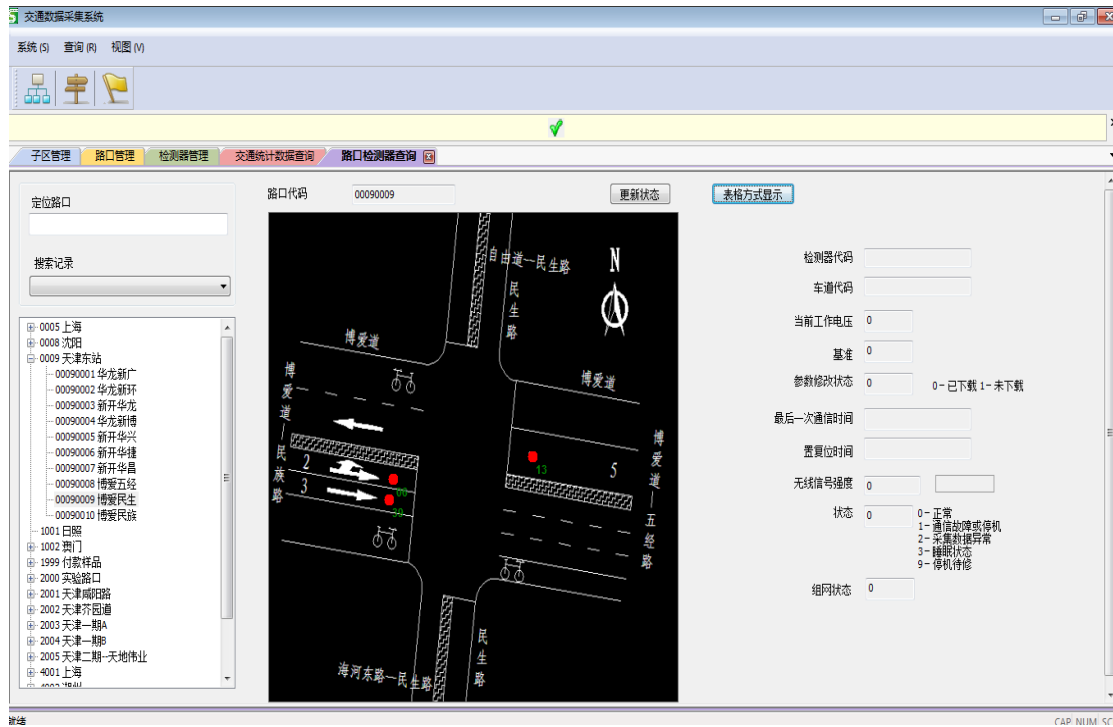
## 8.11.4 Traffic Statistics Data Query



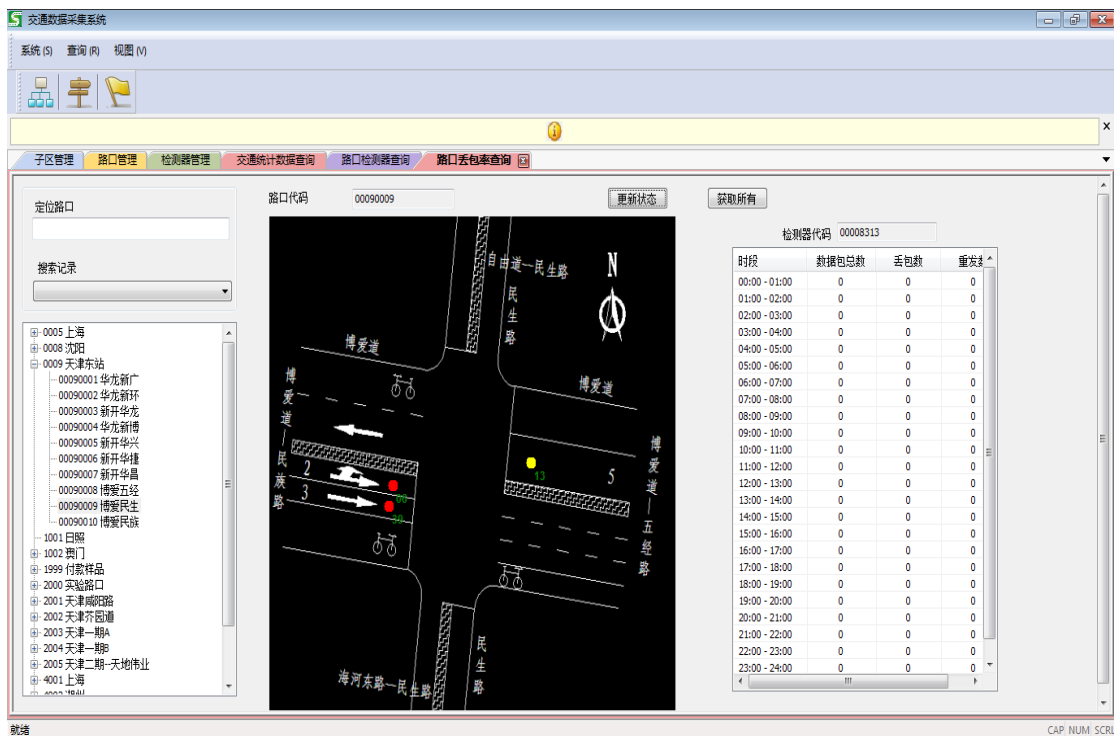
You can perform statistical queries on selected intersections based on lanes and time periods:



## 8.11.5 Intersection Detector Status Query



## 8.11.6 Intersection Detector Packet Loss Rate Query



You can check the wireless data packet loss of each detector at the selected intersection within the last 24 hours.

8.11.7 Detector Fault Query

交通数据采集系统

系统(S) 查询(Q) 视图(V)

子区管理

路口管理

检测器管理

交通统计数据查询

路口检测器查询

路口丢包率查询

故障查询

定位路口

搜索记录

0005 上海

0008 沈阳

0009 天津东站

00090001 华龙新广

00090002 华龙新环

00090003 新开华龙

00090004 华龙新博

00090005 新开华兴

00090006 新开华佳

00090007 新开华昌

00090008 博爱五经

00090009 博爱民生

00090010 博爱民族

1001 日照

1002 贵门

1999 付家坪品

2000 实验路口

2001 天津南阳路

2002 天津芥园道

2003 天津一期A

2004 天津一期B

2005 天津二期-天地伟业

4001 上海

路口代码 00090009

☒ 未处理 ☐ 已处理

查询

| 路口代码     | 时间                  | 故障类型代码 | 故障描述       | 故障级别 | 故障设备代码       | 故障状态 | 备注 |
|----------|---------------------|--------|------------|------|--------------|------|----|
| 00090009 | 2014-04-14 15:10:48 | 1      | Lose Error | 1    | 10108206     | 8    |    |
| 00090009 | 2014-04-14 15:37:31 | 1      | VD Error   | 1    | 00008206:101 | 1    |    |
| 00090009 | 2014-04-14 15:48:53 | 1      | VD Recover | 1    | 00008206:101 | 0    |    |
| 00090009 | 2014-04-14 16:37:52 | 1      | VD Error   | 1    | 00008206:101 | 1    |    |
| 00090009 | 2014-04-15 09:21:24 | 1      | VD Error   | 1    | 00008206:101 | 1    |    |
| 00090009 | 2014-04-15 09:26:58 | 1      | VD Recover | 1    | 00008206:101 | 0    |    |
| 00090009 | 2014-04-15 10:03:08 | 1      | Lose Error | 1    | 00008206:101 | 8    |    |
| 00090009 | 2014-04-15 10:47:56 | 1      | VD Error   | 1    | 00008206:101 | 1    |    |
| 00090009 | 2014-04-15 11:12:46 | 1      | Lose Error | 1    | 00008313:103 | 8    |    |
| 00090009 | 2014-04-15 11:29:54 | 1      | VD Recover | 1    | 00008206:101 | 0    |    |
| 00090009 | 2014-04-15 11:52:30 | 1      | VD Error   | 1    | 00008206:101 | 1    |    |
| 00090009 | 2014-04-15 13:23:53 | 1      | VD Error   | 1    | 00008239:102 | 1    |    |
| 00090009 | 2014-04-15 13:25:49 | 1      | VD Recover | 1    | 00008239:102 | 0    |    |
| 00090009 | 2014-04-15 14:09:11 | 1      | VD Error   | 1    | 00008239:102 | 1    |    |
| 00090009 | 2014-04-15 14:13:27 | 1      | VD Recover | 1    | 00008239:102 | 0    |    |
| 00090009 | 2014-04-15 14:13:27 | 1      | Lose Error | 1    | 00008239:102 | 8    |    |
| 00090009 | 2014-04-15 14:34:10 | 1      | VD Error   | 1    | 00008239:102 | 1    |    |
| 00090009 | 2014-04-15 14:53:47 | 1      | VD Recover | 1    | 00008239:102 | 0    |    |
| 00090009 | 2014-04-15 15:13:15 | 1      | VD Error   | 1    | 00008313:103 | 1    |    |
| 00090009 | 2014-04-15 15:15:37 | 1      | VD Recover | 1    | 00008313:103 | 0    |    |
| 00090009 | 2014-04-15 15:16:16 | 1      | VD Error   | 1    | 00008239:102 | 1    |    |
| 00090009 | 2014-04-15 15:19:51 | 1      | VD Recover | 1    | 00008239:102 | 0    |    |
| 00090009 | 2014-04-15 15:38:52 | 1      | VD Error   | 1    | 00008313:103 | 1    |    |
| 00090009 | 2014-04-15 15:42:54 | 1      | VD Recover | 1    | 00008313:103 | 0    |    |

就绪CAP NUM SCR

## 8.11.8 Client Communication Parameter Settings

The screenshot displays the '系统参数配置' (System Parameter Configuration) window of the '交通数据采集系统' (Traffic Data Collection System). The window has a title bar with the system name and standard Windows window controls. Below the title bar is a menu bar with '系统 (S)', '查询 (Q)', and '视图 (V)'. A toolbar with icons for system management, query, and view is located below the menu bar. A yellow status bar contains a warning icon and the text: '请从窗体左侧的树形控件双击选取路口, 不选择为默认查询全体路口' (Please double-click to select the intersection from the tree control on the left side of the window, do not select as the default query for all intersections). Below the status bar is a tabbed interface with the following tabs: '子区管理' (Sub-area Management), '路口管理' (Intersection Management), '检测器管理' (Detector Management), '交通统计数据查询' (Traffic Statistics Query), '路口检测器查询' (Intersection Detector Query), '路口吞吐量查询' (Intersection Throughput Query), '故障查询' (Fault Query), and '系统参数配置' (System Parameter Configuration). The '系统参数配置' tab is active. The main content area is divided into two sections: '数据库设置' (Database Settings) and '网络设置' (Network Settings). The '数据库设置' section has three radio buttons: 'SQL Server' (selected), 'Oracle', and 'Access'. Below these are input fields for '服务器名:' (192.168.1.119\jwRQDB), '数据库名:' (STDZ\_DAS), '用户名:' (.), and '用户密码:' (\*\*\*\*\*). A '测试数据库' (Test Database) button is located below the password field. The '网络设置' section has input fields for '服务IP地址:' (192.168.1.119) and '服务端口号:' (8630). An '应用' (Apply) button is located at the bottom right of the '网络设置' section. The bottom status bar shows '就绪' (Ready) on the left and 'CAP, NUM, SCRL' on the right.

交通数据采集系统

系统 (S) 查询 (Q) 视图 (V)

请从窗体左侧的树形控件双击选取路口, 不选择为默认查询全体路口

子区管理 路口管理 检测器管理 交通统计数据查询 路口检测器查询 路口吞吐量查询 故障查询 系统参数配置

数据库设置

☒ SQL Server ☐ Oracle ☐ Access

服务器名: 192.168.1.119\jwRQDB 数据库名: STDZ\_DAS

用户名: . 用户密码: \*\*\*\*\*

测试数据库

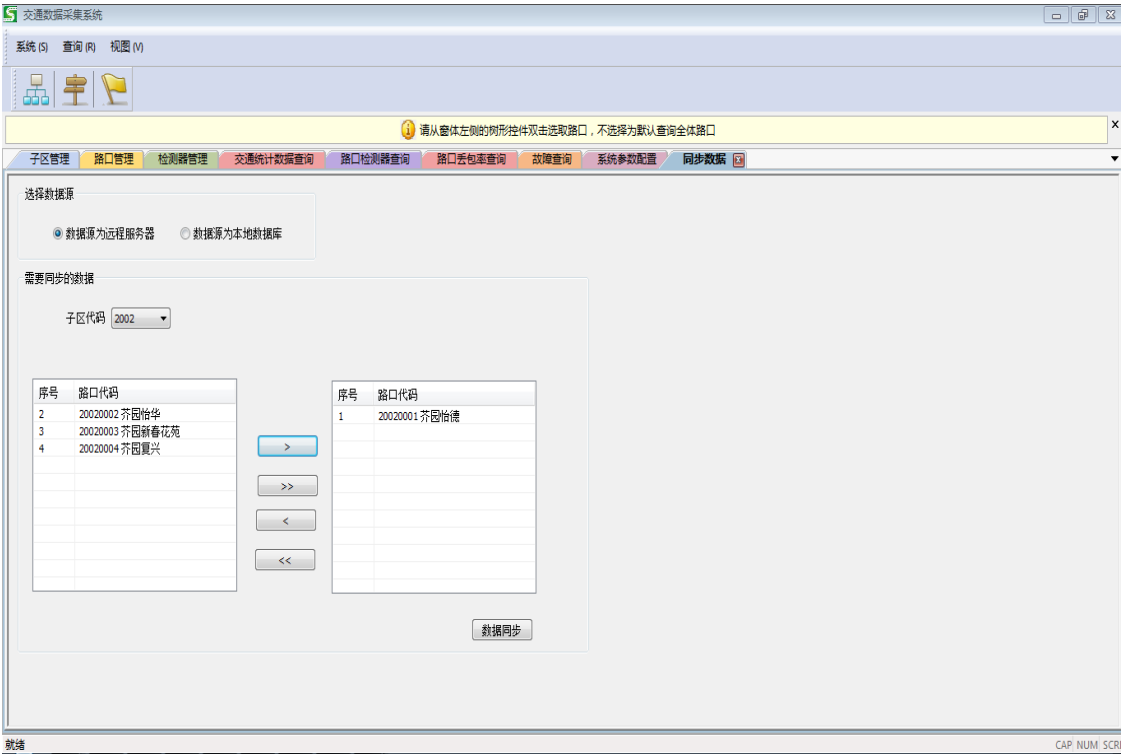
网络设置

服务IP地址: 192.168.1.119 服务端口号: 8630

应用

就绪 CAP, NUM, SCRL

# 8.11.9 Data Synchronization



## 9. After-Sales Commitment and Training Plan

### 9.1 Technical Support for the System

We will provide strong technical support for the system. Our company has a technical support center that handles customer complaints, ensuring timely investigation and resolution of any issues. We aim to respond within 12 hours and provide on-site assistance or other necessary actions within 24 hours.

### 9.2 After-Sales Service

Customer satisfaction and service excellence are our top priorities in after-sales service. We offer a one-year warranty and lifelong maintenance policy for the contracted equipment. The specific standards are as follows:

| Service item<br>Time    | Material expense                | Maintenance service<br>expense |
|-------------------------|---------------------------------|--------------------------------|
| First year              | Free                            | Free                           |
| Second/third year       | Charge material expense at cost | Free                           |
| From the fourth year on | Charge material expense at cost | Charge proper service expense  |

Note: Any requests for software or hardware improvements, expansions beyond the warranty period are not covered by the warranty. However, we will continue to provide the most favorable and high-quality services to the customer for any such requests.

### 9.3 Training Plan

#### 9.3.1 Training Range

It is an important part of system engineering to train technicians for Party A. As the quality of

training will influence the implementation and maintenance to the project, training program should be attached great importance by both parties. Based on our prior experience in software development and system integration, training program can be variously preceded by stages and by groups, from the elementary to the advanced, from theory to practice, and from group teaching to live demonstration, according to the project implementation scheme.

| Target Trainee                        | Equipment | Network | Data base | Application Software |
|---------------------------------------|-----------|---------|-----------|----------------------|
| Manager                               | ∨         | ∨       | ∨         | ∨                    |
| Section Chief                         | ●         | ●       | ●         | ●                    |
| System Administrator                  | ★         | ▲       | ▲         | ●                    |
| Network Administrator                 | ▲         | ★       | ▲         | ●                    |
| Data Base Administrator               | ▲         | ▲       | ★         | ▲                    |
| Operation and Installation Technician | ▲         | ▲       | ▲         | ★                    |

Notes:

- ∨ Macro technical and operation training.

Macro technical and operation training is for managers to fulfill their macro-management, analysis, and decision-making as well.

- Basic technique and operation training.

It is aiming at Section Chiefs to benefit their overall understanding about the techniques used in the system, and to instruct technically on system administration.

- ▲ Relevant technique training and control.

The target trainees are various sorts of administrators. It will help them master all techniques used in the system and facilitate the close cooperation between them.

- ★ It requires all administrators specialized in technique and operation to thoroughly study and give priority to the most important aspects.

- Host computer technique: including computer system technique: computer operation and usage technique, Raid fault-tolerant technique, backup technique, network management technique, and Windows operation system.
- Network technique: including local area network swapping technique, wide area network route technique, security technique, administration of network technique, Internet technique, and network product introduction.
- Theoretical Training: including the rationale, basic operation, and configuration technique for main computer and network system, to make preparations for project implementation and maintenance.
- Field training: provide on-the-spot guidance and technique support to technicians in

the project implementation field to achieve daily maintenance and administration ability to system.

- Training promises: 1. We promise to perform overall training to customers in technique and operation, and to ensure customer maintenance administrators with the abilities of independent performance, administration, operation, failure treatment, daily maintenance and test. 2. Training program provided by original producer will be arranged by us as per customer demands. 3. All training curriculum and teaching material provide by us are free.

### 9.3.2 Training Content

- Training before installation: After signing the contract and before goods arriving and installing, training will be undertaken by training department of the manufacturing enterprises, and its location can be arranged in either our company or the seat of customer. Training contents mainly refer to equipment installation, debugging, and maintenance, LAN principle and design, programming, installation, implementation and maintenance of system and network administration.
- Training on site: after equipment arrived, installed and accepted, training will be made for their technicians about the installation, operation and usage, and administration of the purchased equipment and software.

### 9.3.3 Training course syllabus and scheme

| Series No. | Course Name                                | Training Hour | Experiment Environment | Degree of Course |
|------------|--------------------------------------------|---------------|------------------------|------------------|
| 0          | Introduction to the System                 | 2             | Yes                    | Senior           |
| 1          | Vehicle detector installation              | 2             | Yes                    | Senior           |
| 2          | Vehicle detector router installation       | 2             | Yes                    | Senior           |
| 3          | Intersection or section acquisition center | 2             | Yes                    | Senior           |
| 4          | On-site configuration                      | 2             | Yes                    | Senior           |
| 5          | Windows set up                             | 1             | Yes                    | Elementary       |
| 6          | LAN principle and structure                | 2             | Yes                    | Medium           |
| 7          | Database installation and                  | 2             | Yes                    | Medium           |

|   |                                                                                 |   |     |        |
|---|---------------------------------------------------------------------------------|---|-----|--------|
|   | usage                                                                           |   |     |        |
| 8 | Server software set up                                                          | 1 | Yes | Senior |
| 9 | The installation and usage of application software of management client section | 3 | Yes | Senior |