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Research article

Intelligent traffic safety cloud supervision system based on Internet of vehicles technology

Jian Gao[1], Hao Liu[2] and Yang Zhang[2,*]

[1] Key Laboratory of Technology on Intelligent Transportation Systems, Ministry of Transport, Beijing 100088, China
[2] School of Transportation, Southeast University, Nanjing 211189, China

* **Correspondence:** Email: yang-zhang@seu.edu.cn; Tel: +8618913344511.

Abstract: In view of the poor supervision effect of the traditional monitoring cloud supervision system, this paper puts forward a design method of Intelligent Transportation Security Cloud supervision system based on the Internet of vehicles technology, uses the tsed-01 sensor chip to optimize the hardware configuration of the cloud supervision system, perfects the software functions based on the Internet of vehicles technology, and relies on the Internet of vehicles communication platform and cloud data sharing equipment to optimize the software functions of the cloud supervision system, identify and manage the heterogeneous data sources generated by different modules in the cloud supervision system to simplify the steps of the cloud supervision system and provide data support for the comprehensive decision-making of traffic management. The experimental results show that the intelligent traffic safety cloud supervision system based on the Internet of vehicles technology has good practicability, and has guiding significance for the construction of urban rail transit monitoring cloud supervision systems in the future.

Keywords: Internet of vehicles; intelligent transportation; traffic safety; traffic supervision

1. Introduction

In recent years, the growing urban traffic problems and the development of autonomous vehicle technologies have made the research of more advanced traffic management systems more urgent [1,2]. Intelligent Traffic Management System (ITMS) eases or even solves urban traffic problems by transmitting timely information on traffic conditions to traffic travelers and vehicles, giving them guidance, and at the same time providing optimized and reasonable advice and suggestions to traffic management agencies to improve their management efficiency [3,4]. ITMS technology has attracted a lot of attention in recent years. Jurczenia and Rak investigated the communication system of ITMS [5]. Dureja and Sangwan constructed an intelligent traffic management system through ant colony optimization and internet of things and performed well in terms of average waiting time and average traveling time [6]. The cloud supervision system for ITSM is an effective means of ensuring its smooth operation. The construction of the traffic management information cloud supervision system has experienced a process from scratch, from small to large, from single to large integration, large networking and large application, and has gradually formed an infrastructure with the traffic management integrated application platform, traffic integrated command platform, traffic safety integrated service management platform and traffic management big data analysis platform as the core, constantly strengthening the close integration and deep application of traffic management business and modern information technology [7]. The information cloud supervision system has become an important support for traffic management, and the informatization of traffic management business has been basically realized. The vehicle uses the vehicle networking technology as the terminal carrier, so that the vehicle networking can be applied in urban transportation. The Internet of vehicles mainly consists of a network between vehicles, which uses wireless communication to collect and process data, so as to realize the information exchange between cars, cars and buildings and other facilities, and enable cars to integrate into the city [8]. Car owners will be able to achieve real-time navigation, safe driving, entertainment and communication functions, and the car will also become more humanized with the support of Internet of vehicles technology [9,10]. The last few years have witnessed the rapid development of Internet of vehicles technology [11–13]. In this development process, the traffic management departments of the Internet of vehicles at all levels attach great importance to information security work and actively take measures to strengthen information security management [14]. However, the information security work obviously lags behind the information construction work, information security incidents are still frequent, and the information security situation is still severe. In order to speed up the construction of the security guarantee system of the Internet of vehicles traffic management information cloud supervision system, it is necessary to comprehensively strengthen the security management of the information cloud supervision system, improve the security protection level of the information cloud supervision system, realize “all-weather and all-round awareness of network security situation” and ensure the safe and stable operation of the information cloud supervision system [15]. Based on this, the design method of the Intelligent Traffic Security Cloud supervision system based on the Internet of vehicles technology is proposed.

2. Design of intelligent traffic safety cloud supervision system

2.1. Hardware configuration of cloud supervision system

The core modules of the application of Internet of vehicles technology in intelligent transportation systems are mainly security content, remote supervision and management content, remote automatic diagnosis content, vehicle scheduling and file content [16]. Among them, security includes automatic help function, emergency call function and remote rescue function after vehicle collision, which are organically integrated with remote diagnosis to better provide intelligent transportation services.

Remote diagnosis is mainly about the supervision of vehicle parameters. In order to ensure the safety of the urban rail transit cloud supervision system under the operation of the Internet of vehicles and ensure the service quality of the urban rail transit cloud supervision system under the operation of the Internet of vehicles, the organic whole formed by a series of theories and methods proposed is called the urban rail transit supervision system under the operation of the Internet of vehicles [17]. Establishing a perfect urban rail transit supervision system, carrying out the safety assurance of the cloud supervision system in the construction project, and carrying out the safety assurance and quality assurance in the operation project can effectively improve the safety, reliability and efficiency of the cloud supervision system in the life cycle of rail transit, and its economic and social benefits will be huge [18]. Starting from the regulatory objectives of Urban Rail Transit under the operation of the Internet of vehicles, combined with the actual supervision, the urban rail transit regulatory system under the operation of the Internet of vehicles includes two components: regulatory regulations and standard system, and supervision system which consists of a regulatory system and regulatory technical method system, as shown in Figure 1.

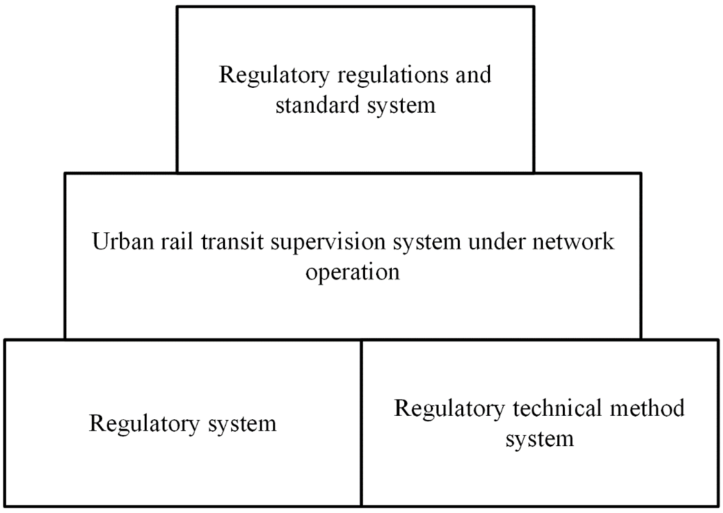

Figure 1. Elements of urban rail transit supervision system under the operation of Internet of vehicles.

There are many information collection devices at the urban road crossings. Not only is the number of devices huge, but also there are complex relationships between various components of the internal cloud monitoring system of the device [19]. The number of information collection devices varies greatly according to different locations, so it is necessary to diagnose the traffic abnormalities of the information collection cloud monitoring system itself and the equipment itself. The traffic abnormality of the device itself is mainly the traffic abnormality of the sensors and controllers in the cloud monitoring system. The parameter settings and status of the cloud monitoring system should be detected in time [20]. The cloud monitoring system itself lacks a relatively perfect detection function, so it should detect the relevant data collected in real time. Hardware configuration and software assurance should be considered when diagnosing traffic anomalies in the cloud monitoring system. In the selection of urban traffic information collection equipment, we should establish a multi-directional diagnostic technology. An IO channel is set for each component for independent configuration. Based on the operation of the cloud monitoring system by high-performance processors, the status of each channel is monitored in real time. Using the phenomenon reflected by the IO template monitored by the tsed-01 sensor chip, the position of the vehicle can be accurately located [21]. The equipment is equipped with PLC tools, which can easily read the information on the Internet, download the corresponding program to each PLC, edit the PLC program for online traffic anomaly diagnosis technology and optimize the program language. At road intersections, UPS is used to monitor the information collection cloud monitoring system. If there is a situation such that the information is not collected, an automatic alarm should be given, the cause of traffic abnormalities should be found in time, and the diagnosis technology should be used to repair traffic abnormalities quickly [22]. The hardware configuration based on online diagnosis function mainly includes the strategy of reasoning and control. Reasoning strategy studies the complex logical relationship between the current traffic abnormal signs and components in information collection, generally including deductive reasoning and inductive reasoning. The control strategy studies the control strategy of the whole information collection and traffic anomaly diagnosis, which generally includes a forward reasoning strategy and reverse reasoning strategy [23]. From this, it can be inferred that the hardware block diagram of information collection and traffic anomaly diagnosis is as shown in Figure 2.

The relevance analysis is carried out from the perspective of data flow and control flow, which directly serves the rail transit integrated monitoring cloud supervision system [24]. Therefore, the design of the hardware part of the cloud supervision system should be consistent with the current implementation specifications of the rail transit monitoring cloud supervision system as far as possible, and the three modules architecture of integrated decision-making, station decision-making and field control should be adopted as the core concept of the hardware part design. Its structure is shown in Figure 3.

After the urban rail transit enters the operation of the Internet of vehicles, the operation management of the single line of the operating line will change to the operation management of the Internet of vehicles, and the operation unit will change from the relatively single operation entity to the diversification of the operation entity [25]. These changes will inevitably lead to the following three changes in the supervision of urban rail transit: first, the management mode will change from experience to science and technology; second, the supervision mode will change from decentralized to centralized; third, emergency support will change from passive to active. The technical framework of the Internet of vehicles traffic management information security supervision cloud supervision system is divided into data source, data acquisition layer, computing and storage layer and business application layer. The whole project is divided into three layers, including gateway channel layer, distribution center, calculation and Analysis Center, data service agent, database interaction center, data forwarding, etc. [26]. The first layer of the gateway is the data injection layer, the distribution center and data analysis are the data interaction layer, and the warehousing, archiving and forwarding are the data output layer. The key equipment architecture of the vehicle supervision cloud supervision system is shown in Figure 4.

The core of Intelligent Public Transport Supervision and regulation cloud supervision system technology is to realize the “interoperability, interconnection and interoperability” of various heterogeneous traffic management technology sub cloud supervision systems through standard interface protocols [27]. At the same time, intelligent public transport supervision and regulation cloud supervision systems can directly call all kinds of information such as traffic management personnel organization, equipment, vehicle management, driver management, accident management, violation management, etc., and it is a comprehensive platform with “rich information, simple operation, intuitive display and intelligent command”.

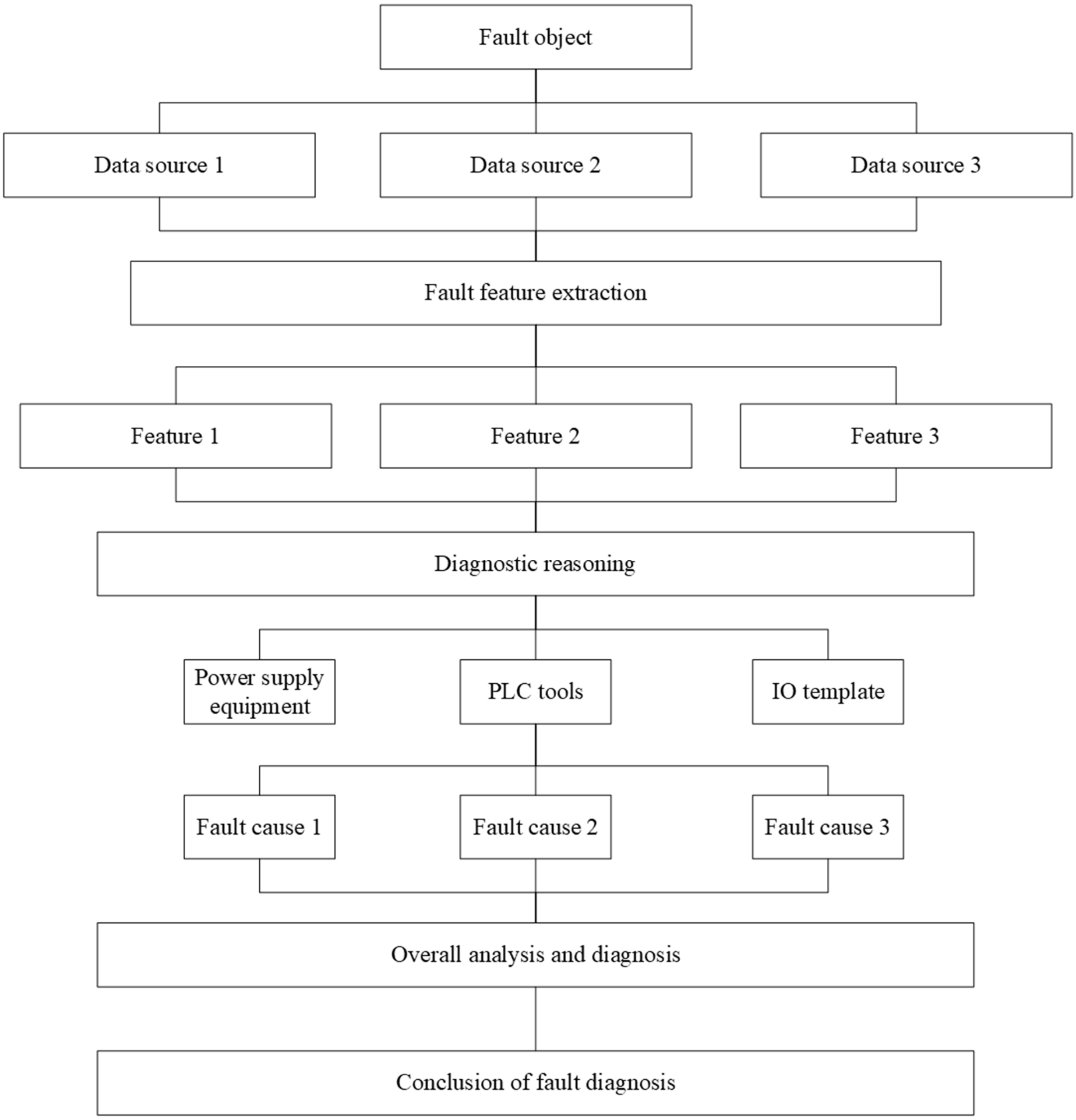

Figure 2. Hardware block diagram of traffic management information collection and traffic anomaly diagnosis.

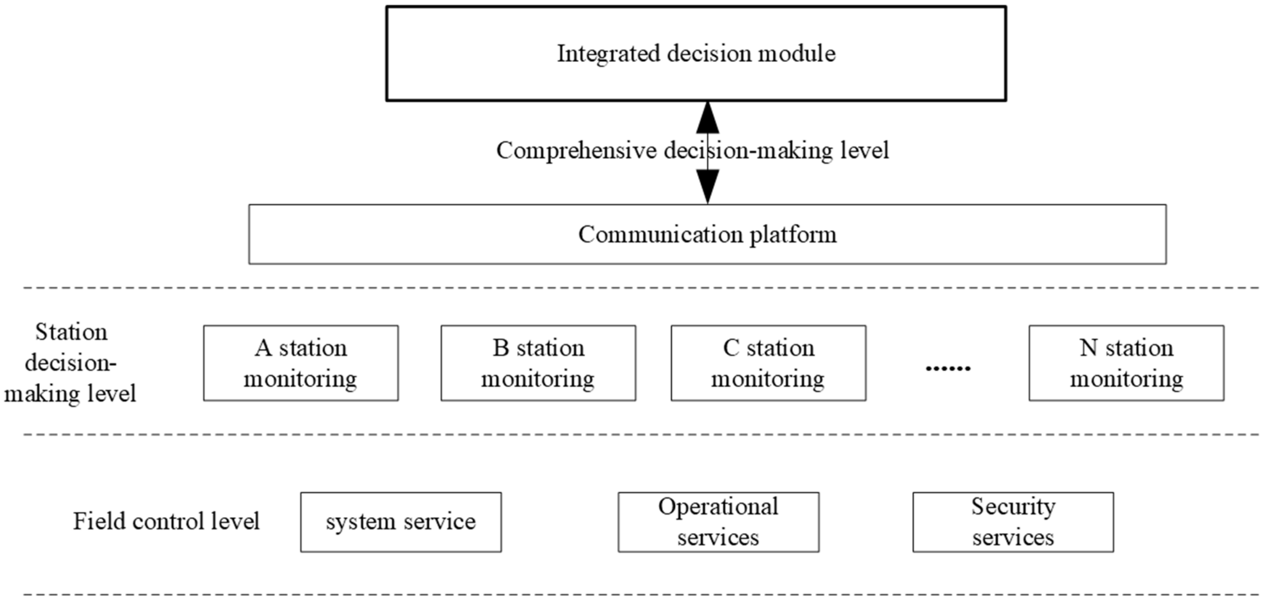

Figure 3. Hardware structure design of cloud supervision system.

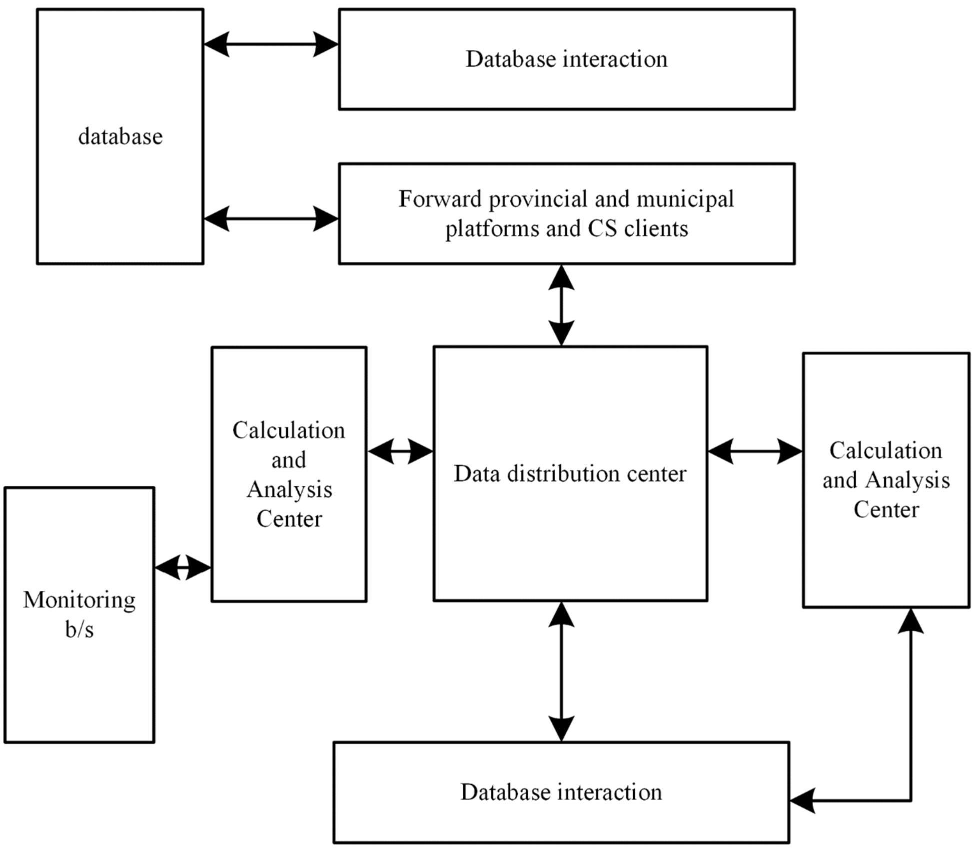

Figure 4. Key equipment architecture of vehicle supervision cloud supervision system.

2.2. Function optimization of cloud supervision system software

The intelligent public transport supervision and regulation cloud supervision system is not only a platform for traffic managers, but also a collection of traffic information. The video image information of urban roads, traffic congestion information, road network reconstruction information, traffic control information, traffic violation record information, traffic accident information, vehicle driver management information and other information are finally summarized on the intelligent public transport supervision and regulation cloud supervision system platform [28]. With the platform of intelligent bus supervision cloud system, a new market with unlimited space for development has been created, which is intelligent transportation information service intelligent and bus supervision cloud system. The software to be developed runs in b/s structure, not c/s structure. It is composed of three parts: client, server and network. According to the application characteristics of the transportation industry, the requirements of software technical performance are shown in the Table 1.

Table 1. Software performance design requirements of the platform.

sort	configure	requirement
1	Cross platform capability	The server and client support the windows operation cloud supervision system of indo2000 and above.
2	Support multiple data formats	It supports the reading and conversion of source data in various formats, and supports the migration of data models and spatial data synchronization in different commercial databases.
3	Massive data support	Support vector data, image data, CAD data, engineering dimensioning data and other data, support TB level massive data, closely combine with client applications, make management and analysis applications convenient and efficient, support the use of relational data bank to manage spatial data, so as to solve the problems of integrated storage management and analysis and calculation of massive data.
4	Support multiple users to access the same data source	It supports multi-user concurrency, has no restrictions on the expansion of the client, and has fast response speed in the case of large amount of data. It supports long transaction processing and historical data management, has spatial data version management technology, provides historical data analysis and management function, and can trace and analyze historical data at any time.
5	According to the application characteristics of the transportation industry, the platform should provide the existing mature network analysis function	The platform provides the following analysis functions: shortest path analysis, best path analysis, multipoint path analysis, time window analysis of stations, complex polygon analysis of service areas, analysis of the nearest facilities for emergency response, path direction analysis, matrix analysis of starting points and target points, etc.

Requirements: client: ordinary desktop PC or notebook computer is required to be able to smoothly run Windows XP and above operating cloud monitoring system. The screen resolution shall be at least 1024 × 768. Use IE6.0 and above software. Server: high end desktop PC or dedicated server [29]. It is required to be able to smoothly run the Windows Server 2018 32 bits Chinese operation cloud monitoring system. It is required to be able to normally connect to the Internet of vehicles, and that the client can normally access the server from the Internet. The server needs to install Windows Server 2018 and SQL Server 2018 software. In addition, it is required to be able to log in and use SCIs cloud monitoring system as a client through a smart phone. Safety assessment is a very important link in the construction and operation of urban rail transit. A full life cycle safety assessment is established in the construction and operation activities of urban rail transit to realize the whole process safety control of urban rail transit construction and operation projects [30]. Operation time is a common characterization index for ITMS systems and was therefore chosen for the present study. And under the vehicle internet operation, the coordination between urban rail transit lines needs to be ensured. Therefore, the operation time index of the Internet of vehicles should not only represent the operation time length of each line, but also represent the coordination of the first and last train time sections of each line in the Internet of vehicles. The formula for calculating the operation time of car coupling and vehicle networking is as follows:

$$T = A^{*} - \prod T_{\mathrm{i}} - T_{j} \tag{1}$$

where A^{*} is the average operation time of the operation line, T_i is coordinate lost time for the first shift, and T_j is the last shift coordination lost time. Then the traffic image information is further collected to obtain the instantaneous image of the transportation prospect:

$$\varepsilon = \frac{\sum_{i}^{\mathrm{j}} T_i}{A^{*}} - T \tag{2}$$

In the practical application of cloud monitoring systems, the average background model is the most widely used, which has high real-time performance and certain robustness. Using the average background model to detect moving targets, set the n background initialization stage and use the previous B_i. The initial background image is obtained from the frame image. In the initial background image I_i, is the background is updated by the current frame and the foreground image is obtained by the difference operation between the background and the current frame:

$$z_i = \begin{cases} \frac{1}{n}\sum_{i=1}^{n} I_i - \varepsilon & i \le n \\ (1-T)\cdot B_i + T\cdot I_i & i > n \end{cases} \tag{3}$$

The above formula represents the calculation formula of the background image. If γ_i represents the background image of frame I, TH indicates the update rate. The higher the value, the stronger the anti-interference ability. In practical applications, generally, n is about 1000 frames and a is 0.01:

$$F_i = \begin{cases} 255 & |z_i - \gamma_i| > TH \\ 0 & \text{otherwise} \end{cases} \tag{4}$$

This formula represents the calculation formula of foreground image. F_i represents the foreground image of the i$^{\text{th}}$ frame and performs the difference operation between the current frame and the corresponding background frame. If the absolute value of the operation result is greater than the threshold value $f(n)$, then the pixel point is the front scenic spot; otherwise, the pixel point is the background point and the horizontal ranging is to measure the distance perpendicular to the road direction, that is, the distance in the y-axis direction. The actual distance in the horizontal direction is directly proportional to the distance on the image, so it is only necessary to solve the ratio of the actual distance and the image distance in different x coordinates, that is, to find a gain function:

$$\eta = \sum F_i z_i - f(n) \tag{5}$$

In order to avoid problems in the software of vehicle networking information collection, set $c_1 c_2$. It is the allocation of two different reliability functions of traffic anomaly diagnosis on the same information recognition framework, and their focal elements are respectively $\{\lambda_{11}, \lambda_{21}, \cdots \lambda_{i1}\}, \{\lambda_{12}, \lambda_{22}, \cdots \lambda_{j2}\}$ set up:

$$\sum_{\lambda_{i1} \cap \lambda_{j2} = \beta} \eta \left\{ a_1(\lambda_{i1}) a_2(\lambda_{j2}) \right\} \geq 1 \tag{6}$$

The operation efficiency of the cloud supervision system is mainly composed of the collection efficiency, information transmission efficiency and information analysis efficiency of the information collection equipment. These three dimensions also represent the three main aspects of the system’s work, and thus they are suitable for representing the system’s efficiency. The formula is as follows: Collection efficiency:

$$p_1 = F_i \eta / v_1 \cdot t \tag{7}$$

In the formula, p_1 is the collection efficiency; v_1 is the acquisition speed; t is time. Transmission efficiency:

$$p_2 = F_i \eta / v_2 \cdot t \tag{8}$$

In the formula, p_2 is the transmission efficiency; v_2 is the transmission speed; t is time. Analysis efficiency:

$$p_3 = F_i \eta / v_3 \cdot t \tag{9}$$

In the formula, p_3 is the analyze efficiency; v_3 is the analyze speed; t is time. Total efficiency:

$$P = p_1 + p_2 + p_3 \tag{10}$$

In the formula, P is the total efficiency. Through the observation and statistics of a large number of traffic scenes, it is found that the road width or lane width of all scenes are the same, and the actual distance of road width or lane width will not change with the difference of X coordinates. Using this feature, this paper makes an actual measurement of the lane width and then counts the number of pixels occupied by the lane width at a certain X coordinate [31]. The gain value is the comparison between the two. Every traffic port should be equipped with an information collection cloud monitoring system, so the workload of traffic anomaly diagnosis will become very large. When setting software programming, the alarm function should be fully considered. In the case of abnormal traffic in information collection, the backup operating device will immediately start the alarm function and be ready to accept the command from the backup panel to maintain the basic operation of the cloud monitoring system. The flow chart of the diagnostic software is shown in Figure 5.

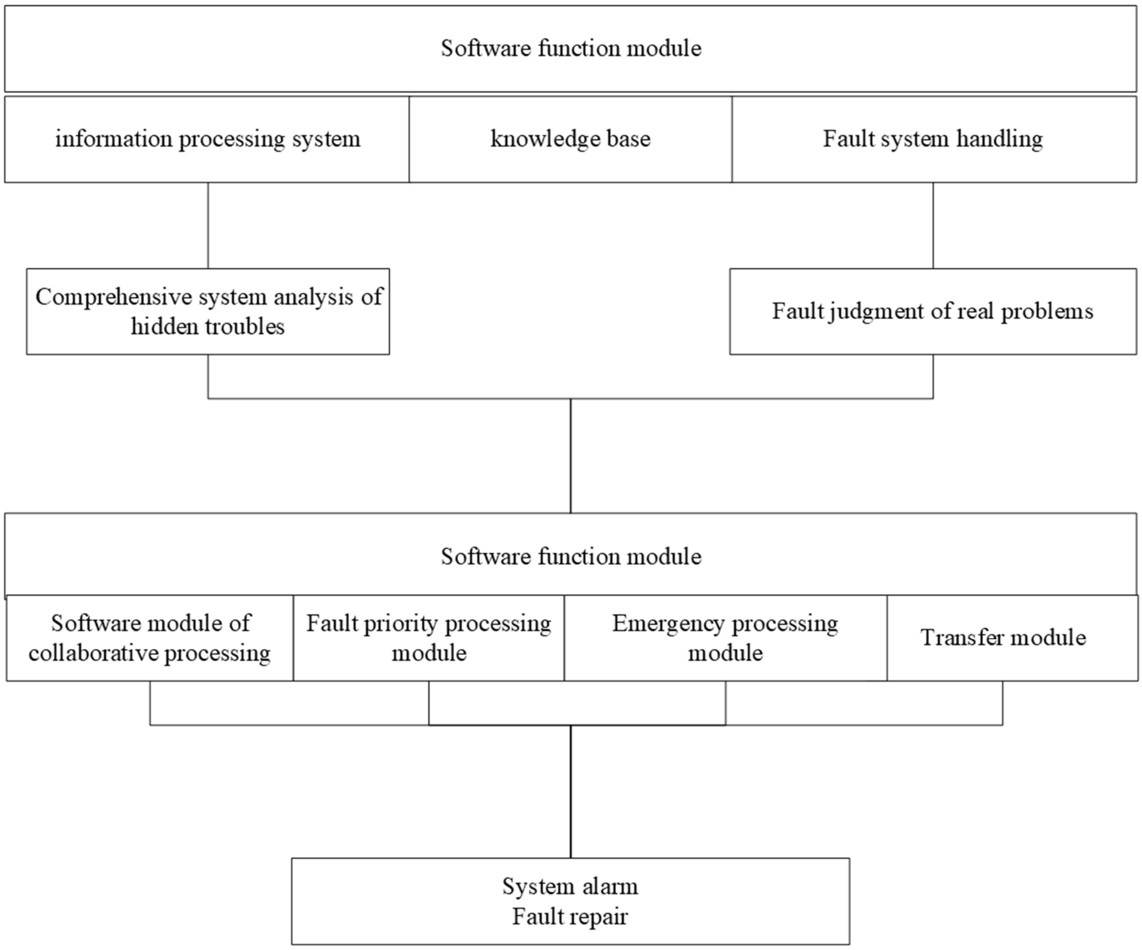

Figure 5. Flow chart of transportation video extraction and recognition.

The collection and management of traffic information based on the above steps can better improve the operation effect of the cloud supervision system. The cloud supervision system of Internet of vehicles traffic management information security supervision is composed of cloud supervision system application software, information cloud supervision system business log collection software and information security transmission and exchange cloud supervision system. The essence of the Intelligent Public Transport Supervision and regulation cloud supervision system is to make the information and knowledge supporting various decisions (including a traffic strategy decision, traffic management decision, traffic mode and traffic route selection decision, etc.) circulate effectively in the cloud supervision system through the effective application of high-tech, improve the science of decision-making, guide reasonable traffic behavior, and achieve the purpose of maximizing the potential of existing traffic facilities. In order to realize the requirements of intelligent traffic control, collecting relevant real-time and reliable traffic information is the premise and foundation of the traffic information cloud supervision system, and then to further analyze the transmission and provision of information according to the purposes and requirements of different traffic management and control. For the intelligent transportation system, it is mainly connected with the on-board equipment, which has a lot of data content and high relevance. For example, it can carry out a comprehensive analysis of fuel consumption, use the on-board terminal to collect a large amount of data, store and analyze, and then use the data processing technology to carry out relevant processing activities. In order to meet the relevant data processing requirements, it is necessary to add a storage system in the design work to ensure that the scalability meets the requirements and provide personalized services for users. The virtualization technology of the Internet of vehicles can also be used to separate multi tenants and form a diversified development model. In the design work, first of all, we need to ensure its security, and use cryptographic algorithms to achieve the purpose of active protection of the system, for example, using two-way identity authentication technology, data protection technology and other processing, so as to improve the security of the system in operation and meet the current user application needs. In terms of data protection, we also need to actively adopt disk array technology and data backup technology to enhance the application effect of the overall technology. In the design process, we should create a real-time database system, enhance the amount of real-time data processing, and improve our own service effect. It is necessary to create a persistent database system and file level storage system to better store relevant data information, so as to form the design mode of an intelligent transportation system under the background of the new era, ensure to enhance the overall design effect, optimize the working mechanism and mode of all aspects and promote the effective implementation of the design work.

2.3. Implementation of intelligent traffic safety supervision

The intelligent public transport supervision and control cloud supervision system is mainly provided by the traffic command center with information organized by the collected basic data of road sections, intersections, elevated traffic and urban entrances and exits. The operating vehicle management sub cloud supervision system includes public transport and logistics management. Public transport management covers the management of taxis and public transport vehicles, and logistics management includes the management of freight and rental vehicles. The emergency rescue sub cloud supervision system includes general accident alarm and disaster relief under special circumstances. The guidance cloud supervision system includes path guidance and parking guidance. Part of the information collected by the sub cloud monitoring system will be shared by the whole cloud monitoring system. By providing historical data and real-time predictable information, the cloud monitoring system will support the decision-making of travel. The cloud monitoring system will release traffic information to the public in real time through the Internet of vehicles query, and release guidance information to various media. The core of the intelligent public transport supervision and regulation cloud supervision system focuses on the information processing cloud supervision system neural network of vehicles, which can be described by the following conceptual model, as shown in Figure 6.

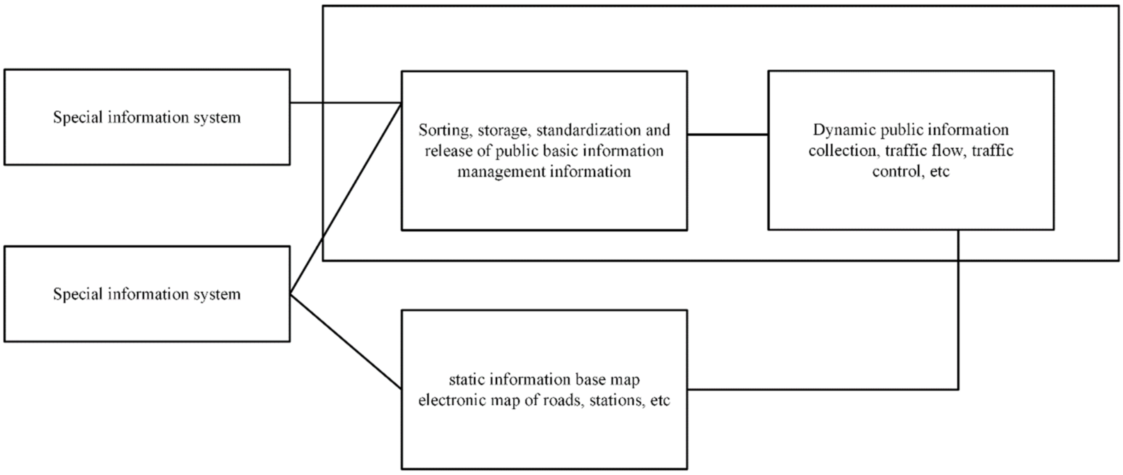

Figure 6. Traffic safety management model of Internet of vehicles.

The monitoring cloud supervision system framework is a very important structure in the urban rail transit cloud supervision system, which can describe the possible functions of the cloud supervision system to the greatest extent, and provide corresponding services. A specific service can be completed through the combination of different hardware. Since the functions of the cloud supervision system are not isolated, it is necessary to obtain important information from other parts of the cloud supervision system and provide main information to other functions at the same time. Therefore, the monitoring cloud system framework is a blend of functions, providing the basis for the completion of all monitoring services. The overall function of urban rail transit integrated monitoring cloud supervision system is shown in Figure 7.

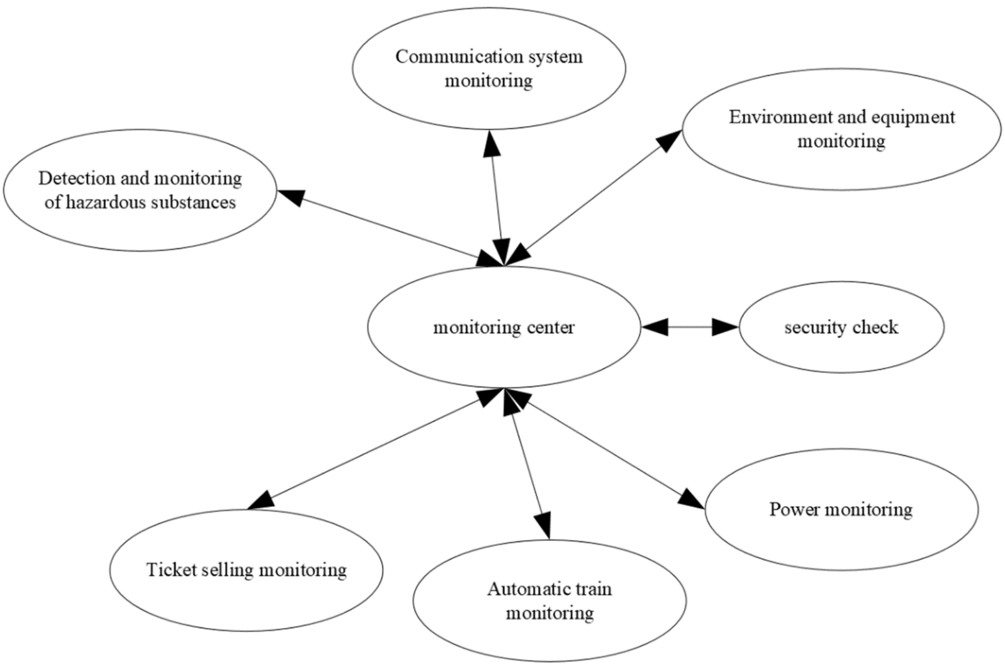

Figure 7. Overall functions of traffic monitoring cloud supervision system.

It can be seen from the figure that the overall structure of the monitoring cloud supervision system is composed of eight monitoring modules. According to the unified concept of different communication systems and data formats in the software functions, the relevance model is used to comprehensively monitor urban rail transit. The correlation metric was used to indicate whether the vehicle state showed excessive changes between two monitoring sessions, and if the correlation between two neighboring vehicle states was too low, a drastic change in the vehicle state was indicated. Correlation refers to the fact that there are certain connections between rail transit, but the quantitative relationship is not rigorous. The correlation coefficient is used to express the closeness between the two variables. Statistical analysis indicators can determine the correlation, closeness and direction between different road conditions. There is a direct relationship between the road conditions measured by the station decision sensor and the regional traffic operation conditions. Generally, the traffic accidents in the corresponding road conditions of the rail transit operation area are relatively low. Since there will be a certain correlation coefficient between the measured values of the two sensors monitoring the cloud supervision system during the operation of rail transit, the calculation formula of the cloud supervision system is:

$$\kappa = \frac{E\left\{\left[A\text{-}E\left(A\right)\right]\left[B\text{-}E\left(B\right)\right]\right\}}{\sqrt{E\left(A^2\right)-E\left(B^2\right)}} \tag{11}$$

In the formula, κ indicates the correlation coefficient; A and B represent the measurement data of two groups of sensors; $E(A)$ represents variable A's mathematical expectation; $E(B)$ represents variable B's mathematical expectations. In the process of vehicle longitudinal dynamics modeling, other vehicles and traffic lights are not considered. When the gear is fixed, the engine torque is T_c and the transmission torque to the clutch is T_e:

$$J_e\dot{\omega}_e = T_e E\left(A\right) - T_c E\left(B\right) \tag{12}$$

The trust value is used to reflect the historical behavior of vehicles, so the trust value of a vehicle should be generated by the comprehensive rating information of different vehicles at different times. The trust value of vehicles is generated according to the historical rating information of vehicles written into the blockchain ledger. When the rating information written into the blockchain ledger is updated, the trust value is also updated. Considering the timeliness of the trust value, the latest e rating information of vehicle r_j^i is intercepted from the blockchain ledger through the time sliding window. The latest rating sequence r_j^{i+E} of vehicle J is expressed as:

$$R_j = \kappa\left[r_j^i, r_j^{j+1}, \ldots, r_j^{i+E}\right] \tag{13}$$

According to the latest rating sequence R_j, generate vehicle trust value F. The trust value is calculated as:

$$\text{Trust}_j = F\left(\sum_{i=1}^{E} R_j - R_j\right) \tag{14}$$

When calculating the vehicle trust value, it will be calculated according to the rating information in the same blockchain ledger, so as to ensure the unity of the trust value throughout the network. Taking full account of the actual operation of rail transit, the correlation coefficient between the measured value of the monitoring point at this station and the measured value of the monitoring point at the next station is set to be greater than 0.4, which is taken as the correlation model between the two sensors. The intelligent transportation vehicle supervision cloud supervision system is used to monitor and manage the whole platform. It is divided into two modules: the supervision client and the server. The client includes two functional modules: vehicle monitoring and human-computer interaction: the server includes four parts: terminal access, calculation and analysis, rule analysis, and data interaction. The functional structure of the whole cloud supervision system is shown in Figure 8.

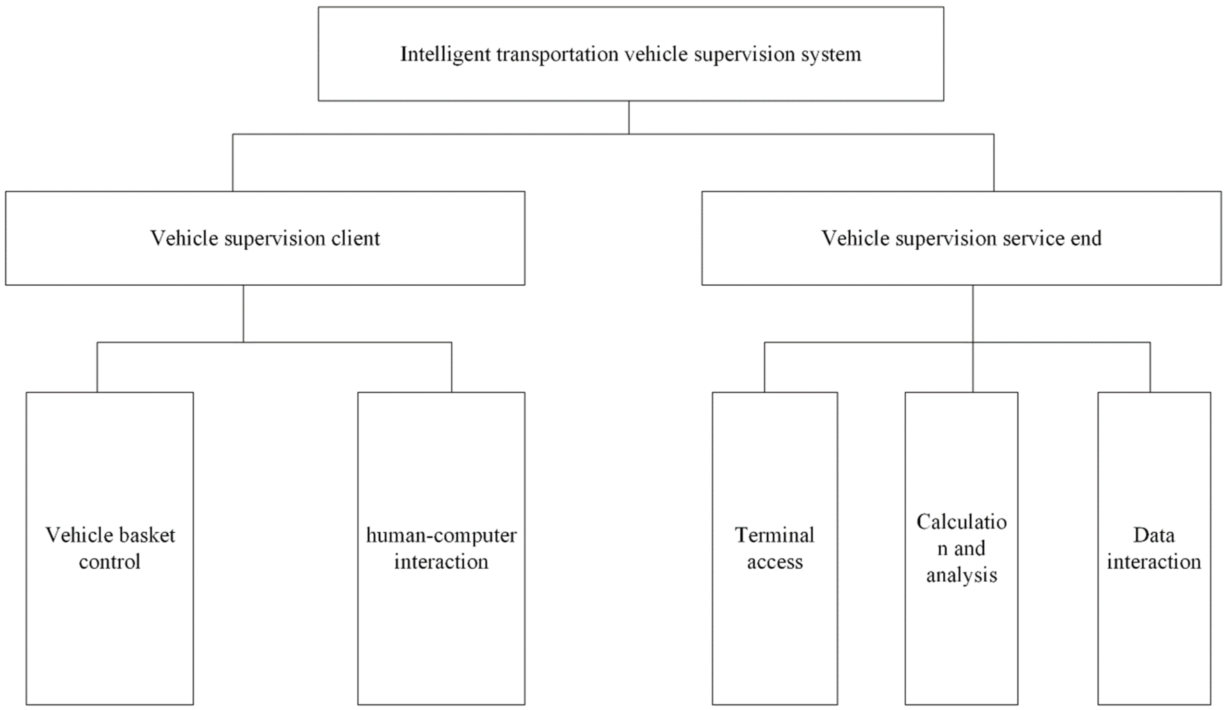

Figure 8. Functional structure optimization of the cloud supervision system.

Accordingly, the work flow of the entire traffic management information cloud supervision system is shown in Figure 9. The remote monitoring terminal or central monitoring terminal of the system can also track multiple or single vehicles. When the vehicle is tracked, the designated vehicle is tracked in real time, the tracked vehicle is displayed in the map, and the designated vehicle is continuously monitored in real time. You can also specify a vehicle that needs to view the track. Right click the historical track and determine the time range to display a list of historical tracks, mainly including track information such as degree, direction, status, time, mileage, position, etc. The monitoring subject is the vehicle. The basic information of the vehicle includes the license plate, vehicle number, terminal SIM number, color of the license plate, query password, terminal model, terminal type and contact information. Through the vehicle monitoring client in the platform, the enterprise administrator or operator can determine the current real-time location information of the vehicle, query the driving route of the vehicle in the past period of time, extract and view the image data of the vehicle during driving, or set and process alarm information, so as to achieve the goal of intelligent management of complex traffic.

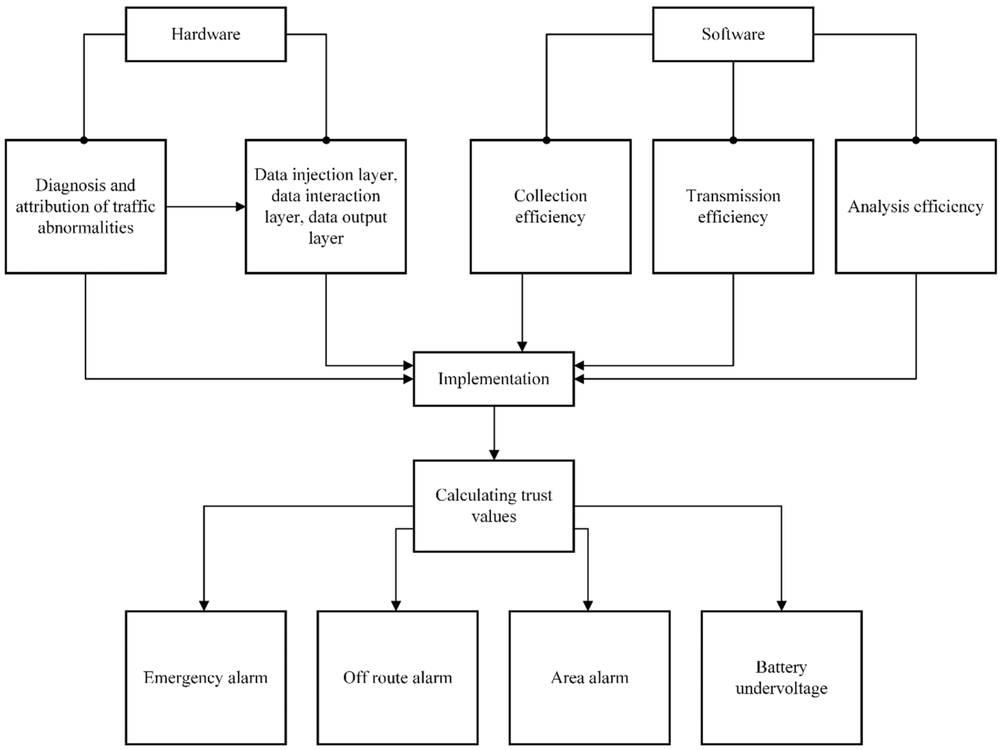

Figure 9. Work flow of the traffic management information cloud supervision system.

3. Analysis of experimental results

Before the test, we need to build a test environment for the cloud monitoring system. The test environment puts forward the environment construction of server and client for software and hardware. Server software and hardware environment server software and hardware environment are shown in Table 2.

Table 2. Server software and hardware environment.

	equipment	model
hardware configuration	CPU	Intel c690 series / Intel Core 17
	Memory	8-32GB
	Hard disk	1*300G 10K Hard disk
software configuration	Operate the cloud supervision system	Windows Server 2018
	database	SQL Server2018
	application server	Lenovo system SR650 & 34.48
	other	Apache-tomcat-7.0.42 , JDK1 7

During the test, the function of the road traffic safety supervision cloud supervision system is tested. In the test phase, we need to ensure the normal operation of the rural road traffic safety supervision cloud supervision system, and the data will not be damaged. During the test, we should find and eliminate as many hidden problems in the cloud supervision system as possible. The basic information management test protocol is shown in Table 3.

Table 3. Test cases of basic traffic information management.

function	testing procedure	Test output	Verification results
Administrative division query	In the administrative division query implementation map, the query basis is determined and the administrative division query order is executed	Refresh and display the list of administrative division records that meet the query basis.	Verification passed
Management unit delete	View the contents of all management companies, select a management company and propose to delete it.	The original management unit record in the reloaded implementation map does not exist.	Verification passed
Modification of Township traffic control station	In the modification implementation diagram of the traffic control station, record the data of the Township traffic control station that needs to be modified, and send the request for modifying the traffic control station.	The original traffic control station records in the traffic control station realization map are updated.	Verification passed
Increase of safety persuasion stations	After entering the safety persuasion station to add the implementation diagram, register all the safety persuasion station data according to the page prompt and save it	A new persuasion station appears in the implementation diagram of the safety persuasion station.	Verification passed

The real-time monitoring function points of the supervision platform are tested, mainly including map roaming, zoom in, zoom out, print map, eagle eye preview, as well as some real-time operations, vehicle query, vehicle positioning and other functions. The test cases, judgment principles and test results of each function point are expressed in Table 4.

Table 4. Test cases of real-time monitoring function of cloud supervision system.

Function point	test case	Pass judgment principle	Verification results
roam	Move the map operation and display the results correctly	With map magnification function	Verification passed
enlarge	Zoom in on the map and display the results correctly	It has the function of magnifying selected landmarks	Verification passed
narrow	Zoom out the map and display the results correctly	It has the function of reducing selected landmarks	Verification passed
Full picture	View the full map operation and display the results correctly	After implementing the “national” directive, the electronic map must display the national electronic map	Verification passed

Send the simulation data to the platform through the vehicle simulation terminal, and then query each response of the platform to judge whether it passes. If an emergency alarm is sent, the platform can show that it can respond and conclude that it passes. See Table 5 for test cases.

Table 5. Test cases of alarm and reminder function of cloud supervision system.

Function point	test case	Pass judgment principle	Verification results
Emergency alarm	The emergency alarm triggered by the terminal is reported to the platform	It can receive and display the alarm information triggered by the terminal on the platform and show the alarm interface	Verification passed
Off route alarm	Trigger the deviation route alarm through the terminal and report it to the platform	It can receive and display the alarm information triggered by the terminal on the platform and show the alarm interface	Verification passed
Area alarm	The regional alarm triggered by the terminal is reported to the platform	It can receive and display the alarm information triggered by the terminal on the platform and show the alarm interface	Verification passed
Battery undervoltage	Trigger the battery undervoltage alarm through the terminal and report it to the platform	It can receive and display the alarm information triggered by the terminal on the platform and show the alarm interface	Verification passed
Emergency alarm	The emergency alarm triggered by the terminal is reported to the platform	It can receive and display the alarm information triggered by the terminal on the platform and show the alarm interface	Verification passed

The paper applies the proposed cloud supervision system to a real-world traffic scenario and the conventional regulatory system is also used in the same scenario for comparison of the results. The transport scenarios used for the tests also involved rural roads and marine transport. Corresponding roadside and in-vehicle facilities have also been configured. The test learned that during the access process, the security supervisor used the unified login loaded interface for identity security authentication. If the session waiting time is more than 1 minute and there is a timeout, it is necessary to clear the MQTT session in time and require the user to authenticate again to avoid the left pages after logging out being illegally operated by attackers. After the test, it is found that the rural road traffic safety supervision cloud supervision system has a certain scalability, which is enough to expand the application functions, deployment methods, spatial data models, services, etc. of rural road traffic safety supervision, which meets the expanding needs of rural road traffic safety supervision, ensuring that the expansion phase can be smoothly upgraded and duplicate functions reduced. After the usability test, we learned that the construction of the rural road traffic safety supervision cloud supervision system can ensure the unified style, simple operation and easy-to-use buttons in the design of each module page and form. When the peak number of 200 concurrent users is used, the waiting time for the return and response of the cloud supervision system is no more than 2 seconds to improve the usability of the cloud supervision system. In order to test the application performance of the designed cloud supervision system in the implementation of maritime vehicle traffic information management, the cloud supervision system is measured and analyzed. The cloud supervision system test is established on the Windows platform. Now, assume that the volume of vehicle traffic information is 100 bits, and then use this cloud monitoring system and the traditional web traffic information management cloud monitoring system for comparative detection. The statistical results of the operation efficiency of the cloud supervision system in ocean transportation are shown in Figure 10 below.

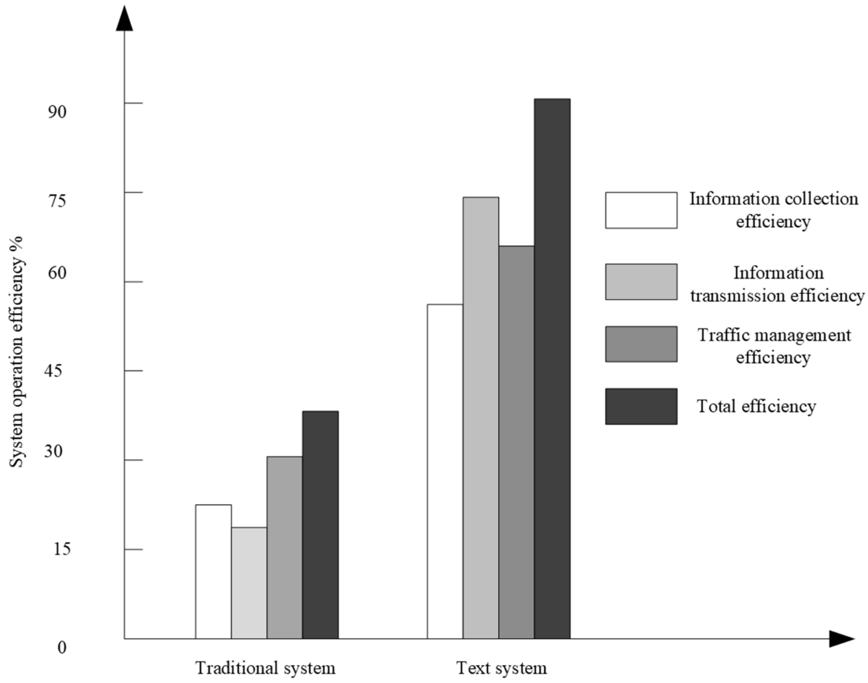

Figure 10. Comparison results of operation efficiency of cloud supervision system.

It can be seen from the figure that the total operation efficiency of the traffic supervision cloud supervision system designed this time is higher than that of the traditional cloud supervision system, which fully achieves the purpose of the cloud supervision system design. Compared to the previous study, the test system also has a higher secrecy efficiency than the random scheme and has a higher secrecy efficiency than the without spectrum sharing scheme and DDQN-based secure offloading and resource allocation (SORA) scheme in relatively higher secrecy rate threshold [32], illustrating its superior supervision performance once again.

4. Conclusions

The security management of the information cloud supervision system is directly related to the normal development of the traffic management business of the Internet of vehicles, the law enforcement of the traffic management department of the Internet of vehicles and the image of the traffic police team, and the protection of citizens' personal information and legitimate rights and interests. Based on this, the construction mode of the intelligent traffic management information security supervision cloud supervision system based on the Internet of vehicles is proposed, the platform technology and functional architecture are generally planned and the application based on big data is proposed, studying the cloud supervision system of information security supervision, carrying out real-time analysis, judgment and early warning, promoting the implementation of various security measures, realizing the systematic management of cloud supervision of information security work and ensuring that the operation and data security of the cloud supervision system will have a good reference for the next research, development, construction and application of the cloud supervision system of information security supervision of national Internet of vehicles traffic management. However, the system proposed in the present study needs to go further by adding considerations for information security. Also, this study did not develop more test scenarios and its usability in other traffic scenarios needs to be further tested. Finally, Artificial Intelligence is also recommended to be incorporated into the present framework to build a real intelligent vehicle. Future research could pay attention to these three aspects.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

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Conflict of interest

The authors declare there is no conflict of interest.

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