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Design and implementation of public transportation emergency command and assistance platform from the perspective of smart policing

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A R T I C L E I N F O

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A B S T R A C T

In view of the pain points faced by the current urban public transportation public security management, such as high security pressure of large-scale activities, lagging police response, and insufficient integration of multi-source data, this paper designs and implements a public transportation emergency command and assistance platform. The system adopts Spring Boot + Vue.js front-end and back-end separation architecture, integrating five core modules: vehicle scheduling, route optimization, passenger feedback, real-time monitoring and data analysis. On this basis, from the perspective of smart policing, the adaptation design of the system in scenarios such as security emergency vehicle scheduling for large-scale activities, public security risk investigation of passenger feedback data, real-time monitoring and linkage with public security command center is studied. At the same time, ideas for expanding police functions such as early warning of key personnel and one-click alarm linkage are proposed. Practice shows that the platform can effectively improve the informatization and intelligence level of public transportation security work, and provide technical support for the construction of an integrated police mechanism of "emotion, guidance, and action".

1.Introduction

1.1.Background and significance of the study

The urban public transportation system is the "artery" of urban operation and a key area for social security prevention and control. With the acceleration of urbanization, the average daily passenger flow of public transportation such as subways and buses is huge, and the characteristics of dense people, strong mobility and closed space make it easy to become a high-incidence area for various emergencies. In recent years, a number of safety incidents in the field of public transportation at home and abroad have shown that the traditional "manpower prevention" model is difficult to meet the security needs of complex situations, and it is urgent to build a closed-loop management system of "early warning, in-process disposal, and post-event traceability" through information technology.

At the same time, security tasks such as large-scale cultural and sports events and important meetings are becoming increasingly burdensome. Taking the 15th National Games as an example, the Guangzhou police relied on the digital traffic command application system to realize the "one map" visual command of all elements such as police deployment, vehicle dynamics, signal light control, and video surveillance, and implemented multi-layer positioning calibration of the escort fleet through the "vehicle-road-cloud collaborative positioning" technology, which greatly improved traffic efficiency. Shanghai clearly puts forward the goal of "efficient emergency command" in the construction of smart buses, requiring dynamic monitoring of the status of carriages and platform passenger flow, automatic identification of emergencies, and deepening linkage with public security, emergency and other departments[1]. These practices show that the deep integration of public transportation operation and dispatch systems with police command systems is an inevitable trend to improve social security prevention and control capabilities.

From the perspective of police practice, there are still three shortcomings in the informatization construction in the field of public transportation: first, the operation data and police data have not yet been connected, and there is an "information island" between the dispatching system of public transport enterprises and the public security command platform; second, passenger feedback, video surveillance and other data have not been effectively transformed into "intelligence products" for public security prevention and control; Third, there is a

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lack of special emergency dispatch tools for the security of large-scale events, making it difficult to realize the coordinated deployment of bus capacity and police force. Therefore, it is of great theoretical value and practical significance to design an auxiliary platform that not only meets the daily operation and management of public transport enterprises but also adapts to the practical needs of public security policing.

1.2.Research status at home and abroad

1.2.1.Current status of domestic research

The research of domestic scholars mainly focuses on the construction of scheduling optimization models, data perception evaluation and system implementation optimization, and focuses on combining the actual scenarios of domestic urban bus operation to propose targeted optimization schemes and technical implementation paths. In terms of scheduling optimization model, Li Xiaojing et al[2] constructed a multi-objective joint optimization model for the efficiency loss caused by the step-by-step optimization of boarding and disembarking points and vehicle routes in customized passenger transport, integrating the hybrid heuristic algorithm of NSGA-III, differential evolution and adaptive large neighborhood search, and integrating ST-DBSCAN to dynamically identify boarding and disembarking points, so that the average connection distance of passengers was reduced to about 1/10 of that without joint optimization; Zhang Ailin et al[3] The modular bus system is introduced, and the dynamic grouping and passenger exchange of cross-regional demand-responsive buses are realized through the design of coupling stations, and the hybrid integer linear programming (MILP) is used to solve the problem, which effectively improves the full load rate and reduces the operating cost. Li Xiaoyu et al[4] paid attention to the random demand disturbance caused by appointment cancellation, constructed a real-time route optimization model considering the cancellation penalty, and designed an adaptive genetic algorithm, which reduced the optimal solution by 3.61% compared with the traditional genetic algorithm. Cheng Hao[5] integrates vehicle-road collaboration with bus scheduling, establishes a dynamic scheduling model with feedback control speed as the core, and uses improved genetic algorithm (Gaussian variation and barrier function) to solve it, reducing the total cost by 12.4% in high passenger flow scenarios. At the level of data perception and evaluation, Xiao Yingying[6] revealed the differences in influencing factors in different administrative regions through a survey of passenger satisfaction in Foshan City and its five districts, and put forward suggestions for overall development and driver team construction. Kou Weibin[7] systematically studied the improvement strategy of bus passenger travel time reliability, fitted the distribution law of on-board time (lognormal distribution) and waiting time (Laplace distribution) based on actual GPS data, and constructed a two-layer planning model and a demand transfer optimization model for bus lane planning. In terms of system implementation and algorithm optimization, Chen Mengyun et al[8] designed a BRT intelligent scheduling system, which integrates Beidou/GPS dual-mode positioning, DSRC-assisted positioning, 4G wireless transmission and bus signal priority algorithm to realize real-time monitoring and priority control of vehicles.

1.2.2.Current status of foreign research

The research of foreign scholars pays more attention to the innovation of basic algorithms, the research and development of low-cost perception technology and the in-depth breakthrough of specific optimization problems, which provides important technical support for the intelligent upgrading of the bus system. In terms of scheduling optimization model, Zhang et al[9] innovatively integrated the optimization of hybrid bus fleet replacement and scheduling, and proposed the Lagrange relaxation heuristic algorithm with the goal of minimizing the whole life cycle cost under the constraints of emissions and budget. Kourepinis et al[10] proposed an improved discrete particle swarm optimization algorithm for the urban bus route planning problem (UTRP), introduced a new initialization function, an improved operator and a post-optimization routine, and effectively dealt with the complex constraints of the NP-hard problem. At the level of data perception and evaluation, Ryu et al[11] proposed a low-cost passenger flow monitoring system based on WiFi sensing, which uses a sliding window algorithm to process the randomness of mobile device signals and realize the estimation of passenger OD and station waiting time. Castellanos et al[12] developed an embedded system based on three-axis accelerometer and GPS to dynamically evaluate vehicle driving comfort through Jerk-acceleration threshold detection and comfort index algorithm.

1.2.3.Summary

At present, remarkable achievements have been made in the fields of public transport scheduling optimization, data perception and system integration both domestically and internationally, yet there still exist multiple limitations: most existing studies focus primarily on improving the operational efficiency of public transport enterprises, with insufficient systematic modeling and function embedding targeting public safety requirements; the information silo problem between public transport operation data and public security command systems has not been effectively resolved, as the two types of business platforms operate independently, and there is a lack of practical exploration on the construction of integrated platforms; functional design for police scenarios including large-scale event security, passenger abnormal behavior recognition, key personnel trajectory tracking and security risk mining is still in its initial stage, with no mature and feasible technical solutions available. It can thus be concluded that the research and development of a public transport emergency command auxiliary platform that accommodates both daily public transport operation management and deeply adapts to actual public security police operations has important theoretical value and practical significance.

1.3.Innovation points and research contributions of this paper

1.3.1.Integrated architecture design of police services and public transportation

This paper is the first to deeply integrate the public transportation operation dispatching system and the public security command system at the platform level, breaking the information barriers formed by the independent operation of the two systems under the traditional mode. The system adopts the Spring Boot + Vue.js front-end and back-end separation architecture, and through unified permission management and data interfaces, it realizes the collaborative linkage of capacity dispatching and police force deployment, providing technical support for the construction of the "police information command" integrated police mechanism.

1.3.2.Enhanced functions for police scenarios and intelligent risk perception

Unlike traditional bus dispatching systems that only focus on operational efficiency, this paper innovatively introduces natural language processing (NLP) keyword recognition and time-space correlation warning mechanisms in the passenger feedback management module. Based on this, a three-level risk level assessment model (red/orange/yellow) was constructed, filling the technological gap in intelligent perception of public safety risks in the public transportation sector.

1.3.3.Forward-looking design of the police expansion mechanism

This article also proposes several feasible expansion schemes for police functions, such as key personnel trajectory warning, one-click alarm linkage, real-time connection of vehicle-mounted videos with the police command center, etc. These schemes provide interfaces for the subsequent integration and connection of the system with existing police systems like the public security big data platform and PGIS (Police Geographic Information System), and have strong scalability and practical application prospects.

In conclusion, compared with the existing public transportation dispatching systems or public security command platforms, the system proposed in this paper has the dual-drive characteristic of "one platform, two perspectives" - for public transportation enterprises, it is a dispatching tool to enhance operational efficiency; for the public security authorities, it is a practical platform for risk perception and command and disposal. It takes into account both operational efficiency and public safety, and has strong theoretical value and practical significance.

2.Relevant technical foundations

2.1.Spring boot and microservices architecture

The backend of the system adopts the Spring Boot framework, and its design concept of "convention is better than configuration" greatly simplifies the development process of enterprise-level applications. Combined with the MyBatis persistence layer framework and Maven construction tools, the decoupling of business logic and data access is realized. The information registration table shows that the system adopts the microservice architecture design, which divides the complex system into independently deployed service units, and each service communicates through RESTful API, which has the advantages of high cohesion, low coupling, and independent expansion. In public security information systems, microservice architectures have been widely used, such as police geographic information system (PGIS), which realizes flexible orchestration and elastic scaling of services through cloud deployment.

2.2.Vue.js front-end frame

The front-end adopts a Vue.js progressive framework and builds the user interface with the Element UI component library. The system implements a development mode in which the front and back ends are completely separated, with the front end initiating HTTP requests through Axios and the back end returning data in JSON format. This architecture not only improves development efficiency, but also reserves interfaces for subsequent access to public security video private networks and deployment of police terminal APPs.

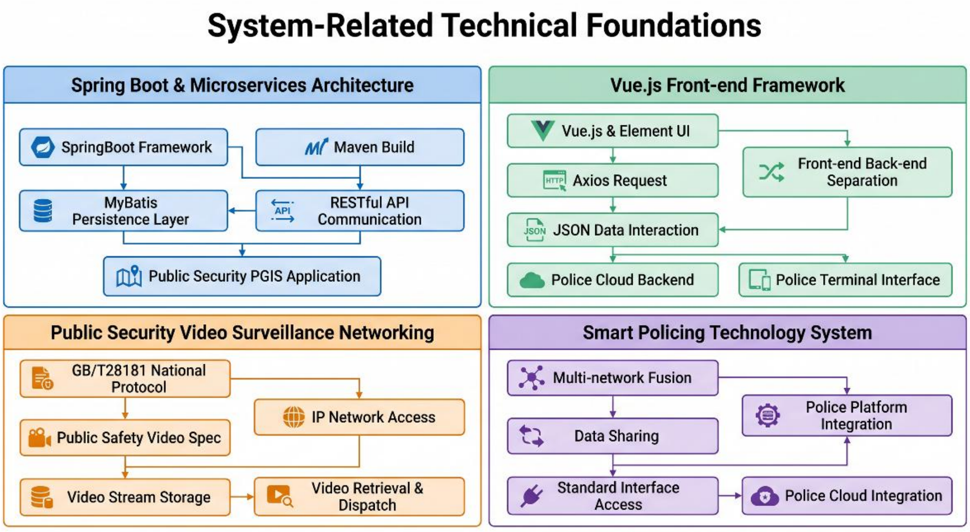

Fig 1. Technical basis of the system

2.3.Public security video surveillance networking technology

According to the "Technical Specifications for the Construction of Public Security Video Surveillance Systems", video surveillance equipment needs to access the information sharing platform through IP networks, support GB/T28181 media transmission protocol, and realize functions such as command and dispatch, video quality diagnosis, query and retrieval. The design of the real-time monitoring module of this platform follows this technical specification, supports real-time forwarding and storage of video streams, and lays a technical foundation for accessing the public security video private network.

3.Overall design of the system

3.1.Demand analysis

This system is open to two types of users: bus operation management personnel and public security police commanders. Business requirements are divided into two levels: basic operation and police security. Basic operational requirements include vehicle scheduling and scheduling, route optimization configuration, passenger feedback processing, real-time vehicle location monitoring, and visual analysis of operation data. Police security needs include emergency vehicle dispatch during large-scale events, security inspections of key routes, monitoring of abnormal behavior of passengers, linkage with the 110 command center, and generation of security situation reports.

3.2.System architecture design

3.2.1.Three-layer B/S architecture (from a technical implementation perspective)

From the technical perspective of software development and deployment, the system adopts the classic three-tier B/S architecture:

Presentation Layer: The front-end user interface is implemented based on the Vue.js framework. HTTP requests are initiated using Axios to conduct asynchronous data interaction with the backend.

Business Layer: Utilizes Spring Boot to build RESTful services, encapsulating core business logic such as vehicle scheduling, route optimization, and passenger feedback processing.

Data layer: Data is stored and managed using the MySQL database, and data access is achieved through the MyBatis persistence layer framework, which implements the ORM mapping for data access.

This three-layer architecture supports the modular development of the system, the separation of front-end and back-end deployment, and the expansion of microservices, ensuring the technical advancement and maintainability of the system.

3.2.2.Four-level logical framework (from the perspective of business functions)

To further meet the data collection, transmission, processing and application requirements in the smart policing scenarios, based on the above three-layer architecture, this system expands into a four-layer logical framework from the perspective of data flow and responsibility division, forming a hierarchical view from physical resources to business applications.

Perception Layer: This includes vehicle-mounted GPS/Beidou positioning terminals, carriage video monitoring equipment, WiFi probes, passenger feedback input terminals, etc. It is responsible for collecting raw data such as the vehicle's real-time location, carriage status, passenger behavior feedback, and video streams.

Network Layer: Relying on communication infrastructures such as 4G/5G wireless communication networks and public security video dedicated networks, the data from the perception layer is securely and real-time transmitted to the platform layer.

Platform Layer: Corresponding to the business layer and data layer in the three-tier B/S architecture, it provides basic supporting capabilities such as data storage, microservice registration and discovery, interface gateway management, and message push.

Application Layer: Targeted at end users (bus dispatchers, police commanders, drivers, etc.), it provides visualization function modules such as vehicle dispatch management, route optimization, passenger feedback handling, real-time monitoring, and data analysis reports.

3.2.3.The logical relationship of the two-layer structure

It should be noted that the three-layer B/S architecture and the four-layer logical framework are not two independent system structures; rather, they are descriptions of the same system from different perspectives: The three-layer B/S architecture is the technical implementation framework of the system, which determines the development method, deployment structure and operation mechanism of the system; the four-layer logical framework is the business function view of the system, clearly dividing the responsibilities and data flow of each layer from the perspective of the entire chain from data collection, transmission, processing to application.

The relationship between the two can be summarized as follows: The "platform layer" in the four-layer logical framework is specifically realized by the business layer and data layer in the three-layer B/S architecture; the "presentation layer" and "application layer" are highly functionally corresponding, but the division of the application layer places more emphasis on the functional aggregation for different user roles (especially public security users). This dual description approach not only maintains the clarity of the system's technical implementation but also facilitates the connection and functional expansion with external systems such as the public security video dedicated network, PGIS, and 110 command center in the police scenario.

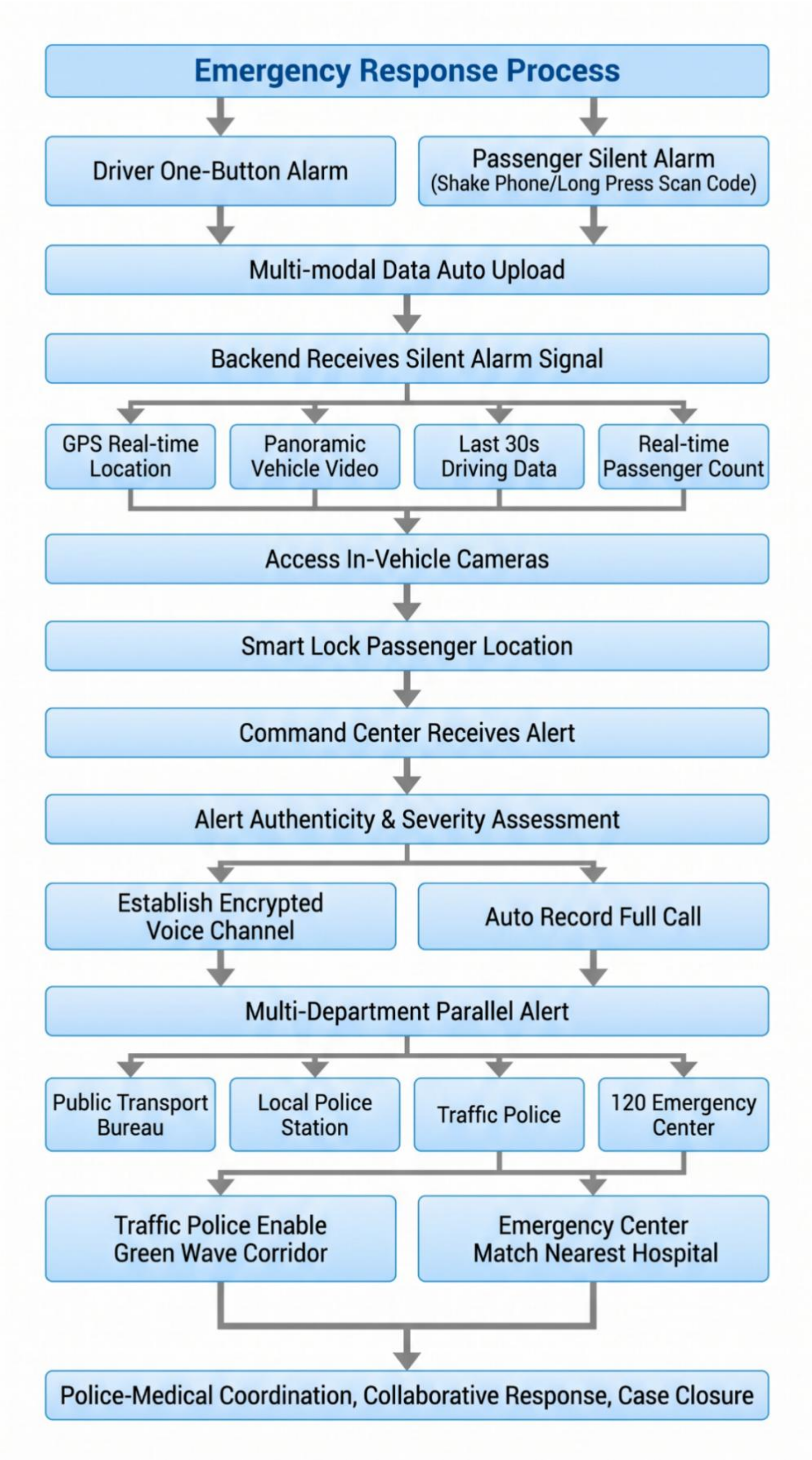

Fig 2. System framework

3.3.Database design

Each table is associated with foreign keys to form a complete operational data chain, providing structured support for subsequent data mining and intelligence analysis.

3.4.Security and permission design

The system integrates Spring Security and JWT (JSON Web Token) to achieve identity authentication and permission control. The RBAC (role-based access control) model is adopted, and roles such as system administrator, dispatcher, driver, and public security commander are preset. The role of the public security commander has special permission configurations: it can view the real-time location of all vehicles, access on-board video surveillance, and receive abnormal early warning pushes, but it cannot modify the operation schedule data to ensure the balance between operational data security and police needs.

Table 1. System core data

Table name	Field name	Field description
vehicle_schedule (Vehicle Dispatch Schedule)	Vehicle ID	Unique vehicle identification
	Route ID	The associated route number
	Departure time	Scheduled departure times
	Arrival time	Plan your arrival time
	Driver's name	Driver's name
	state	Such as "waiting to depart", "driving", "arriving", etc
	Note:	Additional instructions
route_optimization (Route Optimization Table)	Route ID	Unique identification of the route
	Starting location	Start point name or coordinates
	Termination location	End point name or coordinates
	Optimize the post-time	Estimated time (minutes) or moments after optimization
	distance	Route length (km)
	Traffic conditions	Such as "smooth", "slow" and "congested"
passenger_feedback (Passenger Feedback Form)	Feedback ID	Feedback is uniquely identified
	Passenger ID	The passenger number for submitting feedback
	Vehicle ID	The vehicle number you ride
	Feedback	Text filled in by the passenger
	Rating	For example, 1~5 points
	Feedback time	Submission timestamp
real_time_monitor (Real-time Monitoring Table)	Monitor ID	Unique identification of monitoring records
	Vehicle ID	The number of the monitored vehicle
	Current location	Latitude and longitude or site name
	state	Such as "online", "offline", "driving" and "stopping"
	Timestamp	Location/status update time
data_analysis_report (Data Analysis Report Form)	Report ID	Report unique identification
	Report Type	Such as "daily", "weekly" and "public security report"
	Generate date	Report the output date
	Report Summary	Brief conclusion
	The report details	Analyze the content in detail

4.Implementation of core functions of the system

4.1.Vehicle dispatch management module

Vehicle scheduling is the core function of the system, which realizes comprehensive monitoring of drivers, vehicles, routes and status. This module provides the functions of adding, deleting, modifying, conditional search, and pagination display of vehicle scheduling.

The backend controller layer is based on Spring Boot and uses '@RestController' annotations to expose REST interfaces. The key codes are as follows.

```java
@RestController
@RequestMapping("/optimization/vehicle_schedule")
```

```
public class VehicleScheduleController extends
BaseController {
      @Autowired
      private IVehicleScheduleService vehicleScheduleService;


@PreAuthorize("@ss.hasPermi('optimization:vehicle_schedul
e:list')")
      @GetMapping("/list")
      public TableDataInfo list(VehicleSchedule
vehicleSchedule) {
            startPage();
            List<VehicleSchedule> list =
vehicleScheduleService
                  .selectVehicleScheduleList(vehicleSchedule);
            return getDataTable(list);
      }

      @Log(title = "Vehicle Dispatch Management",
businessType = BusinessType.INSERT)
      @PostMapping
      public AjaxResult add(@RequestBody VehicleSchedule
vehicleSchedule) {
            return toAjax(vehicleScheduleService
                  .insertVehicleSchedule(vehicleSchedule));
      }
}
```

The front-end realizes table display and form interaction based on Vue.js and Element UI, supports fuzzy search by vehicle ID and driver name, and provides operations such as adding, editing, deleting, and viewing details. This module provides basic data support for emergency vehicle dispatch in police scenarios.

4.2.Route optimization management module

The route optimization module uses big data analysis technology to adjust and optimize route settings in real time. The domain layer is designed as follows:

```java
public class RouteOptimization extends BaseEntity {
      private Long routeId;
      @Excel (name = "Start From")
      private String startLocation;
      @Excel (name = "Termination Location")
      private String endLocation;
      @JsonFormat(pattern = "yyyy-MM-dd")
      @Excel(name = "optimized time", width = 30,
dateFormat = "yyyy-MM-dd")
      private Date optimizedTime;
      @Excel(name = "distance")
      private BigDecimal distance;
      @Excel (name = "traffic conditions")
      private String trafficConditions;
      // Getter/Setter...
}
```

4.3.Passenger feedback management module

The passenger feedback module collects passenger reviews and suggestions on the service through multiple channels. The system records the feedback ID, passenger ID, vehicle ID, feedback content, rating, and feedback time. In terms of basic functions, the public security commander can view the feedback records involving public security clues, such as "in-car disputes" and "suspicious persons" reported by passengers, and the system automatically marks and pushes them to the police terminal.

4.4.Real-time monitoring system module

The real-time monitoring module uses sensors and video monitoring to grasp the operating status of the vehicle. The system records the monitoring ID, vehicle ID, current location, status, and timestamp. The front-end adopts Vue 3's '<script setup>' syntax to achieve responsive data binding, and key interface elements include vehicle location map display, status identification, timeline playback, etc.

In terms of video collection standards, the system refers to the "Technical Specifications for the Construction of Public Security Video Surveillance Systems"[13], and the image output pixels of the camera are not less than 1920×1080, which supports quality diagnosis functions such as video loss, occlusion, and freezing to ensure that the video data meets the actual combat needs of public security.

4.5.Data analysis and reporting module

The data analysis module gathers various operational data and generates analysis reports through visualization technology. The system supports search by report type, generation date, and other dimensions, and provides Excel export function. In police scenarios, the module can generate special security situation reports, such as "route capacity analysis during large-scale events" and "passenger flow density statistics during key periods", etc., to provide a quantitative basis for command and decision-making.

5.Analysis of police application scenarios

Passenger feedback from traditional bus companies is mainly used to improve service quality, and from the perspective of smart policing, this fragmented information is an important data source for public security risk investigation. The "frequent passenger" mechanism explored by the Beijing Bus Corps proves that passengers who have been trained with the ability to feedback potential safety hazards can effectively play the role of feedback and early warning of hidden dangers.

5.1.Intelligent extraction of public security keywords

In the process of automatic analysis of passenger feedback texts, the system constructs a public security-sensitive thesaurus for the field of public safety, covering keywords with potential public security risks such as "fighting", "suspicious package", "drunken trouble", and "secretly filming". Based on Natural Language Processing (NLP) technology, the system performs word segmentation, part-of-speech annotation, and keyword matching on the unstructured feedback text submitted by passengers, so as to realize the automatic identification and labeling of high-risk feedback. Specifically, the system adopts a method based on the combination of dictionary matching and rules to count the number of sensitive words hit in a single feedback, and when multiple sensitive words are hit, it is regarded as a high-risk signal. In addition, in order to suppress occasional false alarms and improve the reliability of early warning, the system further introduces spatio-temporal correlation analysis: if the same operating vehicle receives multiple passenger feedback with sensitive words within a set time window (such as 5 minutes), it is regarded as a potential group incident or continuous public security hazard. Based on the above two trigger conditions - that is, a single feedback hits multiple sensitive words, or the same vehicle receives multiple related feedback in a short period of time - the system will automatically generate a "public security early warning work order" and push it to the public security management module to provide data support for subsequent police dispatch and on-site disposal. This method effectively integrates text semantic features and spatio-temporal clustering features, and improves the intelligent level of public security risk perception in public transportation scenarios.

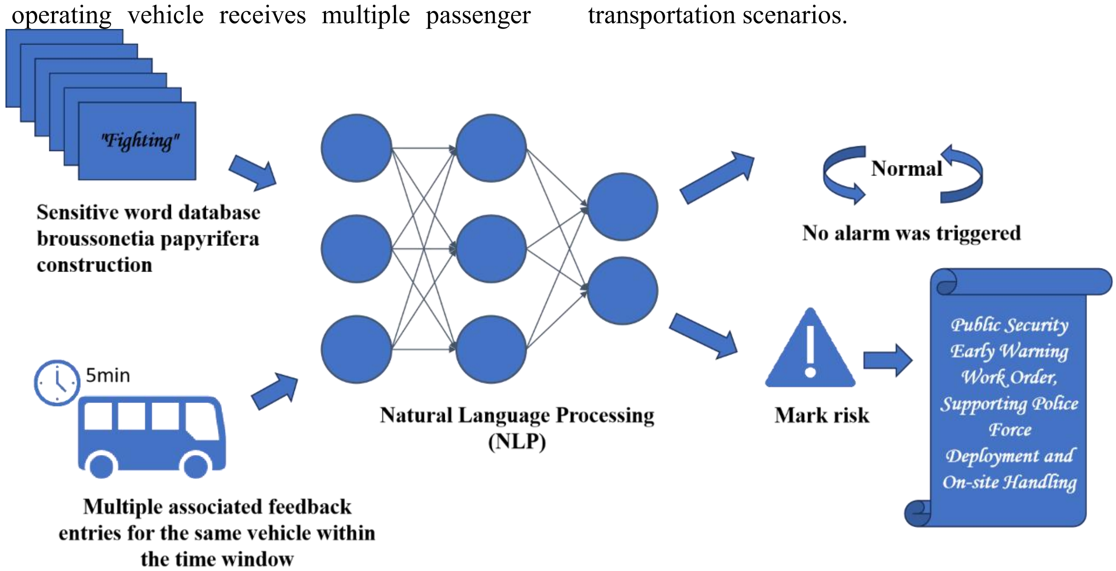

Fig 3. Flow chart of NLP intelligent analysis + public security early warning for bus passenger feedback

5.2.Risk level assessment model

5.2.1.Basis for model construction evaluation

(1) (Essential) Expert Rating Mechanism:Three senior police experts from the Public Transport Branch of the Guangzhou Public Security Bureau and two safety managers from two bus companies were invited to form an expert review team. The expert group independently labeled and classified 200 typical passenger feedback samples from historical records (including 50 feedbacks related to confirmed security incidents and 150 daily service feedbacks) to create an initial risk label dataset. Through Kappa consistency testing, the consistency coefficient of the annotations among experts was 0.85, indicating that the evaluation criteria had a high degree of consistency.

Table 2. Risk level assessment criteria and disposal mechanism

Risk Level	Color Code	Trigger Conditions (Scoring Rules)	Disposal&Coordination Requirements
Level I (High Risk)	Red	Single feedback contains ≥3 sensitive words, OR the same vehicle receives ≥3 sensitive feedbacks within 5 minutes	Real-time push to local police stations and the Public Transport Sub-bureau; initiate police incident coordination
Level II (Medium Risk)	Orange	Single feedback contains 2 sensitive words, OR the same vehicle receives ≥2 sensitive feedbacks within 10 minutes	Push to the jurisdictional police post within 30 minutes; include in patrol monitoring
Level III (Low Risk)	Yellow	Single feedback contains 1 sensitive word	Generate the daily "Public Transport Security Risk Assessment Daily Report"

(2) Data-driven by historical incident records:Based on 217 public transportation-related security incidents that occurred in Guangzhou from 2022 to 2024 (including 42 cases of fighting and brawling, 87 cases of theft, 56 cases of passenger disputes, and 32 other incidents), the passenger feedback texts submitted within the 30 minutes before the incidents were extracted. The TF-IDF method was used to statistically analyze the correlation between frequent keywords and risk

levels. The analysis results show that words such as "fighting", "bloodshed", "knife", and "robbery" are highly correlated with the first-level risk; words such as "argument", "harassment", and "stolen photography" have a strong association with the second-level risk; and words such as "crowded", "emergency braking", and "poor service" are more frequently seen in the third-level risk or non-risk samples.

(3) NLP Keyword Matching and Spatiotemporal Clustering Rules:The system construction includes a public transportation security-specific word database containing 150 sensitive words, covering five types of public safety scenarios such as violent conflicts, suspicious items, harassment and stalking, disputes and arguments, and facility destruction. During the real-time analysis process, the system segments the feedback text submitted by passengers, performs part-of-speech tagging and keyword matching, and simultaneously introduces time-space clustering rules: if the same bus receives multiple feedbacks that hit the sensitive words within a set time window (the first-level risk is 5 minutes, and the second-level risk is 10 minutes), the risk level will be automatically upgraded or an alert will be triggered.

5.2.2.Model validation and effect evaluation

To test the practical utility of the risk level assessment model, this time, 30 incidents of public transportation security in Guangzhou City, verified by the police's alarm records, were selected for a retrospective test. The passenger feedback data corresponding to these incidents within the 30 minutes before the event occurrence were input into the model to check if it could issue corresponding level warnings in advance. The test results showed that the model successfully identified 27 incidents, with a recall rate of 90.0%, and the warning time was on average 12 minutes earlier than that of the manual review by the bus safety officers. 500 daily passenger feedback samples without any security incidents were randomly selected for testing. The system's false positive rate was 6.3%, and a total of 31 pieces of content were wrongly judged as risks. The false alarms mainly stemmed from the passengers' emotional and exaggerated expressions. Subsequent efforts could involve the introduction of the BERT pre-trained language model for fine-grained semantic analysis to optimize this issue. The overall validation results demonstrated that this risk assessment model, which combines keyword matching and time-space clustering rules, can effectively perceive potential safety risks in public transportation, with good recall rates and a reasonable false alarm rate, and can meet the initial application requirements of police operations.

5.3.Scheme design of real-time monitoring system and command center linkage

Real-time monitoring systems are the "eyes" of public transportation security. According to the "Technical Specifications for the Construction of Public Safety Video Surveillance Systems", command centers at all levels should be able to quickly access and control on-site video surveillance, and support the mirror transmission and display of surveillance wall images. This platform has designed a three-level linkage mechanism.

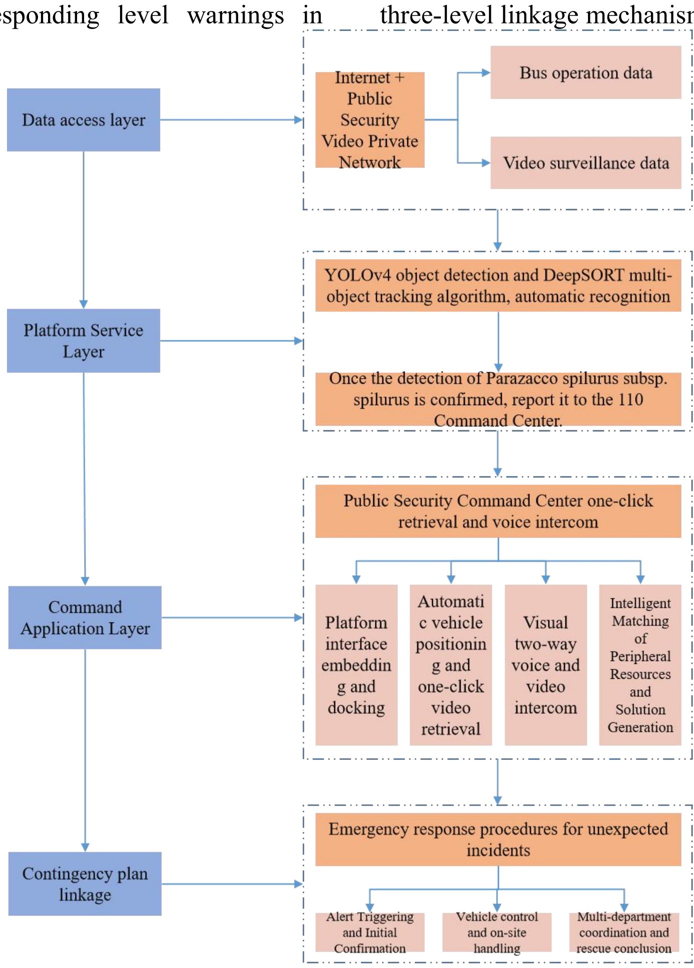

Fig 4. Three-level linkage mechanism

6.Suggestions for expanding police functions

6.1.Design ideas for early warning modules for key personnel

By deploying face recognition cameras on bus terminals and key platforms, real-time capture of passengers' facial features and comparison with the key public security personnel pool, once hit, the system does not trigger the in-car alarm, but silently pushes early warnings to the command center containing information such as personnel avatars, boarding and disembarking stations, accompanying personnel and real-time vehicle locations. At the same time, the system records the riding trajectories of key personnel, and uses the spatio-temporal correlation of multiple buses to analyze their travel laws and possible footholds, providing intelligence support for landing inspection and control. In addition, the module supports red, orange, and yellow three-level deployment control: red indicates immediate arrest, and the system automatically dispatches the nearest police force to follow the car; Orange is for close attention, record the trajectory and notify the destination police station; Yellow is general concern and is included in daily research and judgment.

6.2.Design of one-key alarm linkage mechanism

At present, "one-button alarm" devices are generally installed on buses, but there are problems such as high false alarm rate and single information. The design idea of this system is as follows.

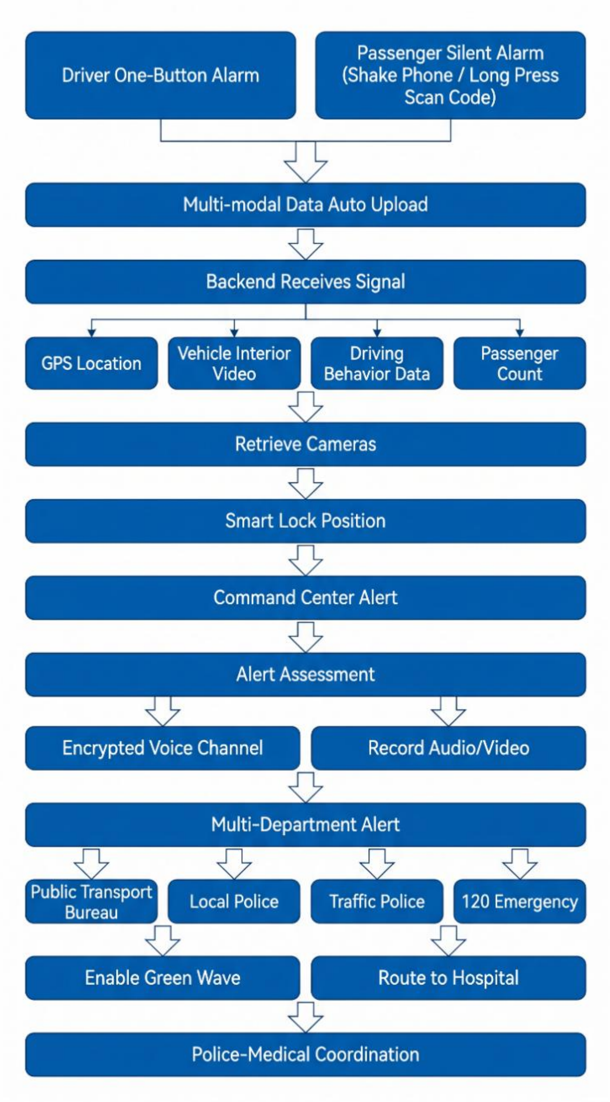

Fig 5. Expansion of police functions

7.System testing and simulation demonstrations

7.1.Test environment

According to the information registration form, the system development environment is: CPU Intel Core i5-10400F, RAM 8GB, hard disk 512GB SSD; The operating environment is CPU AMD Ryzen 5 2600, RAM 8GB, hard disk 1TB SSD; Operating system: Windows 10 and above, JRE 1.8, development tools IntelliJ IDEA, programming languages Java, HTML, JavaScript. The test adopts a combination of black box testing and white box testing, covering functional testing, performance testing, and security testing.

7.2.Functional testing

Table 3. Five core modules of the system

Module Name	Test item	Test results	Note:
Vehicle scheduling management	Add/Edit/Delete/Query/ Pagination	passed	Pagination responds normally when the data volume > 1000
Route optimization management	Conditional retrieval/route calculation/data export	passed	The average route calculation takes 1.2 seconds
Passenger feedback management	Sensitive word tagging/risk rating assessment	passed	The sensitive thesaurus has a total of 150 words, and no misjudgments have been found
Real-time monitoring system	Video access/location refresh/status update	passed	G7E devices have stable video streams
Data analysis reports	Report generation/Excel export/chart display	passed	Excel exports column width adaptive
User rights management	Role assignment/permission control/login authentication	passed	The password complexity check passes

7.3.Performance testing

Using Apache JMeter to simulate concurrent access, the test results show that under the condition of 100 concurrent users, the average response time of the system is 480ms, and the throughput reaches 215 requests/sec. Database query operations maintain millisecond response with millions of data volumes. The system meets the requirements for the concurrent performance of the command platform in the "Research on the Architecture of Transportation Emergency Command System".

8.Summary and outlook

The public transportation emergency command and assistance platform designed and implemented in this paper is based on the Spring Boot microservice architecture and takes Vue.js as the front-end framework, integrating five core functions: vehicle scheduling, route optimization, passenger feedback, real-time monitoring and data analysis. More importantly, from the perspective of smart policing, the system is no longer limited to traditional operation and management, but deeply integrates the actual combat needs of public security: the coordinated scheduling of transportation capacity and police force is realized in the security of large-scale events; dig up clues about security risks in passenger feedback; An efficient linkage mechanism with the 110 command center is built in real-time monitoring. At the same time, the proposed expansion design such as early warning of key personnel and one-click alarm linkage points out the direction for the subsequent upgrade of the system.

The characteristics of the system are "one set of platforms and two perspectives": for public transport enterprises, it is a scheduling tool to improve operational efficiency; For public security organs, it is a practical platform for perceiving risks and directing disposal. This two-wheel drive design concept not only retains the integrity of the original project, but also fully reflects the professional perspective of the cadets of the police academy. Future work can be deepened from the following aspects: first, the introduction of digital twin technology to carry out three-dimensional modeling of key venues and routes to realize the visual deduction of security plans; second, integrate vehicle-road collaboration and autonomous driving technology to explore the application of driverless buses in large-scale event evacuation; The third is to deepen the docking with the public security big data platform to realize cross-departmental and cross-regional intelligence sharing and joint command. With the continuous advancement of smart policing construction, the public transportation system will surely play a more important role in the urban social security prevention and control system.

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