URBAN TRANSPORT IMPROVEMENT BY ESTABLISHING INTELLIGENT PUBLIC TRANSPORT SYSTEM

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ABSTRACT

Public transport has many obvious advantages compared with private transport. Giving priority to the development of urban public transport system is the best way to solve the traffic problems in large and medium cities. In recent years, Intelligent Public Transport System (IPTS) has become the main researching direction of public transport. Applying GIS to the intelligent construction and management of public transport system in China is one of the important means to improve the efficiency and attractiveness of public transport. Combining the research and construction achievements of the existing intelligent public transport, the architecture of the intelligent public transport system was analysed in this paper. Besides, the functions of each subsystem of the intelligent public transport system were studied one by one.

Keywords: Intelligent Public Transport System; GIS; Public Transport; Architecture

1. INTRODUCTION

With the development of urbanization process, more and more people move into the city for a better life. Which brings a lot of traffic problems, such as the rapid increase in the number of motor vehicles, large occupation of the road resources, increasingly saturated traffic volume, congestion and so on. Therefore, we need to solve these problems immediately for the healthy development of the city. As we all known, energetically developing public transport is the best way to solve the transport problem in the city. However, simply relying on the investment and construction of public transport facilities can’t completely solve the traffic problems. It is also necessary to strengthen the utilization and management of public transport facilities and equipment. Here, establishing Intelligent Public Transport System (IPTS) is an effective way to realize this target.

International Association of Public Transport (2002) defined IPTS as Intelligent Transport System (ITS) for public transport. It aims to technically transform the traditional public transport system through advanced theories and technologies. In this way, it can provide technical support for optimizing the allocation of public transport resources, public transport stations, vehicles and working crews, and reducing operating costs as well. Finally establishing a public transport information management system with low-cost and high-efficiency. At present, Intelligent Transport System has been studied and implemented by several public transport agencies over the world to insure a high quality of service to passengers. For example, Hough et al (2002) reported that more than 122 agencies have implemented an IPTS in USA. Among these IPTS, Geographic Information Systems (GIS) and Decision Support Systems (DSS) were the most widely used technologies. Besides, European Commission (Engels et al., 2009) funded an IPTS called CIVITAS, which is implemented in 60 European cities, including La Rochelle, London and Frankfort. Similarly, another IPTS SITREPA (Cachulo et al., 2012) tested in Leiria city. It uses SITREPA Vehicle Embedded Device (SVED) which combines GPS and RFID technologies to locate vehicles. Over a GPRS (General Packet Radio Service) connection, it can provide real-time information for passengers and drivers. For the study, Balbo and Pinson (2010) developed an IPTS, named SATIR, which has been tested on the Brussels transportation network (STIB). The system integrates an Automatic Vehicle Monitoring (AVM) system (using GPS system) and a Decision Support System (DSS) to help action planning and decision making by a multi-agent paradigm.

Utilizing existing map management functions and massive geospatial data storage technologies of GIS, combining with mature GPS mobile positioning technology, GPRS wireless communication technology, computer network technology and database technology, this paper aims to deeply study the architecture of IPTS. In this way, it can promote the implementation of IPTS, which will surely attract more passengers to take public transport and ease traffic pressure, thus solving urban traffic congestion and environmental pollution problems to a certain extent. Which is of great significance to economic development, utilization rate of resources and people common life.

2. ARCHITECTURE OF IPTS

Combining previous studies, five main subsystems of IPTS are given in this section, which are shown as Figure 1.

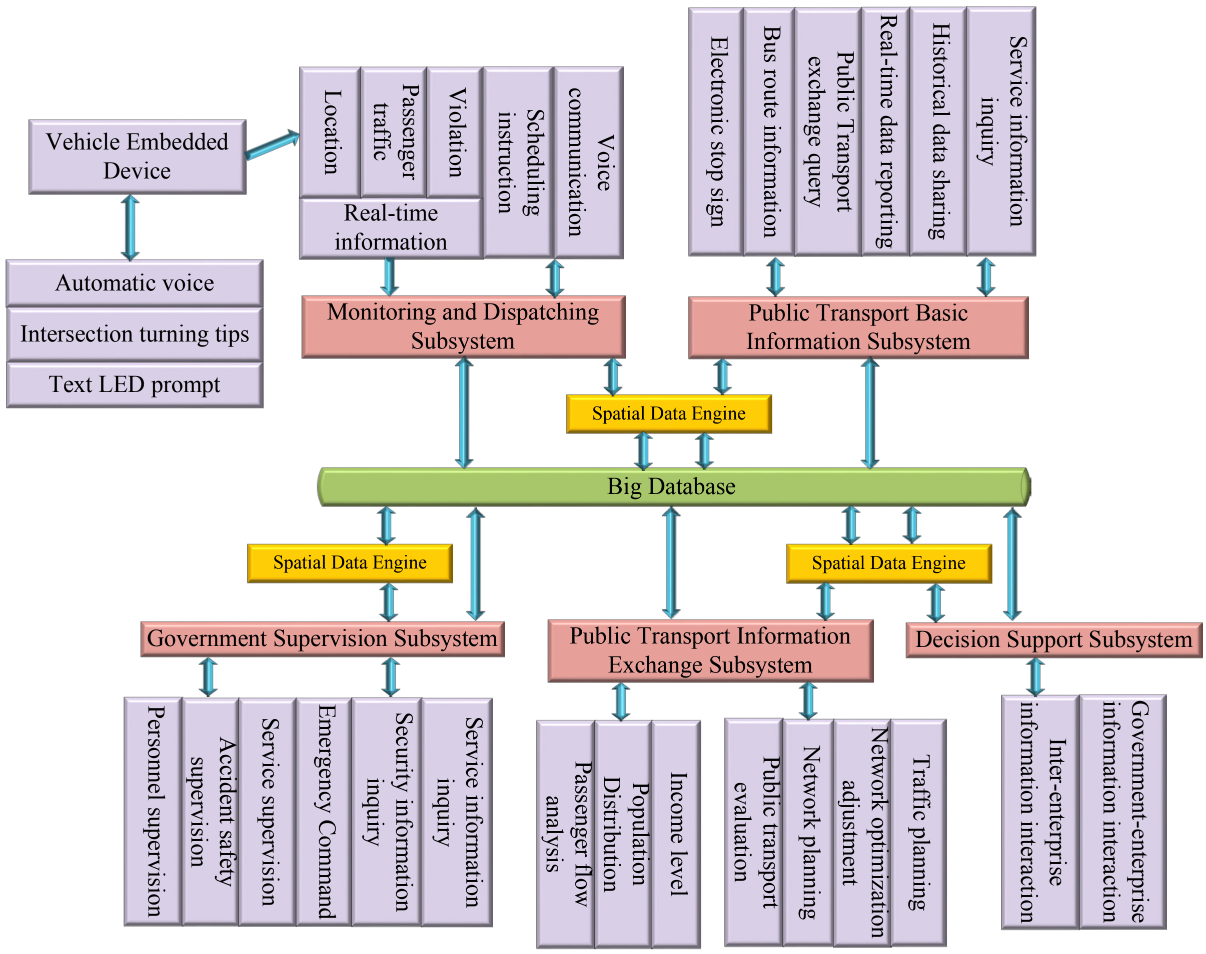

Figure 1: Architecture of IPTS

The basic process of the IPTS is to use GPS, data acquisition instrument, etc. for the bus terminal to carry out data collection such as location and driving status. With GIS as the operation platform, real-time monitoring and intelligentization of public transport vehicles can be realized in the monitoring and dispatching center through wireless communication. And then releasing information about the operation of vehicles and lines through electronic station signs, transfer inquiry desk, Web public transport transfer enquiry system, public transport transfer telephone calls, and mobile phone inquiries, so as to facilitate citizens' travel and improve services. Next, based on the management of ticketing, fuel consumption, maintenance, complaints, accidents, driving safety, personnel and other information, comprehensive evaluations of economic benefits, social benefits and service levels are given to strengthen driving safety management, reduce operating costs, and improve the service quality of employees. Finally, combined with passenger flow statistics, bus travel surveys, geographic economic information, bus network layout, site layout, departure interval, fare formulation, operational status and so on for statistical analysis, thus providing decision support for network planning and route optimization adjustments.

2.1 Public transport basic information subsystem

This subsystem mainly realizes the maintenance and management of static information and dynamic information of the public transport, meanwhile, it shares the information with relevant government departments. According to the established static basic information and dynamic basic information, resources are updated, queried and counted, and based on the resources, data aggregation and analysis are performed. In addition, this subsystem is also responsible for providing services to the public. For example, providing public transport routes to the public via the internet, telephone or radio, and sending real-time data to the electronic station.

Basic information resource management includes the maintenance of static and dynamic basic information.

(1) The static basic information is mainly shown as following:

- Stop information
- Route information
- Vehicle basic information
- Basic information of practitioners
- Vehicle company basic information
- Parking information
- Repair factory information
- Depot information

(2) The dynamic basic information is mainly shown as following:

- Operation planning information. Including route operating plan, vehicle scheduling plan, driver scheduling plan, etc.
- Vehicle dynamic information. Including real-time vehicle information, automatic archiving of vehicle history information, etc.
- Operation recording information. Including route operating information, etc.
- Service information. Including the actual departure information of the first and last shuttle, entering and leaving information from the parking lot, arriving and leaving information at each station, and vehicle supply information.
- Operation security information. Including the information of over-speed, quasi-late, over-station, stagnant station, vehicle interval, average operating speed, vehicle irregular parking and abnormal opening door.

2.2 Government supervision subsystem

The government supervision subsystem mainly includes map basic application module, service supply information inquiry module, operation security monitoring module, real-time monitoring module, security information inquiry module, security information statistic module, emergency command module, etc.

The map basic application module includes map display control, map browsing, layer configuration, measurement function, label hiding and display, etc. The service supply information inquiry module includes basic information inquiry of the vehicle and the driver. Besides, it also offer the inquiry of the vehicle in operation, vehicle entering and leaving the parking lot, first and last departure time and vehicle operation plan.

The operation security supervision module indicates the vehicles in the state of over-speed, carjacking, accident and so on by using different colours on the electronic map, at the same time, it gives corresponding alarm information. The main function of this module is to count the number of the vehicles in an abnormal state, calculate the average speed in the route, etc. The real-time monitoring module includes real-time monitoring, selection monitoring, query, track control, track playback, vehicle alarm information monitoring and GPS data calibration. The security information inquiry module queries the detailed data of the vehicle information and the vehicle alarm information by vehicle company name, vehicle type, license plate number, time period, and vehicle route. The emergency command module includes emergency plan simulation and evaluation and emergency dispatch disposal. The emergency plan simulation and evaluation can simulate a variety of emergency plans for some emergencies, and then, it evaluate these plans to find the best solution for decision-making. In case of emergency, the corresponding items can be automatically called up for decision-making. At the same time, various emergency dispatch orders are sent to the vehicle company in time to let the managers know the implementation of the event handling in real time.

2.3 Public transport information exchange subsystem

The public transport information exchange subsystem mainly realizes the exchange function of static data and dynamic data of public transport. It mainly realizes data transfer through government communication gateway and enterprise communication gateway.

2.3.1 Government communication gateway

Through the government communication gateway, the real-time operation information of the vehicle is accessed from each operator, the historical operation records are periodically written into the history table, and based on a certain communication protocol, the real-time operation information of the vehicle is forwarded to the monitoring terminal connected to the server. The data collection service performs real-time calculation based on real-time data and stores the calculation results to the database.

2.3.2 Enterprise communication gateway

Enterprises access the real-time operation information of their own vehicles into their own database. Afterwards, the historical operation records are periodically written into the history table, and based on a certain communication protocol, the real-time operation information of the vehicles is forwarded to the enterprise monitoring terminal connected to the server. The data collection service performs real-time calculation based on real-time data and stores the calculation results into the bus enterprise database.

2.4 Decision support subsystem

Rasmussen et al (1992) analysed the relationship between decision makers and decision support system. They were horizontal cooperation and vertical cooperation separately. For the horizontal cooperation, the final decision is given by the decision support subsystem. Usually, it is used in autonomous system, and the decision makers only need to supervise the decision making process. However, for the vertical cooperation, decision support subsystem is just a guide to the decision makers. Which means decision makers can interact with the subsystem in data processing, data analysing or decision-making procedure at any time.

Based on the operation data and evaluation data, this subsystem provides the decision makers with passenger flow analysis and distribution data analysis. And then, it displays the data in combination with the graphic to achieve the decision-making goal. It can provide real-time system status query for managers based on comprehensive management of passenger flow statistic, trip survey, population distribution, income level, network layout, stop layout, departure interval, fare formulation, operational status, etc. Besides, the historical data analysis service provides a comprehensive analysis of the company's economic benefits, social benefits and service level, thus to support the development and reform of the company. At the same time, it provides support for network planning, network optimization, route optimization and traffic policy development on GIS platform.

3. CONCLUSIONS

The main objective of this paper is to design the architecture of Intelligent Public Transport System (IPTS). With respect to existing studies and practice, the author give the architecture of IPTS, which is consist of monitoring and dispatching subsystem, public transport basic information subsystem, government supervision subsystem, public transport information exchange subsystem and decision support subsystem. For each subsystem, it contains large and diverse data, therefore, high interoperability level must be insured in this architecture through spatial data engine. Furthermore, all subsystems must be compatible with existing technologies to make IPTS can be carried out easily.

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