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Early Warning of Highway Traffic Safety Information Service System

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Abstract: Vehicular network and big data environment create data conditions and basic platform for improving the quality and level of traffic information service. The aim of this article is to construct a new early warning of highway traffic safety information service system in this environment. Through in-depth analysis the connotation and technology characteristics of vehicular network and traffic information service, make the traffic information service architecture construction as the application object. An early warning of highway traffic safety information service system has been constructed, the application effect is good. Traffic safety early warning can be done in 2 sec. Under the vehicular network environment, this new type of traffic information service system helps to guarantee the traffic safety and efficient operation, more intelligent and personalized traffic information service can be used for the vehicular network users.

Key words: Vehicular network, traffic information service, traffic safety, early warning

INTRODUCTION

Traffic information service mainly includes the pre-trip information service, on-trip information service for drivers, on-trip public transportation information service and personalized information service. Traffic information service aims to facilitate the passengers and drivers in travel, which fully reflect the real-time traffic information. The users utilize all kinds of traffic information to consciously adjust their travel behaviors and to realize the optimization of transportation system. Traffic information service must have the following characteristics: Providing information timely, accurate and reliable; good correlation for travel decision-making; providing traffic information related to the entire region; easy to be used and accepted by the traffic participants and public (Chang *et al*., 2007).

At present, the traffic information service made important contributions for traffic safety and high efficiency. However, the existing traffic information service systems have the following problems to be resolved: comprehensive processing of traffic information needs to be further improved. In order to obtain a higher intelligent level of service information for travel; the processing speed of traffic information needs to be accelerated further, to obtain a real time dynamic information service information for travel; the traffic information service methods need to be further enriched, for obtaining a specific service information for trip.

The recent emergence of vehicular network has brought new opportunities for the traffic information service. Establishing new type of traffic information service system under vehicular network environment becomes possible.

CONNOTATION AND TECHNICAL FEATURES OF VEHICULAR NETWORK AND TRAFFIC INFORMATION SERVICE ANALYSIS

Vehicular network and big data are hot topics in recent academic research. Vehicular network is a specific application of the Internet of things in the field of intelligent transportation. It connects the non-communicating vehicles by using advanced information technology. Get the attribute information, status information of objects involved in the vehicular network. Share information between the objects. Enhance the basic ability of intelligent traffic information perception, transmission and utilization. After the vehicular network deployment at a large-scale, on the one hand inevitable persistent multi-source information will be got from traffic participants, such as human, vehicles, roads and environments. On the other hand, human connect the Internet, mobile Internet with the vehicular network. From these two aspects a big data environment has been built. In recent years, big data mainly from people's daily life, including: Internet, sensor network and the Internet of things (Chen *et al*., 2007).

Vehicular network analysis: The vehicular network is a huge interaction network which is composed of vehicle position information, speed and route information. Using the GPS, RFID, sensor, camera and image processing device, the vehicle can complete its own state and the surrounding environment information collection; using the Internet technology, all vehicles will converge all kinds of information to the central processor; using the computer technology, the amount of vehicle information

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can be analyzed and processed to calculate the best route for different vehicles, to report the traffic condition and to arrange signal cycle (Hossain *et al*., 2010).

Traffic information service analysis: Traffic information service system is also called advanced traveler information systems (for short is ATIS). ATIS provides various information which travels required in the trip to reach their destinations by using vehicles such as cars, buses or both of these two kinds of vehicles based on advanced communication and information technology (Li *et al*., 2010).

EARLY WARNING OF HIGHWAY TRAFFIC SAFETY INFORMATION SERVICE SYSTEM

In order to verify the traffic information service system under the vehicular network environment, an early warning of highway traffic safety information service system is designed in this paper. The system provides early warning information of traffic safety to the vehicles driving on the highway. A distributed mobile computing mode was used to calculate real-time traffic atomic service information, which helped the driving on highway to get safety warning timely and ensure driving safety well. At present, the system has been tested in miniature. From the test results we can see that it works well.

System functions and composition: Early warning of highway traffic safety traffic information service system provides early warning information of traffic safty to the vehicles driving on the highway. Drivers can get a vehicle terminal at the highway entrance. The vehicle terminals collect the real-time basic data of vehicle speed, position etc. And the real-time data is transmitted to the data processing center. A real-time data processing and analysis are done in data processing center. After that, some driving parameters which includes many atomic service information, such as vehicles overspeed, too close distance of two vehicles, accident ahead, congestion ahead, road collapse ahead, road repairment ahead, narrow road ahead, tunnel ahead etc., are gotten. These kinds of atomic safety traffic service information are released to the relevant vehicle terminal. In order to ensure driving safety by early warning the drivers. The vehicle terminals are returned at the exits of the highway.

Early warning of highway traffic safety information service system mainly includes two parts: Vehicle terminals and data center, as shown in Fig. 1. The vehicle terminal has the functions of information acquisition, information transmission and receiving published information. Data center has the function of traffic information atomic service computing. In addition, the data center also supports the relevant information service release function, which mainly shows in the application of electronic map. After obtaining atomic traffic information service from data center computing, the early warning safety traffic information services are released to the related vehicles in a certain range by using the electronic map. At the same time, in order to ensure the completeness of early warning atomic service information,

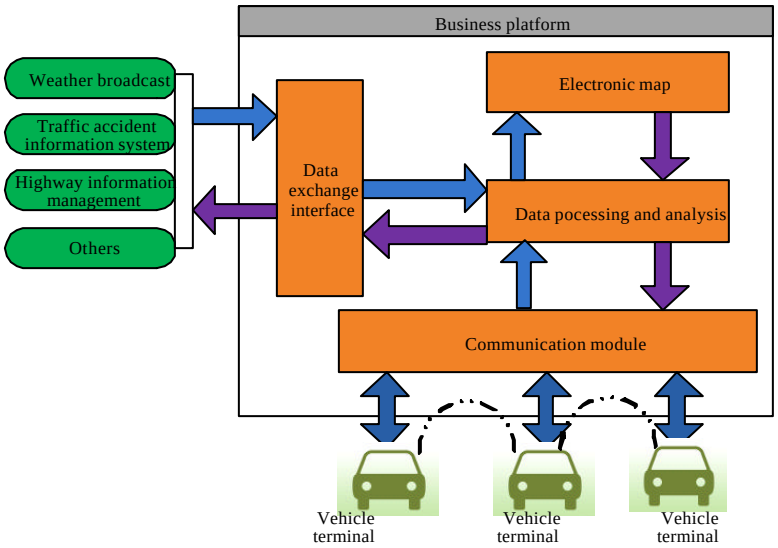

Fig. 1: System composition

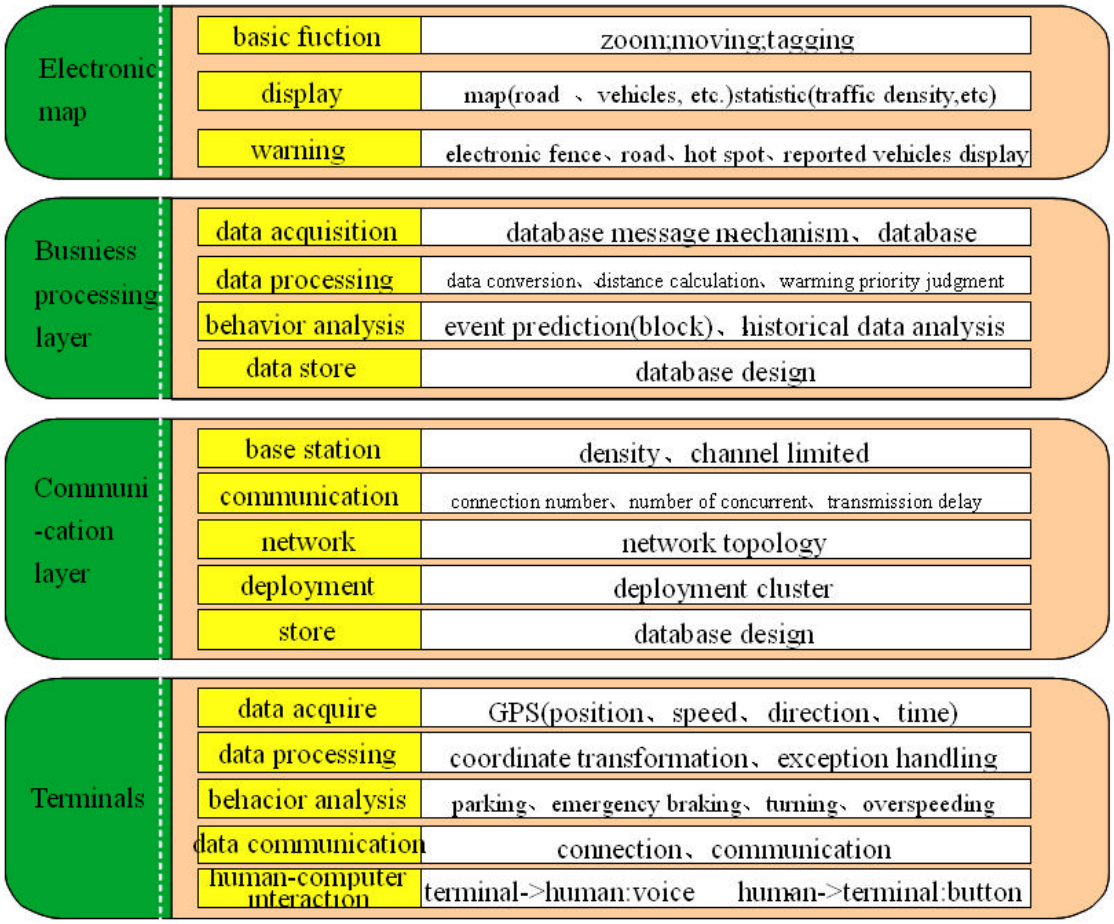

Fig. 2: System architecture

early warning of highway traffic safety information service system also does data exchange between the highway operation and management systems.

System design: Early warning of highway traffic safety traffic information service system can be divided into data collecting layer, communication layer, business processing layer and information presentation layer, as shown in Fig. 2.

The data acquisition task is completed by the vehicle terminal. The basic data collected by termianls main includes vehicle position, speed, direction data. The vehicle terminal also integrates the voice call traffic rescue and atomic service information release functions. The hardware of vehicle terminal include: GPS and Beidou positioning module, GPRS communication module. The system function of vehicle terminal includes data acquisition, data communication and human-computer interaction. For the information processing of terminal collected, there are coordinate transformation, exception handling, time correction, position calibration, parking, emergency braking, turning, overspeeding, retrograde behavior analysis.

The communication layer is mainly concerned with the system future scalability. At present, the system relies on mobile network operator. The communication functions include vehicle terminal acquired basic information upload, warning traffic information issue (on demand and broadcast). When the system need to be deployed for large-scale, there are something to be considered: The base station density, channel limited, communication connection number, number of concurrent, transmission delay, network topology and hardware cluster problems.

Business processing layer is currently involved in database message mechanism, data acquisition and database, data conversion in data processing, distance calculation and warning priority judgment, event prediction (block) in behavior analysis, historical data analysis.

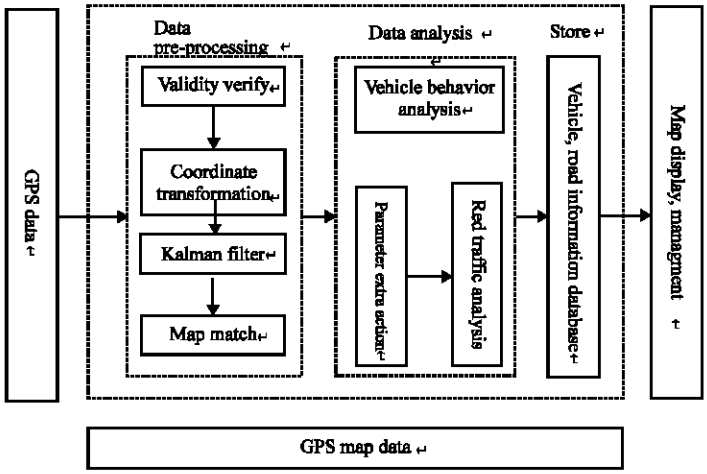

Fig. 3: Atomic service information computing principle

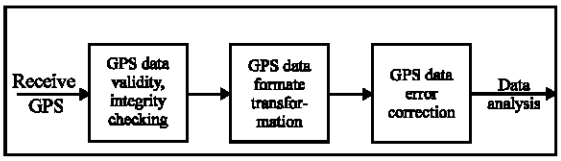

Fig. 4: GPS data pre-processing flow chart

The realization of information presentation layer is how to use electronic map. Electronic map functions include: map zoom, move and tagging; display vehicle, road, statistical traffic density on the map. To show early warning on the map, always uses electronic fence and road or hot spot range. Vehicles which need to deliver data to to the data center can be displayed on a map in a proper way.

Business processing layer is the core of the system. The objects of data processing are the vehicle position and speed information from vehicle terminals. After the analysis of larges number of vehicle terminal upload speed and position information, the behavior of vehicles obtained. These data are the traffic atomic service information for early warning safety traffic service information. This kind of work is done in the data center. The data center is a typical distributed computing system which is consisted by mobile terminals and distributed data center. The distributed mobile computing model is used to obtain traffic atomic service information. Distributed data center is the core of mobile traffic atomic information service computing platform in the future. Existing data center for early warning of highway traffic safety information service system is constructed by the unit of highway administrative management. Each highway management company may has a basic data center. In order to cover a highway network, the basic data centers needs to be interconnected.

The existing data center of early warning traffic safety atomic service information calculation principle is shown in Fig. 3. Including data preprocessing, data analysis, storage and display module. At present the GPS data is the main data be processed.

The process of GPS data preprocessing is: Receiving GPS data; GPS data validity, integrity checking; GPS data format transformation and GPS data error correction. GPS data error correction mainly comprises two steps: Kalman filtering and map matching. The process of GPS data processing is shown in Fig. 4.

Data analysis includes vehicles' status analysis, traffic parameter extraction and road traffic state analysis. After the vehicle driving state division, according to the GPS survey data, the vehicle state is determined. Vehicle running status including: normal driving, over speed, low speed, stop, reverse driving (reverse), abnormal (indeterminate direction, acute acceleration, acute deceleration, acute altitude change), fatigue driving, unknown (in a tunnel or unable to obtain the GPS data). Involved calculation includes: vehicle speed calculation, vehicle running direction calculation and vehicle continued driving time calculation. Then, according to the calculation data obtained vehicle running state can be recognized.

Vehicle speed: According to the GPS speed value, combined with the Kalman filter prediction value, the vehicle speed can be determined. The vehicle running direction: According to the GPS direction, combined with the positioning data judgment, the vehicle running

direction can be computed. Vehicle continuous running time: According to the GPS speed and time, the vehicle continuous running time can be computed.

According to the vehicle speed, vehicle driving direction and the vehicle continued driving time, the vehicle running state can be recognized.

Rules of normal running judgment: Vehicle running speed meets the current driving road speed limit (the speed limit requirements will vary according to the traffic and weather or other reasons, namely dynamic change). That is to say, the running speed is below the maximum speed limit and larger than the minimum speed limit.

Rules of overspeed running judgment: Vehicle running speed is above the highway speed limit of current driving road section. When the vehicle is overspeed, its running status is set to "over speeding".

Rules of low speed judgment: Vehicle speed is less than highway vehicles minimum speed limit of current driving road section. When the vehicle is in low speed running, its running state is set to "low speed".

Rules of parking judgment: Ideally, when a vehicle is parking, the speed of a GPS positioning data should be zero. But because of the GPS positioning errors, there will produce a drift velocity value which should be a speed threshold. This speed threshold can be determined by experiments and the Kalman filter prediction value. When the vehicle speed value is less than or equal to the threshold, a vehicle parking can be determined. When a vehicle is parking, the running state of the vehicle is set to "parking".

Rules of reverse driving (reverse) judgment: A vehicle's running direction is opposite with roadway's direction.

Rules of abnormal driving judgment: Vehicle acceleration changes too fast, the running direction and road direction deviates too large, the GPS elevation data changes acuity.

Rules of driver fatigue judgment: The driver continuously drives for more than 4 h.

Rules of running status unknown judgment: Over several time steps, unable to get the vehicle GPS data.

When the driving is in abnormal condition, works should be done: Remind the driver to drive carefully; when the reminder is invalid, an artificial talk need to be established to know the reason, to persuade, until give an alarm.

For the road traffic conditions, we analyse on the smooth degree of road and traffic accident. The road traffic conditions are usually divided into smooth, congestion and block three cases. The premise of road traffic state is the extraction of traffic parameters. The traffic parameters used in this paper are the traffic density (density), average speed, traffic flow (traffic), running time and time occupancy. Traffic state identification usually uses the above parameters and some methods, which includes the fuzzy reasoning method, pattern recognition method and neural network method, to complete the state recognition.

Future works: Existing highway traffic warning information service system is focuses on calculating atomic traffic information services. This system achieves the desired goal. In the further works, the system will obtain early warning atomic traffic information services, combined with service cooperation method to get in-depth value-added traffic information service. A typical vehicular network new traffic information service application will be implemented. With this new kind of information service, the quality of service, traffic warning information and intelligence level will be improved.

CONCLUSION

Vehicular network big data environment gives us a data foundation for improving the quality and level of traffic information service. In this article a new traffic information service system has been constructed. After the connotation and technical features of vehicular network and traffic information service system in-depth analysis, a new early warning of highway traffic safety information service system is designed. The early warning of highway traffic safety information service system runs well. In the future, we will further optimize the distributed mobile traffic information atomic service computing model, further expand the system's traffic information service cooperation, to provide practical experience to promote the use of new type network traffic information service.

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