Vehicle Information Collection and Communication System Based on CAN Bus and GPS

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Abstract. With the proportion of automobile industry in people's work and life increasing year by year, the automotive intelligent terminal market has ushered in a huge development prospect. On-board information system is a set of control system used to collect, store and display all kinds of information status in the process of automobile running. Controller Area Network (CAN) is a serial communication field bus network that effectively supports distributed monitoring or real-time control. Through the CAN bus technology, the vehicle-mounted intelligent terminal can easily interact with other devices in the automobile, so as to master the running status of the vehicle. The vehicle-mounted 3D acquisition system continuously acquires the traveling position of the measuring vehicle through GPS, and provides geographic coordinates for the 3D spatial images acquired by the measuring vehicle, thus realizing the 3D scene with spatial geographic coordinates. Relying on CAN bus and GPS technology, the vehicle-mounted intelligent terminal can conveniently obtain the surrounding road condition information and send its own vehicle data to the remote control center.

Keywords: CAN, GPS, Information Acquisition

1. Introduction

With the continuous advancement of science and technology and the continuous expansion of road construction, which has led to the vigorous development of the automobile industry, the importance of on-board information to drivers is also increasing. In the early 1990s, the United States and Germany developed a complete digital car information system to better facilitate the driving of car drivers. At present, this technology has been revised and improved [1]. The black box, another physical form of in-vehicle information systems, has been tried in the Americas and the European Community for many
years. Controller Area Network (CAN) is a serial communication field bus network that effectively supports distributed monitoring or real-time control [2]. It is a multi-master bus, and the communication medium can be twisted pair, coaxial cable or optical fiber. Since it is impossible for the management personnel to follow every vehicle, it is very inconvenient to monitor and manage it, so the operating conditions of the operators and the status of the vehicle itself cannot be grasped in time. The vehicle-mounted three-dimensional acquisition system continuously obtains the traveling position of the measuring vehicle through GPS, and provides geographic coordinates for the three-dimensional spatial image obtained by the measuring vehicle, thereby realizing a three-dimensional scene with spatial geographic coordinates [3]. In the process of driving, not only need to pay attention to the geographic location information of the current transportation vehicle, but also need to collect information such as the state of the car door and the cargo in the car, and finally send the obtained relevant data information to the server side, so that the background management personnel can obtain it in time Information on cars in transit [4].

Early in-vehicle terminal products were mainly in-vehicle audio and radio stations. Due to the lack of a complete central control module and a good display module, such products could not be well integrated into the car. With the development of computer information technology, vehicle information technology is bound to be widely used [5]. Vehicle information technology is the use of computer technology, fieldbus technology, wireless communication technology and satellite positioning technology to monitor the operating status, location and construction status of the vehicle [6]. The problem facing the traffic departments at all levels is how to improve the level of road traffic management through scientific methods and reduce accidents. The entire transportation industry also needs a product that can effectively guarantee vehicle safety and provide real-time dispatch management, so that China's traffic management can truly enter the era of intelligence [7]. Through CAN bus technology, the vehicle-mounted intelligent terminal can easily carry out data interaction with other devices in the car, so as to grasp the operating status of the vehicle. One of the biggest features of the CAN protocol is to abolish the traditional station address encoding, and instead encode the communication data block. This way of encoding according to the data block can also enable different nodes to receive the same data at the same time[8]. Relying on intelligent transportation technology, the vehicle-mounted intelligent terminal can easily obtain information about the surrounding road conditions and send its own vehicle data to the remote control center.

2. Analysis and design of vehicle information acquisition system

2.1. Demand analysis of vehicle information acquisition system

When the vehicle is running, if the goods in the vehicle can be counted frequently on the way, the probability of loss or omission of goods can be greatly reduced. The existing intelligent diagnosis systems of vehicles are generally based on computers, and some need computer networks to realize them. However, the actual operation of vehicles is often carried out in remote places. How to diagnose and repair the faults of vehicles in remote places in time is an urgent problem to be solved. In the process of driving, the real-time geographic location information of the vehicle is the only basis for judging whether the vehicle is driving on the normal route. Sending the vehicle's own location information to the server at regular time is beneficial for the managers to have a real-time control over the logistics process, and to know the specific geographical location of the vehicle in time when there
is a problem with the item information, which is beneficial to take a quick response plan. Most condition monitoring points still use traditional mechanical transmission methods, such as wind pressure and hydraulic pressure monitoring, or adopt the method of pipeline connection. This results in high complexity of installation and wiring and low reliability.

Before the driving process starts, the initial state of the door is closed, and the unregistered user cannot do any operation on the contents of the car, thus ensuring that the unapproved personnel cannot change the contents of the car. Regardless of the maximum information capacity of several electronic control units on a car, each electronic control unit needs to lead out two wires to be connected to two nodes together, and these two wires are called data wires. In the process of driving, if it is not point-to-point direct, it is inevitable to take out or put in items on the way. CAN bus is a small-scale fieldbus communication system facing industrial field and harsh environment, and emphasizes low cost and high reliability. Therefore, according to 051 model, it only adopts data link layer and physical layer. The data link layer is divided into logical link control sublayer (LLC) and media access control sublayer (MLAC). In the process of logistics, opening the door is a sensitive operation. The application for opening the door must be put forward by the driver in charge of the logistics process as valid information, and the door can only be opened with the consent of the back-office manager. CAN bus adopts short frame structure, which has low probability of interference and high reliability of data transmission. More importantly, the nodes of CAN bus have the function of automatically closing the bus in case of serious errors, cutting off its connection with the bus, so that other operations on the bus are not affected.

2.2. Overall design of vehicle information acquisition system

Navigation and positioning using electronic map is a basic function of vehicle-mounted intelligent terminal. In design, it is mainly developed on the basis of existing vector map data because there are many vehicle-mounted devices. Equipment is scattered. In order to diagnose each equipment efficiently, reliably and in detail, hard wiring can be used to collect diagnostic information of each equipment. In the on-board diagnosis network system, each vehicle is provided with a vehicle diagnosis computer, and each train is provided with a train diagnosis computer, and each device in the vehicle is connected with the vehicle diagnosis computer of the vehicle through the CAN bus. At present, most GIS development tools on the market provide secondary development languages for users, such as AML language, Avenue language and MapBasic language [9]. The host development mode is short in cycle and difficult to develop. Because of the special GIS development language, the stability of the system is greatly improved, and some functions can even be transplanted directly. Data acquisition and communication devices also need to collect the geographic coordinates, speed, direction and current standard time of vehicles. Therefore, a GPS global positioning information receiving module is needed in the design of data acquisition and communication devices to realize corresponding functions.

CAN bus represents "0" and "1" with two complementary logic values of "explicit" and "implicit". When the explicit and implicit bits are sent simultaneously on the bus, the result is that the bus value is explicit. $V_{CAN-H}$ and $V_{CAN-L}$ are two interface pins between CAN bus transceiver and bus, and the signal appears in the form of "differential" voltage between the two lines, as shown in Figure 1.
Figure 1. Numerical representation of bus bits

The maximum transmission distance between any two nodes on CAN bus is related to its bit rate, as shown in Table 1. The maximum communication distance here refers to the distance between two nodes on the same bus.

Table 1. Maximum distance between any two nodes of CAN bus system

| Bit rate /kbps | 2000 | 1000 | 500  | 250  | 125  | 100  | 50   | 25   |
|---------------|------|------|------|------|------|------|------|------|
| Maximum distance /m | 50   | 120  | 280  | 520  | 600  | 1200 | 3000 | 6500 |

The application of CAN bus technology in equipment fault diagnosis system can increase the reliability of the system, reduce the wiring, and facilitate the expansion or modification of the system and fault-tolerant design. Because there is a lot of information needed to be diagnosed by each equipment and the diagnosis information is not directly related to the train safety, in order to reduce the wiring of the train diagnosis system and improve the real-time and reliability of the diagnosis information of the train diagnosis system, the on-board diagnosis network system based on CAN is adopted. The data acquisition and communication device has built-in standby power supply, which can realize uninterrupted power supply. When the vehicle is working, the vehicle-mounted high-power DC power supply supplies power to the vehicle-mounted data acquisition and communication device, and charges the battery at the same time [10]. In actual operation, by loading the existing electronic map data files, combined with a series of algorithms such as path planning, the optimal driving route can be provided for users, and real-time direction guidance can be given to drivers during vehicle operation.

3. Implementation of vehicle information acquisition system

The GPS receiver continuously provides the latest geographic location information, and the information acquisition system is responsible for processing data and sending real-time valid data at certain intervals. When designing a CAN network, the physical layer has a great choice, but the requirement of nondestructive bit arbitration in the medium access layer in CAN protocol must be guaranteed, that is, the principle of bus competition for message acquisition with higher priority when bus competition occurs. The vehicle-mounted data acquisition and communication device is responsible for collecting CAN real-time data and GPS data, preprocessing data, transferring system
parameter configuration, transmitting real-time data to the vehicle-mounted computer, and transmitting real-time data to the remote monitoring center through 3G wireless routing. The physical layer must support the state characteristics of implicit bits and explicit bits in CAN bus [11]. When the explicit bit is not sent, the bus is in a recessive state, and when the bus is idle, the bus is in a recessive state. When one or more nodes send explicit bits, the explicit bits cover the implicit bits, making the bus in an explicit state. As an information collection node in the Internet of Vehicles, each vehicle-mounted intelligent terminal collects the vehicle state information during driving and distributes it to the remote server host to complete traffic dispatching management or remote real-time monitoring, thus alleviating a series of problems such as vehicle congestion, environmental pollution and traffic accidents.

When the uncontrolled electric vehicle is connected to the power grid, it is only connected to the power grid as a load. If the components are independent of each other, the additive model is used to decompose the time series, and if there is some correlation between the components, the multiplication model is used to decompose the factors. The load forecasting model needs to forecast the historical data of several years, which will be used for the annual forecast data of the model. Figure 2 shows the architecture of multiphase support vector machine prediction model.

![Figure 2. Multiphase support vector machine prediction model architecture](image)

In-vehicle communication system must have comprehensive and powerful capabilities in ensuring the safe and accurate transmission of information and data, protecting personal privacy and guarding against network attacks. Compared with traditional information push channels, intelligent push of road information in vehicle communication system has the characteristics of faster, more accurate and wider audience. The information behavior of vehicle intelligent terminal users is directly related to the needs of vehicle intelligent terminal users. Therefore, an important foundation of theoretical research on building personalized information service of vehicle-mounted intelligent terminal is the research on information behavior of vehicle-mounted intelligent terminal users. Figure 3 shows the structure of the vehicle-mounted intelligent terminal with the vehicle as the terminal.
In the process of driving, after the goods are increased or decreased, it is necessary to count the goods information and match the waybill to prevent errors. At the same time, it is necessary to send real-time cargo information to the server regularly. The principle of data exchange is simply to stratify the data received from Ethernet. The vehicle-mounted data collection and communication device collects equipment status information and construction operation data of vehicles, and GPS geographic position information including time, longitude, latitude, speed and direction. After the CAN controller chip is initialized correctly, it can send data at any time according to the requirements of the system. During data transmission, as long as the flag bit of the transmission data buffer is detected to be high, the data to be transmitted can be sent to the data transmission buffer of the controller. When using, users need to install radio stations at both the sending and receiving ends of signals and design communication protocols according to the actual usage, so the development cycle of the equipment is long and there is no flexibility for transplantation [12]. Because the communication process does not depend on the communication operator, the cost of communication traffic will not be generated. In-vehicle communication system needs to obtain vehicle driving position information, status monitoring information and fault information from sensor network. The emergence of big data in vehicle-mounted communication system enables vehicle designers and producers to obtain a large amount of running state data of vehicles, find out the causes of vehicle failures and accidents from the perspective of data, and improve the design and production of vehicles in a targeted manner.

4. Conclusion

Most of the time, the GPS of the measuring vehicle can obtain three-dimensional position information. In the later data processing, it can provide guarantee for data matching collected by other sensors. During data transmission, as long as the flag bit of the transmission data buffer is detected to be high, the data to be transmitted can be sent to the data transmission buffer of the controller. CAN bus adopts short frame structure, which has low probability of interference and high reliability of data transmission. More importantly, the nodes of CAN bus have the function of automatically closing the bus in case of serious errors, cutting off its connection with the bus, so that other operations on the bus are not affected. As an information collection node in the Internet of Vehicles, each vehicle-mounted intelligent terminal collects the vehicle state information during driving and distributes it to the remote server host to complete traffic dispatching management or remote real-time monitoring, thus alleviating a series of problems such as vehicle congestion, environmental pollution and traffic accidents. In actual operation, by loading the existing electronic map data files, combined with a series
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