Function Requirements and Technical Design of a New Type of BeiDou‑based Vehicle Travelling Data Recorder

Qiangye Gao [a], Yongsheng Cao

Dept. of Equipment Technology, Bengbu Automobile NCO Academy, Bengbu 233011, China

[a]gaoqiangye@163.com

Abstract

The paper studies a new type of BeiDou-based vehicle travelling data recorder, which can be used as a vehicle terminal in the intelligent vehicle monitoring and management system for recording, storing, transmitting and monitoring the information related to vehicle travelling status. The paper elaborates function requirements of the new type of vehicle travelling data recorder, puts forwards the technical design principle of the new type of vehicle travelling data recorder and the main technical route adopted, and carries out planning and design of overall composition of the new type of vehicle travelling data recorder.

Keywords

BeiDou, travelling data recorder, monitoring and management, vehicle terminal.

1. Introduction

Independently developed and operated by China, BeiDou Navigation Satellite System (BDS) is a global navigation satellite system being implemented now. The system construction goal is to build an independent, open and compatible, technology advanced, stable and reliable navigation satellite system that covers the world. At the end of 2012, BDS formerly started to provide passive positioning, navigation and timing services to the Asia-Pacific region, and is planned to achieve global coverage by about 2020 [1]. Considering national safety strategies and economic interests, it has important practical significance to publicize and apply BDS in relevant industries, especially in vehicles.

Furthermore, the fast development of many China's modern information technologies such as mobile communication, short-distance wireless transmission, GIS, database and computer control has provided powerful guarantee for the research and development of a new type of BeiDou-based intelligent vehicle monitoring and management system, which can solve the problems in vehicle dynamic management including real-time monitoring of vehicle use, information acquisition and transmission, fine management, alarm, navigation and visualization of materials on transportation. The vehicle monitoring and management system is generally composed of two parts such as the monitoring center and vehicle equipment [2]. The new type of BeiDou-based vehicle travelling data recorder (hereinafter referred to as data recorder) studied in the paper can be used as a vehicle terminal in the vehicle monitoring and management system for recording, storing, transmitting and monitoring the information related to vehicle travelling status. In addition, it can also give alarm indications to the driver, effectively prevent the driver from driving against traffic regulations, and stop the occurrence of traffic accidents.

2. Function Requirements of Vehicle Travelling Data Recorder

2.1 Satellite Positioning Function

The core of vehicle dynamic monitoring and safety management is to master the vehicle position and moving status. Therefore, the data recorder should first be provided with the satellite positioning function. The monitoring center is able to monitor and command a controlled vehicle only after the vehicle has been accurately positioned and its position and moving status information has been transmitted to the monitoring center. The use of BDS is highly recommended for the acquisition of positioning information of the data recorder.

2.2 Data Recording Function

The data recorder should be provided with the function of recording vehicle travelling track data, travelling safety monitoring data, accident doubt data, etc. to facilitate the inquiry, analysis and processing after data acquisition by the monitoring center.

Travelling Track Data Recording Function

The data recorder should be able to continuously record and store vehicle travelling track data in an optimized rule according to the vehicle travelling speed, travelling direction and time change laws. The data includes: real-time time, position, speed and direction when the vehicle is travelling.

Travelling Safety Monitoring Data Recording Function

The data recorder should be able to continuously record and store vehicle travelling safety monitoring data, including: over-speed travelling times, start time, end time and maximum travelling speed of all over-speed travelling, fatigue driving times, start time, end time and continuous driving time of all fatigue driving, emergency braking times, start time and end time of all emergency braking and travelling speed at the beginning of emergency braking, accumulative travelling mileage, travelling mileage of the current statistical time range, etc.

Accident Doubt Data Recording Function

According to *GB/T 19056-2012 Vehicle Travelling Data Recorder*, the data recorder should be provided with the accident doubt data recording function, that is, to record the travelling speed at an interval of 0.2 s and record the positioning information at an interval of 1 s, with continuous recording until 20 s before the travelling is finished and storing once [3].

Data Recorder Basic Data Recording Function

The data recorder should be able to store basic data such as installation parameters and setting parameters (travelling safety monitoring parameters, technical adjustment parameters).

Log Recording Function

The data recorder should be able to store the data recorder basic data modification contents and time data, store the time when the system self-diagnosis abnormal information occurs and the contents data. The abnormal information includes: main module and peripherals connection abnormality, travelling speed judgment abnormality, etc.

2.3 Data Communication Function

Short-distance Wireless High-speed Communication Function

When the vehicle installed with the data recorder returns, at the unit gate or parking lot gate, it will automatically establish wireless connection with the wireless data receiver and transmit relevant travelling data to the wireless data receiver through short-distance wireless high-speed communication. Then the wireless data receiver will transmit the data to the server of the monitoring center through the ground wired network, or large amounts of travelling data stored in the data recorder can also be acquired manually through the wireless data receiver.

Mobile Communication Function

The data recorder can be mounted with the mobile communication module to carry out real-time communication with the monitoring center and realize real-time monitoring and management of the vehicle.

2.4 Safety Alarm Function

When the driver breaks the driving rules or faults occur in the data recorder, the data recorder should be able to give a safety alarm to the driver through the buzzer indication sound to indicate that the driver should normalize his driving behavior. The abnormal information includes: main module and peripherals connection abnormality, travelling speed judgment abnormality, etc.

3. Technical Design of Vehicle Travelling Data Recorder

3.1 Design Principle

The data recorder should be designed by following the principle of unified planning, comprehensive integration, advanced performance and applicability, safety and confidentiality, considering various influential factors, and ensuring standardized and highly reliable equipment, convenient capacity expansion, simple operation and maintenance and optimal performance-price ratio.

3.2 Main Technical Route

Adopting BDS-B1 Positioning Mode

Now relevant scientific research institutes and enterprises in China have made breakthroughs in the satellite navigation baseband and RF chip research field, and developed many BeiDou navigation chips, which can fully meet the requirements of data recorders for small size, low power consumption and low cost. Meanwhile, considering national defense safety and China's economic benefit, the B1 frequency signal of BDS is adopted in the data recorder for satellite positioning, that is, the BDS-B1 positioning mode is adopted. Now B1I and B2I are the only open service signal (as opposed to authorized service signal) between space segment and user segment of BDS that has been officially announced [4].

Adopting CDMA/GPRS Mode to Realize Real-time Communication

When the vehicle installed with a data recorder with the CDMA/GPRS module goes out for duty, the data recorder will send the vehicle position data to the monitoring center at fixed time or fixed distance according to the preset parameters, and the monitoring center will write the position data received into the database and display the position of the vehicle on duty in a real-time manner on the system monitoring software. The monitoring center can also use the CDMA/GPRS mobile communication function to carry out point-to-point communication with the vehicle, so as to realize the purpose of two-way information interaction and direct monitoring and commanding, as shown in Fig. 1.
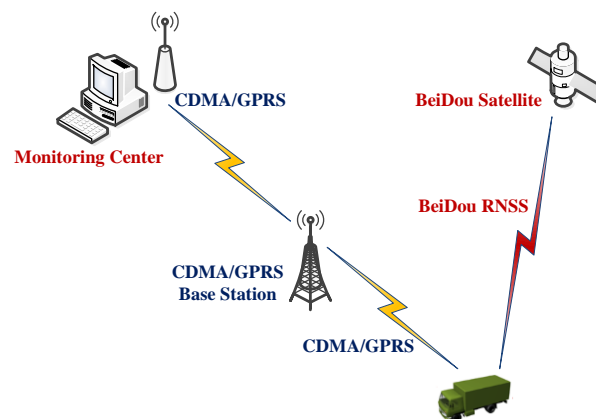

Fig. 1 CDMA/GPRS real-time communication

Adopting Domestic EUHT Technology to Transmit Vehicle Travelling Data

With the fast development of electronic information technology, the short-distance wireless communication technology such as Wi-Fi, Bluetooth, Zigbee and domestic EUHT technology has developed rapidly. Especially Wi-Fi and Bluetooth have been widely applied in mobile phones and other portable terminals. Wi-Fi even monopolizes the local area network areas such as families and offices. But Wi-Fi and Bluetooth belong to overseas technology and the chips are produced abroad. As a new generation of high-speed broadband wireless communication technology independently researched and development by China, EUHT is the only Internet communication technology in the world that can support ultra broadband, high data rate and high reliability in a high-speed moving environment. Compared with similar 802.11ac at abroad, EUHT is superior to it in the basic performance such as bandwidth, capacity, etc., and totally excels its opponent in the key technology.

EUHT has been established as industry and national standards in February 2012 and August 2014 respectively. Its industrialized application has been realized in many industries such as intelligent high-speed railway, intelligent intercity track, intelligent transportation and intelligent reinstallation in 2015 [5]. Considering national defense safety and the support of domestic career, EUHT technology is adopted for the acquisition of vehicle travelling data. When the vehicle installed with the data recorder goes into and out of the gate of the parking lot or unit, the EUHT wireless communication module of the data recorder will be connected to the wireless data receiver in the duty room at the gate of the parking lot or unit, and automatically transmit the vehicle travelling safety monitoring data and some travelling track data to the wireless data receiver. The wireless data receiver will then transmit the data to the monitoring center through the wired network. When the vehicle returns, the administrator can also manually acquire large amounts of travelling track data, travelling safety monitoring data and accident doubt data through the wireless data receiver, as shown in Fig. 2.
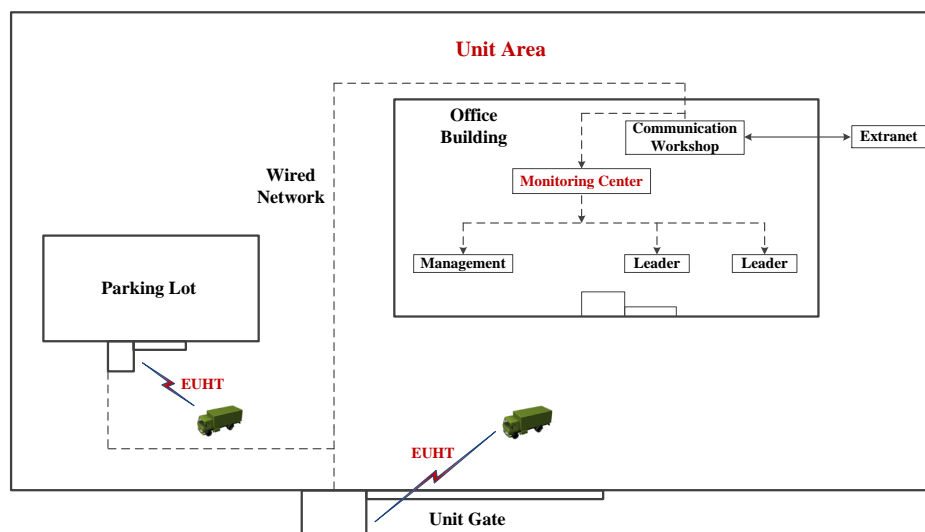

Fig. 2 EUHT mode for transmission of vehicle travelling data

Adopting Modular Design and Embedded Programming

Considering standardization, universality and comprehensive integration of the equipment, modular design is adopted in the circuit board of the data recorder and various function modules are designed independently. Especially for the mobile communication module, modular design can realize the assembly and disassembly of UIM cards and password modules according to the need. The motherboard of the data recorder adopts embedded processor with low power consumption, low cost and high performance. Integrated development tools are applied for embedded software development, so as to simplify the application design, guarantee software quality and shorten development cycle.

3.3 Overall Composition of Data Recorder

According to the function requirements of the data recorder and the technical route to be adopted, the overall composition of the data recorder is designed as power supply module, comprehensive processing module, BDS positioning module, EUHT short-distance wireless transmission module, CDMA/GPRS mobile communication module, storage module, alarm module and peripheral interface, etc.

Power Supply Module

By referring to mature vehicle equipment design experience, the power supply module adopts broad voltage input design, and is designed with the circuit that is resistant to reverse connection and surge with over-voltage protection. As the power of the data recorder is supplied by the vehicle's power supply, the power supply circuit of the data recorder should ensure that the device can work reliably when the input voltage is within +9V~+32V, and can endure surge impact at the moment of ignition, and the device will not be damaged even if short-time reverse connection occurs.

Comprehensive Processing Module

The function of the comprehensive processing module is to control and coordinate the work of all modules in the data recorder and ensure data interaction between the modules.

BDS Positioning Module

The BDS positioning module adopts domestic mature navigation module. After the power supply module provides power for it, the satellite positioning data will be transmitted to the comprehensive processing module through the UART port. The core part of the BDS positioning module is the baseband processing unit, whose main function is to separate and recognize the signals of all satellites from the multi-access signals, and then carry out despreading of BeiDou navigation signals. The carrier wave is demodulated on the basis of despreading gain to eliminate the influence of frequency deviation and restore the baseband signal. Finally, the code status, carrier wave and phase position status at an epoch time after despreading and demodulation will form the original measurements, which will be transmitted to the application processing module together with the navigation data for further processing and calculation, and then the positioning result is transferred.

EUHT Short-distance Wireless Transmission Module

The embedded software programming is carried out on the basis of EUHT protocol to realize linear adjustability of transmitting power of the EUHT short-distance wireless transmission module, so as to meet the need of high-speed short-distance transmission in different electromagnetic environments. Moreover, through the embedded software programming, EUHT wireless transmission on-off area can be controlled to prevent the vehicle travelling data from being disclosed.

CDMA/GPRS Mobile Communication Module

The CDMA/GPRS communication mode is adopted. The independent modular design is adopted to realize the assembly and disassembly of UIM cards according to the need. The module carries out data transmission with the comprehensive processing module through UART port.

Storage Module

Mini SD card storage and EEPROM ferroelectric storage are adopted in the storage module. The organic combination of the two storage modes not only ensures the storage of data information of large capacity, but guarantees long-time storage of key parameter information while ensuring long-time stable and reliable work of the device.

Alarm Module

The main function of the alarm module is to provide sound indication for the driver, including power-on self-diagnosis and warning indication. The warning method adopted in this part is buzzer.

Peripheral Interface

The peripheral interface of the data recorder should include three antenna interfaces for BDS, EUHT and CDMA/GPRS, power supply interface, data transmission interface, etc.

4. Conclusion

In the context of the urgent needs for publicizing and application of BDS and intelligent vehicle monitoring and management, the paper studies a new type of BeiDou-based vehicle travelling data recorder used in the intelligent vehicle monitoring and management system. The data recorder applies some domestic advanced information technologies such as EUHT short-distance wireless communication, CDMA/GPRS mobile communication, modular design and embedded programming. It has many advantages of advanced technique, high automation, localization of component, and convenient mounting and operation, etc. It can enhance vehicle utilization rate and safety control level, so it has very high economic benefits and publicizing and application value.

References

[1] China Satellite Navigation System Management Office. Report on the Development of BeiDou Navigation Satellite System (Version 2.2) (China 2013), p. 6-8.

[2] Junhuan Li: Design and Realization of GPS/GPRS Based Vehicle Terminals, Digital Communication World, (2012) No.6, p.74-76. (In Chinese)

[3] China National Standardization Management Committee. Vehicle Travelling Data Recorder (China Standardization Press, China 2012), p. 5.

[4] China Satellite Navigation System Management Office. BeiDou Navigation Satellite System Signal-In-Space Interface Control Document (Version 2.0) (China 2013), p. 1.

[5] Information on http://www.nufront.com.