The vehicle diagnostic information system based on OBD standard

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Abstract

In order to realize the diagnosis of different vehicle bus, and display different vehicle diagnostic information according to the concern of users, this paper designs a vehicle diagnostic information system based on OBD (on board diagnostic) standard. Realize the vehicle diagnostic and information display system that support the CAN bus and K bus. Using OBD diagnostic equipment real-time access to vehicle information, then configurable displaying in mobile terminal.

Keywords

OBD, Vehicle ECU, data acquisition, CAN, K.

1. Introduction

With the popularity of the car in life, repair and maintenance of vehicles has become a major issue of concern. The production and sales of cars must comply with the OBD-II standard from 2008 onwards in China. OBD system can get important parameters of the vehicle monitoring and report the vehicle faults to users [1]. It is simple, practical and independent of external sensor devices [2, 3]. At the same time, the vehicle data users pay attention to is not the same, since the users composed of car owner, maintenance personnel and vehicle factory testing personnel. Vehicle speed, engine speed, fuel consumption, and vehicle lamp is the basic needs of the car owner to the vehicle diagnostic equipment. Vehicle maintenance personnel concerned data is vehicle oxygen sensor data, vehicle fault codes and vehicle maintenance related diagnostic information. The car factory test personnel is focus on mileage and vehicle fault type diagnosis information, which is beneficial for the improvement of production process.

In previous works [4, 5, 6], OBD diagnostic equipment that integration of GPS and GPRS module to collect the vehicle parameters and uploaded to the backend server, but they cannot achieve diagnostic data display to users in the real-time. Tahat[7] achieve OBD data acquisition through ELM327 integrated chip, and upload diagnosis data through a Bluetooth device, but as a result of integrated chip, it is difficult to implement custom collection of diagnostic data. Burje and Yang [8, 9] design a CAN bus vehicle online diagnosis data collection, but they cannot support K bus.

The system in this paper is built with Fujitsu 16 bit car chip as the main control chip of the OBD data acquisition equipment, supporting vehicle diagnosis of CAN bus and K bus. The design and implementation of software development based on the analysis of the OBD protocol, according to different users, custom acquisition and display vehicle data, and upload data to the vehicle monitoring center backstage.

2. System overview

The on board diagnosis system designed in this paper consists of four parts: vehicle ECU (electronic control unit), OBD data acquisition equipment, mobile terminal and vehicle monitoring center, as shown in figure 1.

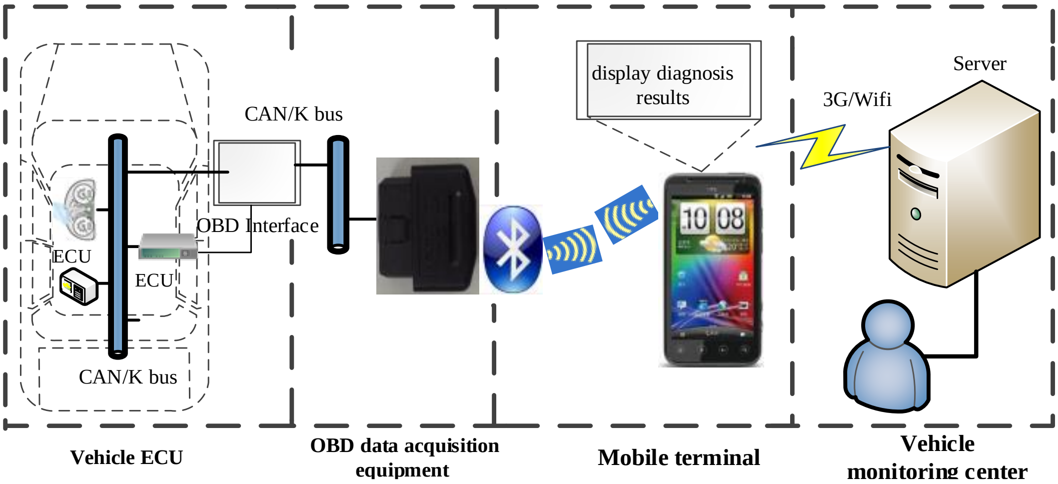

Figure.1 vehicle diagnostic information collection and display system

Vehicle ECU is the electronic control unit of the vehicle. ECU collect all part information of the engine through a variety of sensors, data transmission by vehicle bus, and a variety of signal analysis and processing. External diagnostic equipment can achieve communication with vehicle ECU Through the OBD and access to vehicle diagnostic information.

The OBD data acquisition equipment is a device realized external device communicate with vehicle network. After getting the response from ECU, equipment transmits the data to the mobile terminal via Bluetooth devices.

The mobile terminal sends different data request to OBD data acquisition device according to the user group, then display diagnostic data in the interface, and upload the data to vehicle monitoring center server through the network.

3. Diagnostic protocol analysis and data structure design

External diagnostic equipment can only request and obtain vehicle diagnostic data according to the diagnostic agreement after the completion of the device initialization. The OBD system reference different international standard protocol according to the vehicle bus. The design of the OBD data acquisition equipment in this paper support two vehicle bus, which is CAN (controller area network) bus [10] and K [11] bus.

3.1 Device initialization process

The purpose of device initialization is to automatically detect whether the car regulations support online diagnosis based on CAN or K bus requirements. According to the OBD diagnosis system regulations, vehicle ECU must response 0x01 diagnosis service of ISO15031-5[12] request, a diagnosis service is shown in table 1. By sending a diagnosis basis request for the service 0x01, to verify whether successful initialization.

CAN bus device initialization is try to communicate to ECU after setting different baud rate, CAN identify in accordance with the provisions of ISO15765-4[13]. Complete the initialization in the correct response vehicle ECU, and successfully established a communication. There are two kinds of device initialization in K bus, which are quick initialization and 5 Baud initialization.

3.2 3.2 Diagnostic protocol

After the equipment and the vehicle ECU initialized successfully, communication start with the External vehicle sent a request message to ECU. The ISO15031-5 protocol defines the external diagnostic equipment and vehicle ECU communication request service and data format. Protocol definition content is applicable to the CAN bus and K bus. The external device requests are divided into 9 services, as shown in table 1.

Table.1 OBD system diagnostic service

Diagnostic service number	Diagnostic service
01	Request current powertrain diagnostic data
02	Request current powertrain diagnostic data
03	Request emission-related diagnostic trouble codes
04	Clear/reset emission-related diagnostic information
05	Request oxygen sensor monitoring test results
06	Request on-board monitoring test results for specific monitored systems
07	Request emission-related diagnostic trouble codes detected during current or last completed driving cycle
08	Request control of on-board system, test or component
09	Request vehicle information

OBD diagnosis equipment request must contain the request diagnosis service and PID (Parameter ID), each PID corresponding to different vehicle data information, ECU will send a response after the receipt of the request. Table 2 lists some request data of service 1.

Table.2 OBD system PID sample

parameter	service and PID（hex）	parameter	service and PID（hex）
Monitor status since DTCs cleared	01 01	Air intake temp	01 0F
Fuel pressure	01 0A	Mass Air flow	01 10
Engine RPM	01 0C	Throttle position	01 11
Vehicle speed	01 0D	Engine runtime	01 F

3.3 Design of data structure

System data divided into three data structures which are bus data, Bluetooth and HTTP data, when communication in vehicle ECU, OBD data acquisition equipment, mobile terminal and mobile vehicle monitoring center. OBD data acquisition equipment transfer vehicle bus data and Bluetooth data, and mobile terminal realize the interactive of Bluetooth data and HTTP data. The vehicle bus data includes CAN bus data frame and K bus frame. The data field exchange shown as figure 2.

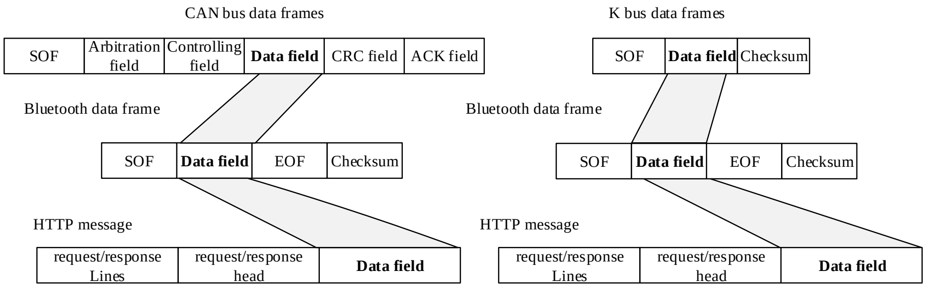

Figure.2 flow chart of data communication

CAN bus data field supports a maximum of 8 bytes, while K bus data field supports a maximum of 64 bytes. System provides the response from vehicle bus packed to a Bluetooth data field is support a maximum of 64 bytes, and a Bluetooth data field to the vehicle bus request supports a maximum of 8 bytes. The mobile terminal will packet Bluetooth data field into a HTTP packet and upload it to the vehicle monitoring center.

The CAN bus data respectively using 11 bit and 29 bit CAN identifier according to the standard frame and extended frame. K bus message header contains the format byte, destination address, source address and length information etc. Bluetooth data use the CRC check to ensure data accuracy based on the Bluetooth protocol. The mobile terminal and vehicle monitoring center communication by post communication mode. The request line contains a method field, URL field and the HTTP protocol version field, and the response line consists of state bank. Request and response headers head by the keyword and value pairs.

Vehicle bus data field and Bluetooth data field exchange, using direct conversion, means the vehicle data bus and Bluetooth data in the conversion process, no additional data and data modification. Bluetooth data transformation into HTTP packets, after conversion mobile terminal, the data content is parsed into the actual data values. As for the vehicle speed information, according to the OBD diagnostic protocol described above, external device need transmission service 0x01, PID 0xOD to vehicle ECU. Bluetooth request data field and the vehicle bus data field is 010D. Received 01 ECU service requests, according to the OBD protocol, ECU response one response byte identified as 0x41, one PID byte 0x0D and one byte of speed information. The mobile terminal determine content information is the current vehicle speed information through analytic PID, calculate the actual speed value through the byte speed. Then terminal display speed in the interface, and in the form of key value pairs, the speed of information are packed into HTTP message data field.

4. Software design

4.1 System architecture

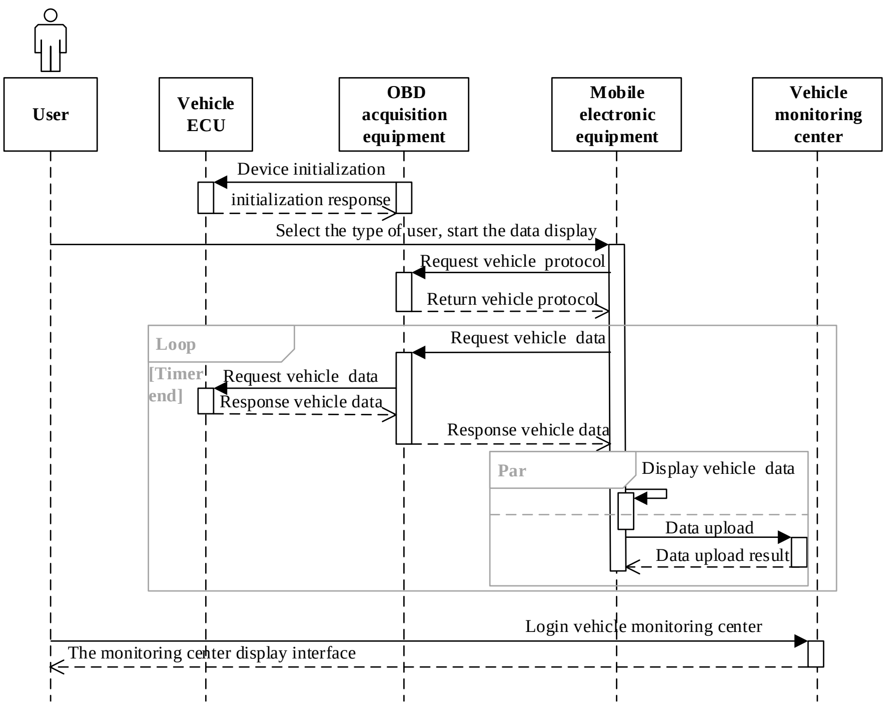

Figure.3 system sequence diagram

The sequence diagram of the system is shown in Figure 3, the OBD data acquisition device initialize the vehicle ECU according to the different protocol, after it mounted to the vehicle. The mobile terminal application program will ask the user to choose their user groups when they use the program for the first time. The mobile terminal send data request to the OBD data acquisition device according to the different user groups, and display the diagnostic data in real-time after get correct response from the OBD equipment. The diagnostic data upload to the vehicle monitoring center in the same time.

4.2 The software design of OBD data acquisition equipment

The OBD data acquisition equipment is an interface to obtain vehicle operation information and diagnostic data. The OBD equipment wait for mobile terminal data request after scanning vehicle agreement successfully. When received a request data, equipment analysis those data and sent the message to the vehicle ECU after assembled data to a vehicle communication message. Then returned response data to the mobile terminal. After completion of the communication, the OBD equipment will wait for the next data request from mobile terminal equipment. The OBD data acquisition device work flow is shown in figure 4.

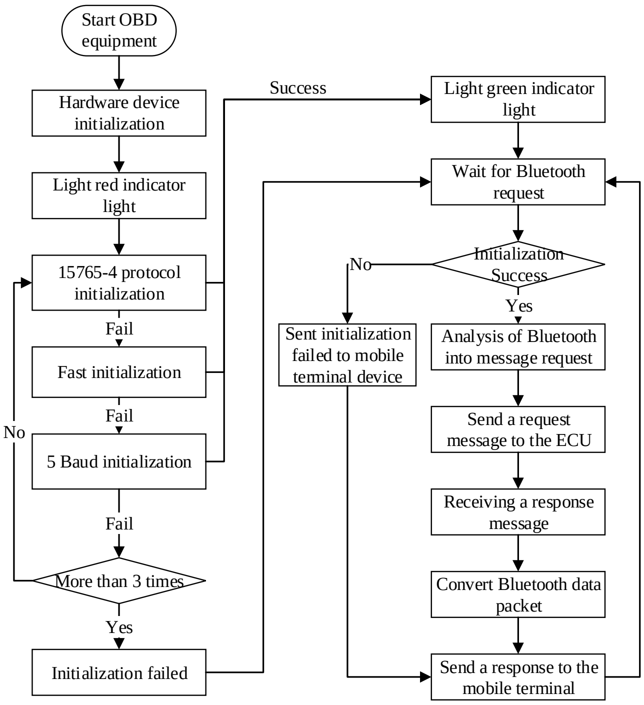

Figure.4 OBD data acquisition equipment overall software flow chart

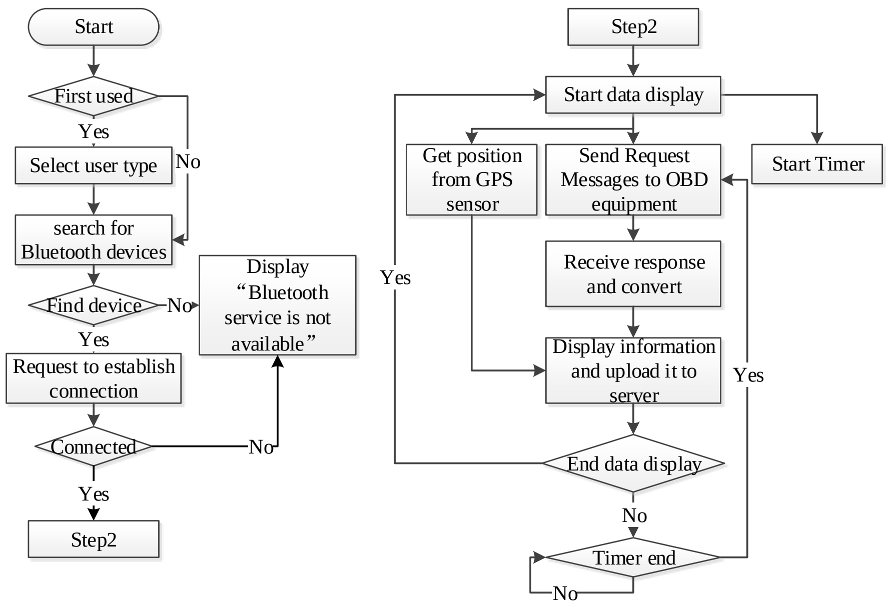

Figure.5 overall mobile terminal software flow chart

4.3 The realization process of mobile terminal

The mobile terminal achieve to set and send the request data of vehicle diagnostic, and display diagnostic information in a friendly way. Through the mobile terminal platform with 3G network or WIFI , mobile devices based on HTTP protocol, upload the diagnostic data to the vehicle monitoring center. The overall implementation process as shown in figure 5. The geographical position information obtained by the GPS sensor in the mobile terminal, and display at the mobile terminal interface with diagnostic information of the vehicle together. At present the mobile terminal has achieved the development of the Android, using Eclipse as a mobile client development environment.

5. System testing and result analysis

After system built, this system is tested in CAN bus vehicles, including the Toyota Yi Zhi, Hyundai Elantra, and a K bus vehicle Volkswagen Lavida. OBD data acquisition equipment can collect the vehicle data accurately and quickly, and the mobile terminal can display those vehicle data friendly in the user interface. As shown in Figure 6, is the interface that use the mobile terminal device for the first time, and select the user group.

Figure 7 is the display interface of mobile terminal in a test of Toyota Yi Zhi, after selecting user group as owner. The interface shows the speed, driving time, average speed, the driving mileage, average fuel consumption, engine speed and fault lamp is lit or not. The speed of a byte of data and analysis, the minimum value is 0km/h, maximum 255km/h, a bit corresponding to 1km/h. The engine speed by two bytes of data and analysis, the minimum value is 0RPM, the maximum value is 16383rpm, a representative of bit 1/4rpm. The vehicle driving time from the mobile terminal to complete by the timer. The driving mileage calculated by driving time and average speed. The graph shows that the speed of 29km/h, the vehicle continued driving for 31 seconds, and the average speed is 35km/h. The average fuel consumption cannot be presented in real time, since the data selection models do not support detection level in providing input. The car is running properly, so the fault lamp is not lit.

Figure.6 User group selection interface

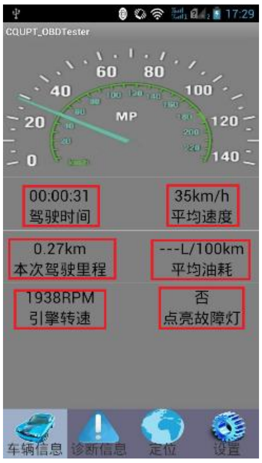

Figure.7 the owner interface

6. Conclusion

This paper propose a vehicle data diagnosis system, applicable to vehicle diagnosis of CAN bus and K bus, real-time display of the vehicle diagnostic information by mobile terminal. This system can be configured according to the different of the use group, and the concerned data of this group will real-time acquisition and display. The test shows that this system is stable and reliable, it can accurately obtain the vehicle diagnostic information and real-time display them in the mobile terminal, and the data can be transmitted to the remote vehicle diagnostics center for further processing. The system provides a feasible solution for data acquisition and analysis of vehicle diagnosis.

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