Design on Automobile Engine Fault Diagnosis System

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Abstract

Based on the analysis of Kwp2000 diagnostic communication protocol, a protocol conversion circuit board is developed for the vehicle on-board diagnostic OBD2 system using this protocol. Application software of automobile fault diagnosis based on PC. It use the DLC (data connection port) and ECU to get data.The hardware of diagnosis system mainly adopts ELM327 automobile apecial protocol control chip to realize the communication between PC and ECU of automobile engine. The design of the software part is based on Java programming,which enables the serial communication module to provide good interface for the application layer,and achieve better data processing and data analysis purposes.The test results show that the data accord with the actual conditions, and the function meets the needs of users.

Keywords

Kwp2000; ELM327; K-line communication; Java programming; PC diagnosis.

1. Introduction

Currently,the installation of electronic control units of vehicles have been equipped with on-board diagnostic systems[1].

With the popularity of notebook computers,compared with hand-held diagnostic equipment,PC has The advantages of fast data processing,large system capacity,easy to operate,flexible development, simple hardware and software structure,short development cycle and low cost.Compared with the universal diagnostic equipment,the special diagnostic system is designed according to the detailed information provided by the manufacturer.The system has more complete function,more stable use,more accurate diagnosis and can meet the needs of customers[2-3].

In this paper, the ELM327 chip is used to read the ECU data of the automobile engine through OBD2 to display the running status of the vehicle, to eliminate the complicated communication protocol, and to provide a simple and easy way to use automobile fault diagnosis system.

2. Communication Protocol

2.1 KWP2000 Communication Protocol

Each vehicle has many different control and diagnosis systems. Only when the diagnostic equipment enters the specified system can the fault code, data flow and other information of the system be read.The Kwp2000 protocol users K –line communication, which requires K line to trigger, wake up ECU, and then enter the system.

2.2 Physical Layer

Kwp2000 data communication network is a kind of communication network based on client-server model[4],which adopts"single bus structure",In the network,the client acts as the diagnostic device,and the server is the electronic control element in the car,which sends the request through the client.The way of the server answers to complete all diagnostic communication services.

2.3 Data Link Layer

Kwp2000 message structure consists of three parts:the header,the data byte,the check sum .The format of the message is shown in Table 1.

Table 1 Kwp2000 message frame structure

Header				Data				Checksum
Fmt	Tgt1)	Src1)	Len1)	Sld	Data0	…	Datan	CS
Maximum of four bytes 1) optional bytes				Sending 255 bytes of data at the most once				A Byte

Message format byte see Tables2,It include 2-bit address schema information and 6-bit length information[5].A1 and A0 define the frame header format used in the current message.L5 to L0 specifies the size of the data field,which can represent 1 to63 bytes of data information,and if L0 to L5 are all set to zero,an additional byte is used in the frame header to indicate the data size.

Table 2 Kwp2000 message format

A1	A0	L5	L4	L3	L2	L1	L0
msb							lsb

3. System Design

3.1 The Overall Design of Diagnostic System

The system adopts ISO14230 diagnostic protocol based on K-bus.Therefore,the realization of system diagnosis and the design of K-bus communication are based on the rules of application layer and data link layer in ISO14230 ,respectively.The design of diagnostic system is mainly divided into two parts: PC diagnostic software module and diagnostic communication hardware module.The overall framework of the diagnostic system is shown in Fig.1:

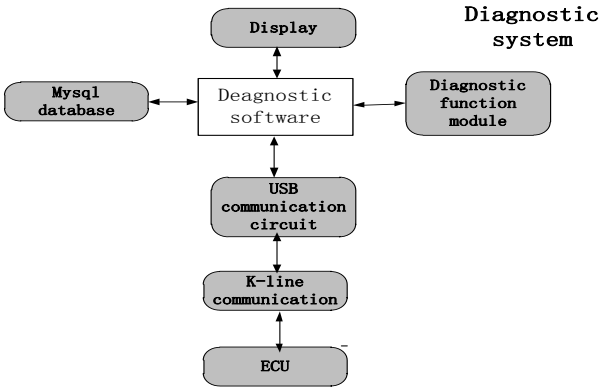

Fig.1 Overall block diagram of system diagnosis

3.2 Design of Communication Hardware based on K bus

The hardware of communication equipment is mainly composed of USB communication circuit and protocol conversion.It is reponsible for the signal conversion between ECU and PC,the output signal of ECU is cached,voltage converted,re-code,Finally,through the USB interface circuit connected to the PC,and the request signal of the PC is transmitted to the ECU after the conversion.as shown in

Fig.2.Among them,5V power supply is provided by computer USB interface,and 24V power supply is provided by automobile ECU.

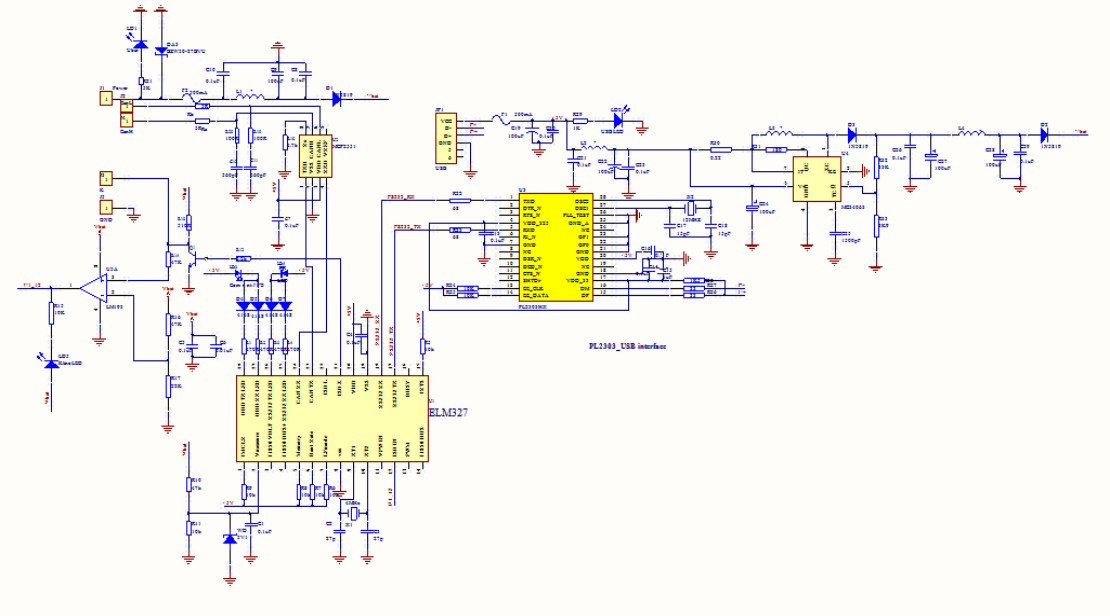

Fig.2 Hardware circuit diagram

3.3 Design of Communication Software

The communication connection Module realizes the function of Communication connect between Diagnostic Software and Automotive engine ECU.The software development environment takes advantage of Java JDK1.8.First of all,the system displays the human-computer interface at the beginning of operation,identifies the virtual serial port,matches the baud rate[6],and realizes the communication between the diagnostic software and the ECU serial port.Communication connection by sending ELM327 chip setting command and ECU communication connection command.

ELM327 has two command formats,the first is an internal command that starts with AT,and the other is an OBD connection command(that is,a hexadecimal ASCII code that only sends the OBD command).To set up a vehicle connection.When the OBD command 1081 is sent to the engine ECU,the connection communication is established,where 10 is the startup communication service identifier,81 is the startup communication request service identifier[7-8].The communication connection service request,positive reply,and negative reply message are shown in Table2、3、4 respectively.Where Cvt indicates contract item,M means mandatory,U indicates that can be selected by the user,C means conditional,S means to force the selection of a parameter.

Table 3 Request Message

Date	Parameter name	Cvt	Hex Value	Mnemonic
#1	Initiating communication service identity	M	10	STC
#2	Initiating communication request service identity	M	81	DCM

Table 4 Positive Response Message

Date	Parameter name	Cvt	Hex Value	Mnemonic
#1	Positive response service identification	S	50	STCPR
#2	Key byte 1	M	81	DCM

Table 5 Negtive Response Message

Date	Parameter name	Cvt	Hex Value	Mnemonic
#1	Negtive response service identification	S	7F	NACK
#2	Initiating communication service identity	M	10	STDS

The communication connections is shown in Fig.3:

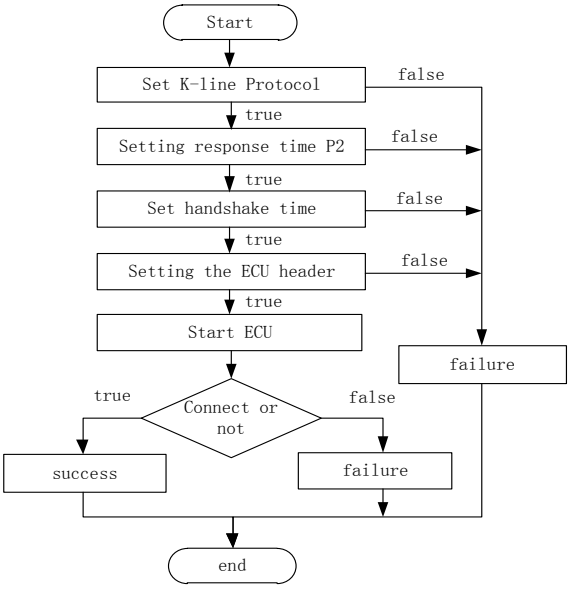

Fig.3 Flow chart of communication connection

The overall program to connect to ECU is as follows：

```
public void connect(object sender)
{
Try
{
setting();  //Scan the serial port to initialize the exit configuration function
SerialPortOpen();      //Open serial port
ConnectToEcu();        //Connect to the ECU
SendToEcu();        //Send data to ECU
ReadFromEcu();     //Read data from ECU
 }
Catch
{
New RuntimeException(“Serial port connection failed”);
}
}
```

4. Design of Diagnostic Software

4.1 Development of Diagnostic Application Software

PC diagnostic softwore is the platform for the interaction between users and the system, and is the core part of the whole system function[9].In order to ensure the comprehensiveness of the software function, the portability and expansibility of the system,the independence of the fault and the friendliness of the interface, the design principle of the software engineering has been fully

implemented in the design and development of the software.The method of structured and modular programming is adopted, and the combination of serial communication, data acquisition, data analysis and database query is realized by combining the related theories of relational database system. The overall structure of the software is shown in Fig.4:

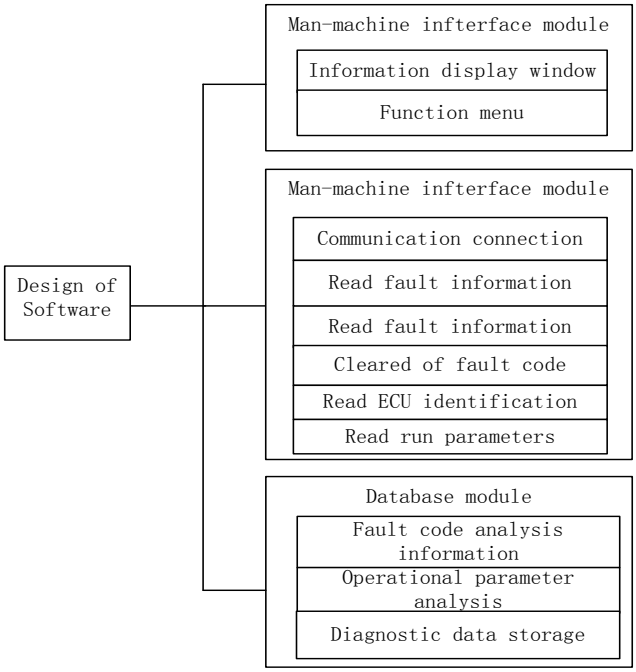

Fig.4 Software architecture

The main function of the man-machine interface module is to realize the friendly man-machine interface and the information interaction with the background database. By interacting with the diagnostic database, the diagnostic service layer provides functional services including reading information stored in the ECU about the version of ECU, car fault codes,vehicle travel records, parameter measurement,and so on.The database module provides fault code parsing information, running parameters parsing information and storing diagnostic data.

4.2 Results of System Operation

The diagnosis page of PC diagnostic application software is obtained by running the automobile diagnosis system. The results are shown in Fig.5:

Fig.5(a) Initialization interface

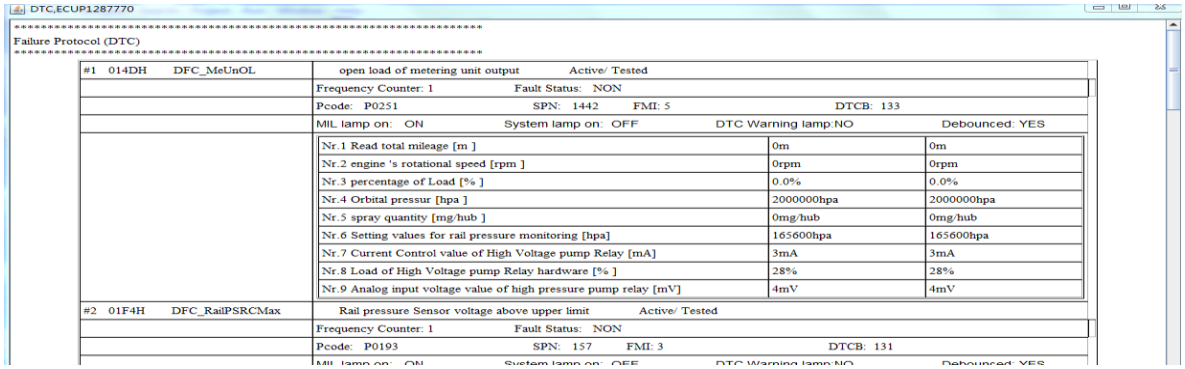

Fig.5(b) Diagnostic trouble codes

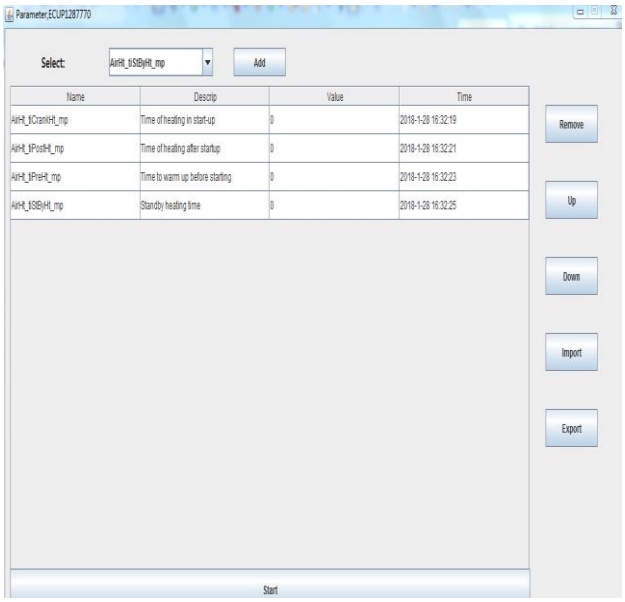

Fig.5(c) Parameter measurement

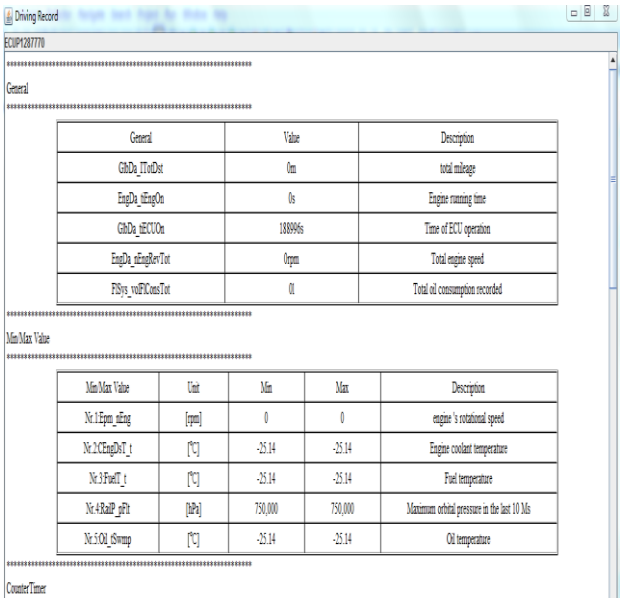

Fig.5(d) Driving record

At the beginning of the initialization of the main interface,the vehicle engine diagnostic system software has established a communication connection with the car electronic control unit,as shown in Fig.5a).Through the function of reading the fault code,the number of the fault code and the details of each fault code are displayed in the new window table.After reading the fault code,it can be saved in the local file through Excel.For reference information in the event of subsequent similar failures,as shown in Fig.5b).After using the troubleshooting function,the user can continue to operate other diagnostic functions.The parameter measurement function and driving record of using automobile engine are shown in Fig.5c,Fig.5d respectively.

5. Conclusion

The PC-based automobile engine fault diagnosis system developed in this paper can collect the data of EDC17 series automobile engine and has passed many real vehicle tests.The test results show that the system has good stability and the results of diagnosis are correct and the obtained data accord with the actual working conditions.

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