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Remote Monitoring System for Power Battery of Electric Vehicle

XiangXiao Guo [1*], BiXiong Huang[2]
(College of Automotive Engineering, Shanghai University of Engineering Science, China)

ABSTRACT: In order to improve the safety of the electric vehicle and enhance the monitoring ability of the battery safety, a remote monitoring system for the power battery of the electric vehicle is designed, which consists of the vehicle terminal and the background monitoring platform. The vehicle terminal connects to the OBD interface of automobile, simultaneously collects the vehicle GPS information and transfers to the backstage server through the GPRS network. Background monitoring platform is designed by LabVIEW software to realize the real-time acquisition and display of the battery related information, The system is proved to be of good stability, low cost and high reliability.

Keywords : Vehicle terminal, STM32F103RCT6, Power battery, Remote monitoring

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I. INTRODUCTION

With the popularity of electric vehicles, more and more attention has been paid to its safety, in which the safety of power batteries is very important . In order to effectively supervise electric vehicles, the state is also actively promoting relevant policies, the "electric vehicle remote service and management system technical specifications" is a good manifestation. The specification provides the support for further improving the electric vehicle popularization and application, data monitoring, effect evaluation and safety supervision[1].

According to the above background, this paper designs a remote monitoring system of electric vehicle power battery based on vehicle terminal and background monitoring. The system provides a reference for the promotion of electric vehicle monitoring system, this system can be further optimized on the electric vehicle safety monitoring, establish a set of supervision environment, so as to enhance the overall safety of electric vehicles at this stage.

II. OVERALL PLAN OF MONITORING SYSTEM

The system is mainly divided into two parts: vehicle terminal and background monitoring platform. The vehicle terminal consists of embedded microprocessor module, CAN acquisition module, GPS module and GPRS module. The terminal through the OBD interface to connect vehicle CAN network, some operation information and power battery relevant information can be obtained; the GPS module also collected real-time vehicle location information; microcontroller will collect relevant battery information and the location information of the vehicle battery pack uploaded to the GPRS module, information is transmitted to the remote monitoring platform through the wireless transmission. The background monitoring platform uses LabVIEW visualization software to build display interface, and real-time display of the relevant operation information of electric vehicles. The overall play of monitoring system is shown in figure 1.

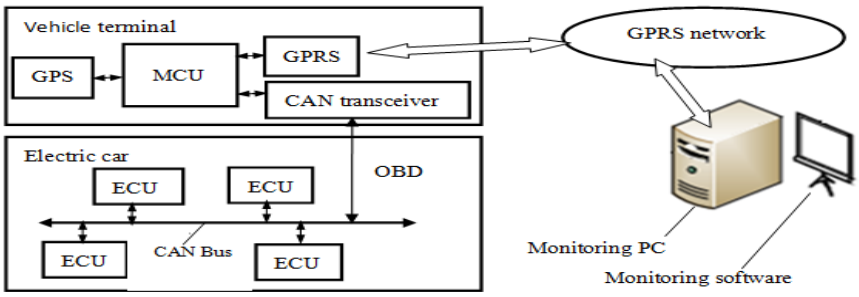

Figure. 1 System Structure Diagram

[*] *Corresponding author.*
E-mail addresses: 344190166@qq.com (XiangXiao Guo)

III. HARDWARE CIRCUIT DESIGN OF VEHICLE TERMINAL

The hardware circuit of the vehicle terminal is divided into 5 modules: microprocessor module, power module, CAN communication module, GPS module, GPRS module.

3.1 Microprocessor module

Embedded microprocessor is the core for embedded system. This system uses STM32 microcontroller based on ARM cortex-M3 kernel, application of M3 kernel is suitable for low power consumption and low cost and high performance; STMicroelectronics has also developed a library function for the M3 kernel chip package, allows developers to get rid of a lot of tedious operations on the register, API function interface greatly simplifies the difficulty of development. Taking into account the resources with the system requirements, finally we select STM32F103RCT6 processor ,which has 256KB Flash, 48KB SRAM, 72MHZ speed, up to 5 USART, built-in CAN controller, peripheral rich, that's enough to meet the requirements of vehicle terminal hardware.

3.2 GPS module

The system uses NEO-M8N model of U-BLOX as the positioning module. The module has a full range of functions, to meet the strict requirements of professional positioning. The NEO-M8N carries out serial communication with the monitoring terminal and outputs the command frame in accordance with the NMEA0183 protocol. The monitoring terminal can obtain corresponding information, such as location information and GPS speed when monitoring the vehicle. The pin of microprocessor PA2/USART2_TX is coupled to the RXD pin of GPS module, for transmitting data output; The pin of microprocessor PA3/USART2_RX is coupled to the TXD pin of GPS module, for receiving data; the GPS module TIMEPULSE pin is connected with a blue LED , used to display the operation status of GPS module; VCC is the main power to the GPS module power supply, power supply voltage is 3.3V. The hardware circuit of the GPS module is shown in figure 2.

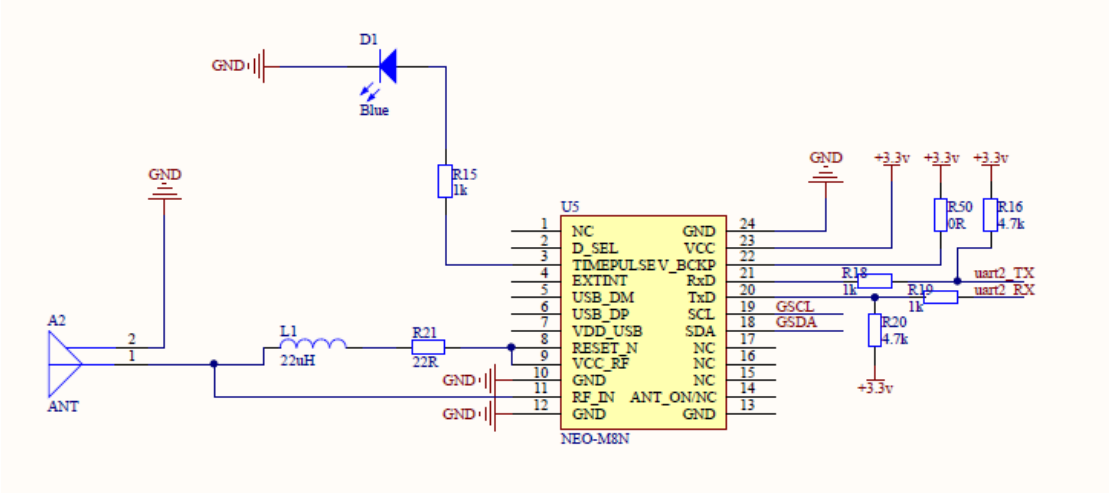

figure. 2 GPS Circuit Diagram

3.3 GPRS module

The GPRS module selects M26 module of Shanghai QUECTEL company, is an ultra small LCC package GSM/GPRS four frequency module ,which is perfect to meet the small size module product demand, to help customers effectively reduce product size and optimize product cost. The communication module for the 4.1V voltage by 2 VBAT power pin (get converted by the MIC29302 module), data transmission through USART and microprocessor, GPRS_TXD and GPRS_RXD respectively with the UART3_RX microprocessor and the UART3_TX pin is used to send and receive information. SIM_VDD is the SIM card power input, SIM_DATA is the data input and output, SIM_RST is the reset pin, SIM_CLK is the real time clock, NETLIGHT is used to indicate the network status, and the remaining GND pin is used for grounding.

3.4 Power module

The power supply module is used to supply the voltage needed for the microcontroller, the GPRS module and the GPS module. Because the terminal uses the 12V output power of the automobile OBD interface as the power supply, the power DCDC conversion is needed. TPS4331DDA chip is used to convert the 12V voltage into 5V output to meet the 5V voltage requirement on the terminal; the ASM1117 module is used to convert the 5V power to the 3.3V output, and to supply power to other modules. The circuit diagram of the power module is shown in Figure 3.

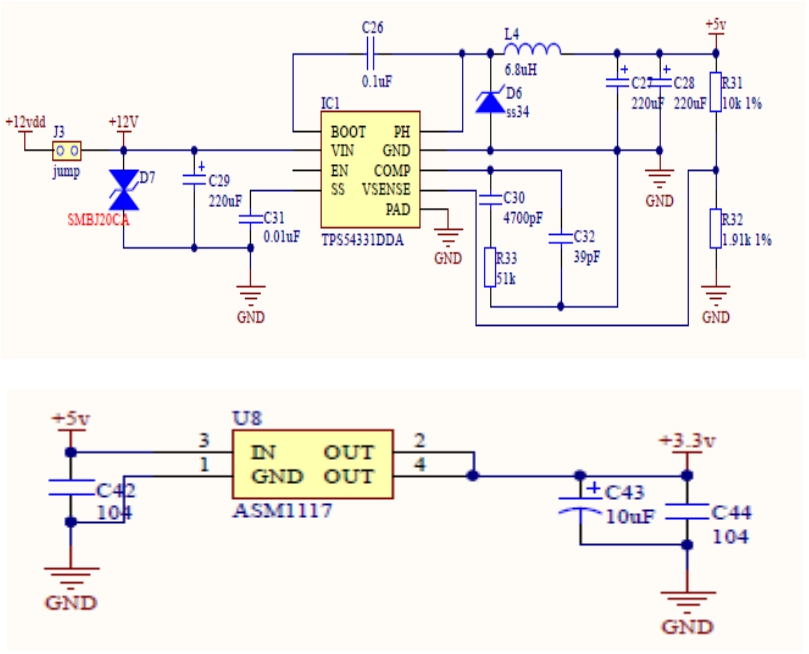

Figure.3 Power Circuit Diagram

3.5 CAN module circuit design

The module mainly implements the collection of electric vehicle data, the essence of which is to access the whole vehicle CAN network through the OBD port and send the collected vehicle information to the server[2]. The selected ARM processor chip STM32F103RECT6 already contains the CAN controller, and only needs to select the CAN transceiver and design the corresponding circuit. Using TJA1050 module as the CAN transceiver, TJA1050 fully meets the ISO 11898 standard, with has high rate (up to 1Mbit/s), extremely low electromagnetic radiation (EME), electromagnetic interference (EMI), high advantages. The hardware circuit of the CAN module is shown in figure 4.

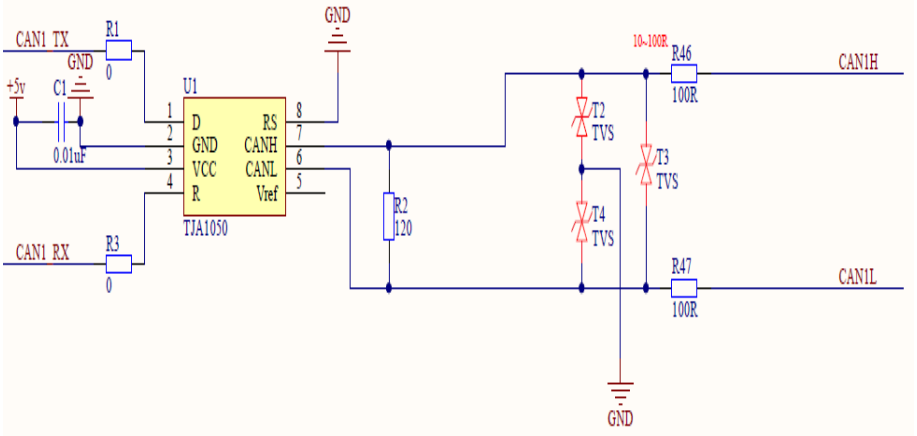

Figure.4 CAN Transceiver Circuit Diagram

IV. DESIGN OF SYSTEM SOFTWARE

4.1 Lower computer software design

The embedded software of the vehicle terminal is programmed under the MDK environment. Because the terminal has more tasks, the real-time operation system is used to realize the multi task management. Different from the front and rear systems, the operating system can be modular programming, real-time higher. µC/OS II is a lightweight operating system, after many years of development, the real-time operating system's stability is very strong, it has small amount of code, and it's suitable for a number of multitasking microcontroller transplantation and deployment [3]. We carry out the transportation of the µC/OS II operating system on the main chip STM32F103RCT6 of the vehicle terminal, configure the corresponding function interface, and then deploy our application code on it.

4.1.1 Introduction to engineering architecture

The project has 7 main groups as follows: User packet has main program and STM32 interrupt configuration file; Task packet contains 4 tasks, the relevant code were written about GPRS module, GPS module, CAN module and scheduling task;the BSP group has corresponding module initialization function , which is board support package; port and OS group have the configuration file contains the µC/OS II system and source code; StdPeriph_Driver is outside the library functions provided by ST official version 3.5; CORE packet has kernel-related code and startup code. The entire engineering structure shown in Figure 5.

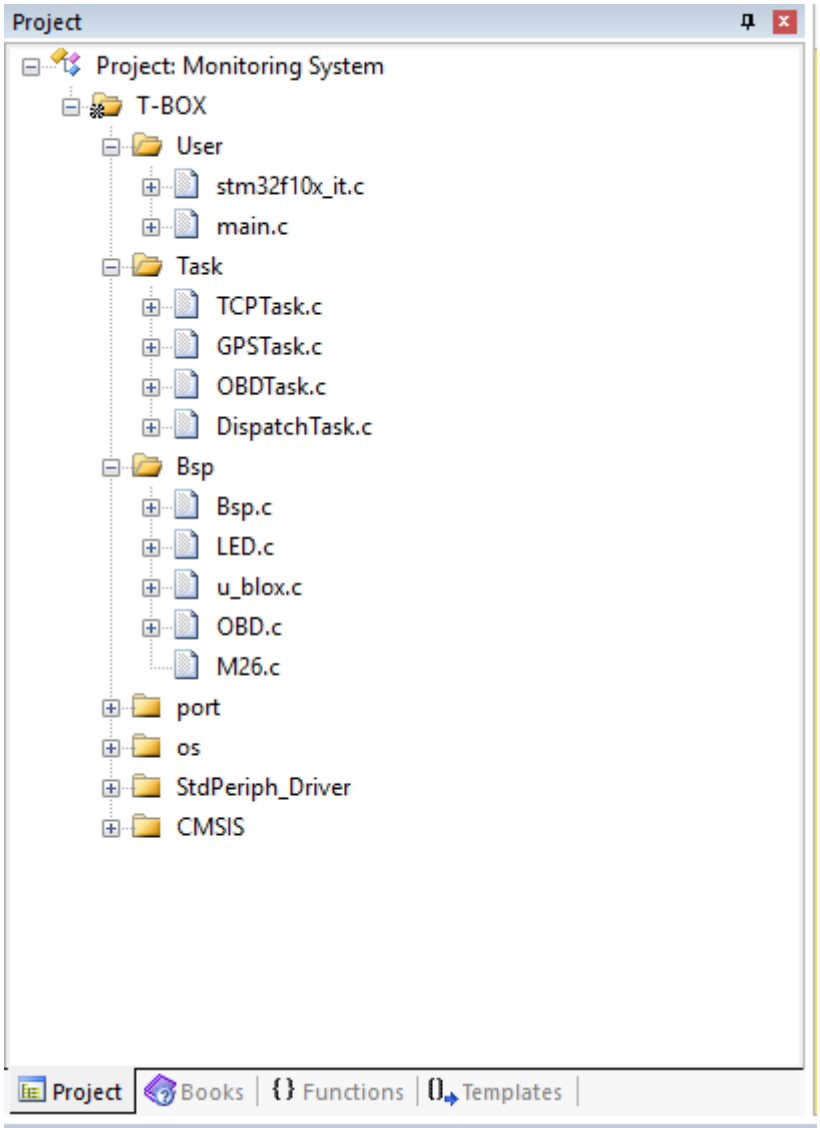

Figure. 5 Engineering Architecture Diagram

4.1.2 Program flow analysis

There are three main tasks and a scheduling task ,which are collected location information coming from the serial GPS module; CAN message acquisition module according to the protocol analysis; GPRS communicate with server successfully and send the information of GPS and CAN-bus[4]; scheduling task is used to coordinate and communicate between the various tasks. The three tasks run on the µC/OS operating system, and through reasonable task management, the real-time performance of the whole system has been improved, and meanwhile, the management of the task is also convenient.

4.2 Background monitoring software design

Background monitoring PC software is designed by LabVIEW2014 development environment. Compared to other programming environment, the difference of LabVIEW is that it uses a graphical programming language, the basic unit of program design is exist in the form of chart is very intuitive, after hardware resources to build a good development environment, using LabVIEW software development, test data can be analyzed more easily, in the form of block diagram of program files is also easy to maintain, easy to change. At the same time, LabVIEW

integrates the underlying drivers of common communication interfaces, and also provides a variety of programming toolkits that can further reduce design time and reduce development costs[5].

The remote monitoring center receives the data sent by the vehicle terminal through the wireless module on the network by the server which specifies the public address IP address. To ensure the accuracy and reliability of data acquisition, this system uses TCP protocol as the core data transfer function to design the program of network communication and data receiving module [6]. By the host computer software as a server to establish a network connection interception, at the same time using LabVIEW software with TCP interception module, TCP provides writing module, TCP reading module, TCO module and other close interface functions to achieve the remote monitoring center server and terminal data communication. Because the data analysis of CAN message is completed on the on-board terminal of the lower computer, the data can be displayed directly by building the front panel after the data is received by the host computer. At the same time can be written into the spreadsheet module with the use of LabVIEW, focuses on the running of the electric vehicle battery related parameters are stored, provide data support for the analysis of electric vehicle power battery life.

V. SYSTEM TESTING AND ANALYSIS

The vehicle terminal is installed on a campus electric vehicle and matches with the background server. All the information of the whole vehicle can be observed on the remote monitoring interface. The display interface is shown in Figure 8 below. In addition to real-time display of operation parameters, but also has the function of storage, the stored data can be used for further performance analysis of power battery, related prediction and analysis on the service life of the electric vehicle power battery.

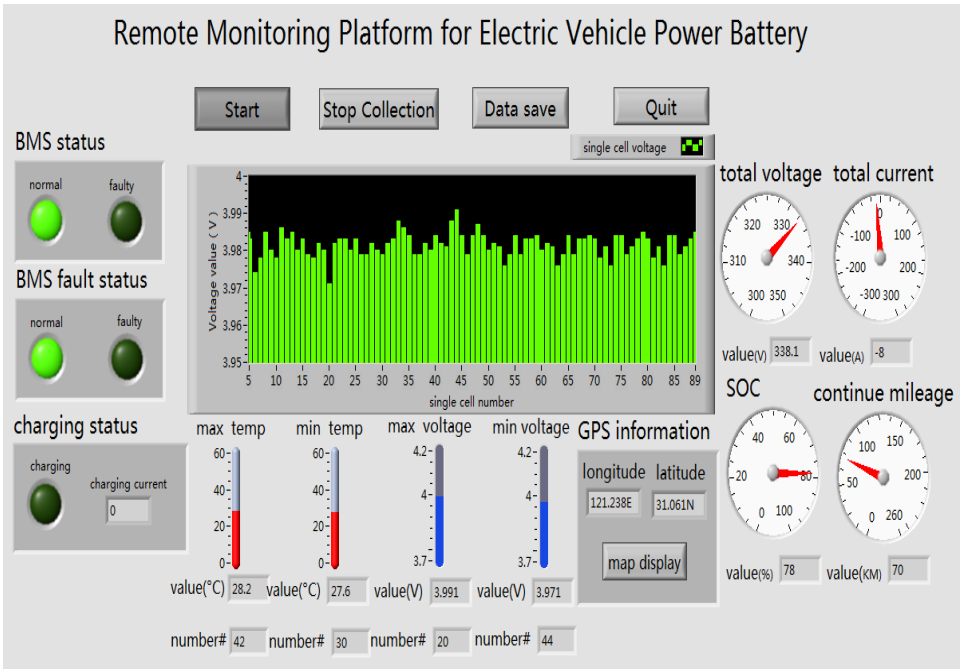

Figure. 6 Monitoring Platform Software

The system can support the map playback function, access to the vehicle trajectory by GPS, with the help of third party tools can display map, vehicle running route can be tracked, it's easy to check the location information of electric vehicles.

VI. CONCLUSION

The monitoring system can complete the following functions: receiving and CAN information , analysis of electric vehicle electric vehicle CAN bus BMS information acquisition, battery parameter, electric vehicle running speed, location and other information, the related parameters of electric vehicle by sending to the server through the GPRS network , it is proved the validity and practicability of the system through testing and practical application. latter can according to the electric vehicle power battery life prediction data, development of fault early warning applications, in order to improve the safety of electric vehicles to improve security, reduce security risks of power battery, worthy of wide use.

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