Research Paper

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Design and Implementation of Automotive Control Features using ARM

Engineering

KEYWORDS : ARM 7 TDMI, CAN (Controller Area Network), EEPROM (Electrically Erasable and Programmable Read Only Memory)

Prof. M. Nirmala — Dept of EEE, Kumaraguru College of Technology,Coimbatore, Tamilnadu, India.

M. Dineshkumar — ME (Embedded Systems), Kumaraguru College of Technology, Coimbatore, Tamilnadu, India.

ABSTRACT

This paper is proposed to develop a low cost system which provides solution to the existing automotive control issues. This system has three main principle components namely On-board Diagnostic (OBD) unit which does live monitoring and fault identification of vehicle Electronic Control Unit (ECU), Vehicle to Vehicle Collision Avoidance Unit (VVCAU) is used to avoid crashing between vehicles and Black Box (BB) records the relevant details about a vehicle such as speed, engine temperature and distance travelled. The design selects ARM 7 TDMI as embedded controller, Controller Area Network (CAN) protocol for communication between nodes, I2C (Inter-Integrated Circuit) for on-board communication, and Electrically Erasable Programmable Read Only

1. INTRODUCTION

ECU is a heart of the vehicle automation. The malfunction occurs in ECU causes major problems in vehicle. An automated electronic module which monitors status of ECU is called as OBD [4]. Engine temperature monitoring and status of CAN bus are mainly considered in the diagnostic unit. Because engine temperature is important in engine control unit**,** if this value goes to abnormal, some unwanted gases [8] (i.e. CO, SO_2, HC, and NOx) exhaust from vehicles due to improper combustion. All electronic units including ABS (Antilock breaking system) and Engine control units are connected by CAN bus, so monitoring of CAN bus is very essential for the safety of vehicle.

On the roadway driver usually keep a safety distance from one another. On the other hand, due to the driver's interruption, long-time driving tiredness, or a sudden break applied by another car, a serious collision may occur. Even though the driver is in a conscious mind, he cannot respond immediately to control his/her vehicle. Sometimes crash may occurs due to bad weather situations as mist, vapor, fog and so on. Therefore, with the help of obstacle detection and [2] distance measurement sensor, a front end collision warning system is developed to prevent vehicle from the collision is named as VVCAU.

Many cases remain pending due to unknown reason of an accident. To avoid these problems, a design is proposed to enhance on-board recording device [1] [3] [5] (i.e. Black Box) which records all the information about a vehicle which helps to discover and to analyze the reason of an accident.

Hence a combined system is essential to provide the solution for all the above problems. The proposed system will make use of all the above mentioned modules like VVCAU, OBD, and BB at a low cost.

2. DESIGN OF SYSTEM HARDWARE

The system uses ARM 7 TDMI-S (LPC 2129) microcontroller as a master controller. The diagram of system hardware is shown in the figure 1.

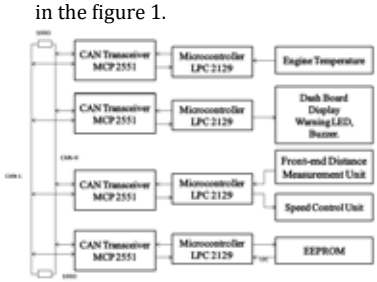

Fig 1: Design of System Hardware

LPC2129 feature includes [6], 32-bit ARM7 TDMI-S microcontroller in a tiny LQFP64 package, 16 KB wide on-chip Static RAM, On-chip Flash Program Memory is 128/256 KB wide. Two interconnected CAN interfaces namely as CAN1, CAN2 with advanced acceptance filters, Four channel 10-bit Analog to Digital converter with conversion time as low as 2.44ms, Multiple serial interfaces including two UARTs (Universal Asynchronous Receiver and Transmitter), Fast I2C has a 400 Kbits/s of baud rate and two SPIs (Serial Peripheral Interfaces), In-System Programming (ISP) and In-Application Programming (IAP) via on-chip boot-loader software. Flash programming takes 1ms per 512 byte line. Two 4-byte timers (with four capture and four compare channels), Dual power supply: CPU operating voltage range of 1.65V to 1.95V, Input and Output (I/O) power supply range of 3.0 V to 3.6 V with 5 V tolerant I/O pads.

2.1. OBDU

2.1.1 Engine Temperature

Generally engine temperature level goes high during combustion process. Cooling system is usually used in all vehicles to exhaust this excess heat. This cooling system controls engine temperature level but sometimes this cooling system attain malfunction.

This problem can be defeated by installing Thermistor based coolant temperature sensor. Positive Temperature Coefficient (PTC), Negative Temperature Coefficient sensors are commonly used in automotive engines. It is a transducer which is placed on the engine control unit and it continuously monitors coolant temperature. This sensor converts heat energy into electrical energy. Operating range of this sensor is -45°C to 1000°C.

The engine runs best when its coolant temperature is about 93°C [7]. Critical point of coolant temperature is varying as manufactures. The reference temperature limit value is 100°C. Whenever sensor reading crosses this limit warning alarm will be turned "ON" and displays warning message as "Check Cooling System".

2.1.2. Status of CAN Bus:

CAN is widely used in automotive technology. The CAN is a Arbitration type of bus. That means there is no clear address in the messages. All the nodes in the network are able to receive all messages. To be more specific, the messages transmitted from any node on a CAN bus does not contain addresses of either the transmitting node, or of any intended receiving node. The arbitration field is made of the 11-bit or 29-bit identifier, the Remote Transmission Request (RTR) bit, and in case of the 29-bit format also of the IDE (identifier extension) bit, and the SRR (substitute remote request) bit. Negative Acknowledgement (NAK) is one of the CAN definitions which is used on a message oriented interface between the Host and the CAN open Task. The previously sent request or command did not execute successfully.

MCP2551 is a High Speed CAN Transceiver IC chip that serves as the interface between a CAN Protocol controller and the physical bus. It would have been operate at speed up to 1 Mb/s.

Status of CAN bus is examined by whether all nodes are properly connected or not. This can be achieved by comparison of transmitted and received data. This system uses 125kbps baud rate, 11-bit identifier and 8-bit data length for CAN communication.

2.2. VVCAU

A VVCAU operates, in the following manner: a sensor installed at the front end of a vehicle frequently scans the highway for detecting vehicle or an obstacle. If such an obstacle is found, the system determines whether the vehicle is in imminent danger of crashing, and if so, a collision warning is given to the driver. It is constructing with help of Ultrasonic Sensors which measures the distance between the vehicles.

The sensor determines distance between vehicles continuously and displays the predicted value on a display screen. Based on the distance Speed of a vehicle is controlled by varying Pulse Width Modulator (PWM) signal. The generated PWM signal is supplied to DC motor of Electric vehicle for controlling speed of the vehicle.The system uses Max Sonar High Performance Range finder sensor for predicting distance. This sensor operates on 2.5-5.5V range. It detects objects from 0 inches to 254 inches (6.4 meters). The relation between distance and generated PWM is shown in table 1.

Table 1: Distance vs. Speeds

Distance (cm)	Speed (generated PWM signal)
600	90
500	65
400	35
300	25
200	10
100	0

2.3. Vehicle Black box

Vehicle Black box referred as Electronic data recorder. It records main driving data such as engine temperature, speed of vehicle, trip time and date. The recorded data will be analyzed to find out reason for the accident. EEPROM device is interfaced with microcontroller by I2C bus. I2C is "synchronous serial, Half Duplex, 2 wired bus communication protocol". I2C supports "MASTER AND SLAVE CONCEPT". It has 2 lines or bus namely SDA (Serial Data), SCL (Serial Clock). SDA is bi-directional and SCL is uni-directional. I2C supports 7 bit and 10 bit addressing format. Data is valid only when the clock is in high state. When clock is low the data is placed on the SDA line. When the clock is HIGH the data start moving in the SDA line and reaches the slave or the master depending on who is the destination.

EEPROM is an electrically erasable programmable read only memory. This system uses IC 24c08B two wire serial EEPROM. The memory of the EEPROM is 8 kilo bits. This device holds the memory until applying electrical erasing signal. The collected data is analyzed in PC (personal computer) by using VB.net.

3. DESIGN OF SYSTEM SOFTWARE

The software coding is developed by Keil IDE (Integrated Development Environment). It translates high level language (Embedded C) into corresponding target system hexadecimal code (Hex).The Hex code is downloaded into target using Flash magic Programmer tool. The data flow diagram of VVCAU is shown in figure 2.

Fig 2: Data flow Diagram of Collision Avoidance Unit

4. RESULTS AND CONCLUSION

The analysis had been done by MATLAB. The graph between coolant temperatures proportional to time . Critical temperature level falls between 6 - 7 minutes. CAN communication work is simulated and verified by using Keil Peripheral Simulator. CAN2 Controller Transmit data and it receives by CAN1 is shown in figure 3. CAN2 Controller Transmit 8-bit data as 55H with 11FH as a identifier. CAN1 Controller Receive 8-bit data as 55H with 11FH as a identifier . The recorded data from EEPROM is read and an analysis done by PC is shown in figure 4.

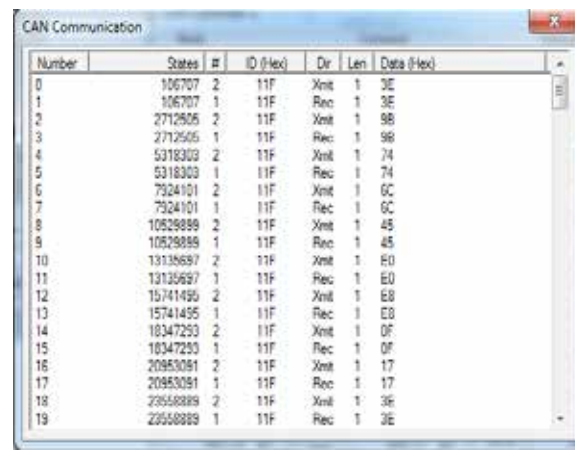

Fig.3: CAN Communication

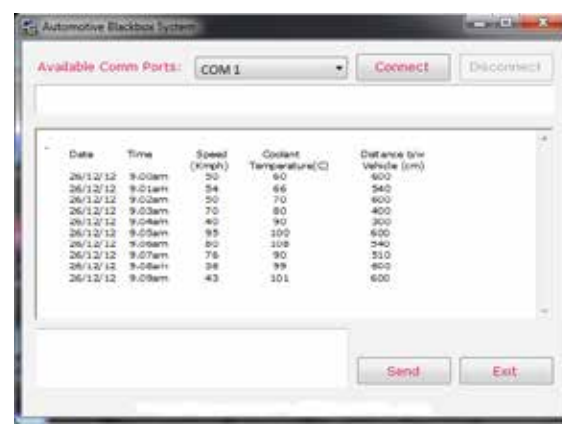

Fig.4: VB.net Data Retrieving from BB

Today's higher end vehicles only have an advanced automotive features, safety and security. But, this low cost system is proposed to all vehicles which improves security and safety of a vehicle. Very few modifications in such a vehicle can make it suitable for the real time system.

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