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AUTOMOTIVE MONITORING SYSTEM

***Himanshu Hastak, *Krutika Dhakate, *Lohitha. D**

**Student Sense, VIT University Vellore India*

ABSTRACT

The aim of this project is to get a fully functional device working all modern vehicles and make information available to drivers or mechanics in an touch screen device which will provide more insight into what is occurring in the car in real time. Implementing some additional sensors using CAN protocol will help in monitoring the vehicle for engine misfires, tyre pressures, temperature of engine etc. The data logged into ECU can also be accessed using the OBD-II protocol.

Keywords: Automotive monitoring, CAN, CAN bus.

INTRODUCTION

Robert Bosch a leading name in automotive technology developed an in vehicle communication protocol best known for its reduced complexity in wiring circuitry known as (CAN) CONTROLLED AREA NETWORK protocol .CAN protocol uses a priority based message scheduling which has numerous advantages few important of them are efficient utilization of bandwidth, flexibility, easy implementation and small message overhead etc. CAN protocol developed in the early 1980s by Bosch is a serial bus communications [3]. Afterwards, CAN protocol was standardized as ISO-11898 and ISO-11519, thus establishing the standard protocol for in-vehicle communication in the automotive industry. By connecting all the electronics in vehicles with CAN, they can be controlled from a central point know as the Engine Control Unit (ECU), which helps by increasing functionality, adding modules if needed, and building an efficient processes for diagnosing errors. CAN protocol offer an efficient communication between sensors, actuators, controllers, and various other nodes in the vehicle real-time applications.

CAN is best known for its simple reliable, and high performance communications [5]. The CAN uses two wires (twisted pair) communication over the bus. The bus can have a multi master structure wherein each connected device on the bus can transmit or receive data. At a given time one device can act as a master transmitter while all the others act as listeners. CAN being a priority based communication protocol if more than one devices attempt to access the bus at the same time for data transfer, the one with the highest priority gets the arbitration of the bus while the others returns to listening state. CAN protocol can make a distinction between four message formats or frames [2] namely data frames, remote frames, error frames, and overload frames.Data frame consists of following parts :A Start-Of-Frame (SOF) bit generally set to 1 (recessive) followed by an arbitration field which consists of eleven-bit identifier and the Remote Transmission Request (RTR) bit. The control field consists of six bits to indicate number of bytes of data in the data field. The data field can range from zero to sixty four bits or 8 bytes .Cyclic Redundancy Checksum (CRC) field follows the data field enabling the listener to check if the received bit sequence is corrupted. The two-bit acknowledgment (ACK) field is used by to receive an acknowledgment of a valid data or a negative acknowledgement for invalid frame. The end of a message frame (EOF) is a series of seven recessive-bits.

Extended CAN protocol consists of a data frame with a twenty-nine-bit identifier along with other fields. Error detection and handling are very important factors which help in increasing the performance of CAN. Error detection in CAN for vehicular applications can be done in following five different ways: bit monitoring and bit stuffing, as well as frame check, ACK check, and CRC. The primary aim of this project is development of a system which helps in monitoring various parameters viz. Engine temperature, Carbon monoxide percentage in the exhaust of vehicle, Battery Voltage etc using CAN protocol

LITERATUREREVIEW

TABLE 1: HISTORY OF CAN

1985	Start of development of CAN at Robert Bosch GmbH
1986	CAN V1.0
1991	Extended CAN2.0 protocol Part 2.0A –11-bit identifier Part 2.0B –29-bit identifier (extended frame format)
1992	CAN in Automation (CiA) established.
1993	First car, a Mercedes S-class, was equipped with CAN
1994	First standardization at ISO
1995	Open CAN protocol
1998	Development time-triggered CAN (TTCAN) networks
1999	Use of CAN-linked equipment in all motor vehicle applications

Fairchild et al., [15] in 2002 and Johnson et al., in 2004, published in their research paper that the engine temperatures generally should not exceed 110^{o}C, and exhaust system components reach level of 600^{o}C. CO emission rate [14] according to BS IV regulations April 2010 has

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TRAN-SREC-EIVER

been found out as 0.5 g/km for diesel engines and 1.0 g/km f engines. In-vehicle networking, also known as multiplexing, is a method for transfe a among distributed electronic modules via a serial data bus. Bosch distributed a few s of the CAN detail and the most recent is CAN 2.0 distributed in 1991. This detail has two sections; section A is for the standard organization with a 11-bit identifier, and part B is for the expanded arrangement with a 29-bit identifier. A CAN gadget that uses 11-bit identifiers is normally called CAN 2.0A and a CAN gadget that uses 29-bit identifiers is regularly called CAN 2.0B. These benchmarks are uninhibitedly accessible from Bosch alongside different details.

CAN bus is one of five protocols used on-board diagnostics (OBD)-II vehicle diagnostics standard. The OBD-II standard has been mandatory for all cars and light trucks sold in the United States since 1996, and the EBD standard has been mandatory for all petrol vehicles sold in the European Union since 2001 and all diesel vehicles since 2004.

HARDWARE

1. *MICROCONTROLLER*

Microcontroller generally termed as short computer because when we consider the computer system it consists of various peripherals which all are grouped together to define a functionality. Microcontroller is a device at the heart of any embedded system but functions as the brain of the systems.Microcontrollers now-a-days are developing into very low power devices. General operating range for microcontrollers is around 5V. They are characterised by strong Arithmetic logical units on chip RAM and RROM for storing data and codes.The microcontroller is chosen more often than the microprocessor because it consists of on chip memory. But the components embedded on the chip are fixed. The microcontrollers are found wider applications in automation, embedded systems, remote controls, office machines etc. Microcontrollers like PIC developed by Microchip Technology may have built in CAN protocol which can be used for this project.Some microcontroller may use four bit words and operates at different clock frequencieslower the clock rate lower is the power consumption and it will be of order nanoseconds while the ,Microcontroller is sleeping condition. There are micro-controllers deals with the control of digital and non-digital electric systems.

2. *CAN TRANSCEIVER*

The MCP2551 is a high-speed CAN, fault-tolerant device that serves as the interface between a CAN protocol controller and the physical bus. It will operate at speeds of up to 1 Mb/s. Typically, each node in a CAN system must have a device to convert the digital signals generated by a CAN controller to signals suitable for transmission over the bus cabling (differential output). It provides a buffer between the CAN controller and the high-voltage spikes that can be generated on the CAN bus by outside sources.

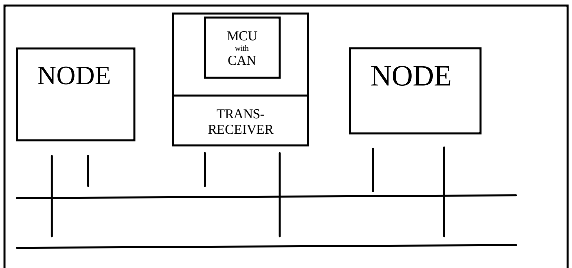

Figure 1:CAN Bus

It is a low current standby operation. There is insurance against harm because of short out battery terminals. Up to 112 hubs can be associated. MICROCONTROLLER is joined with CAN Transceiver at the motor side as appeared in the Temperature sensor and battery voltage circuitGas sensor and LDRare joined I/Oports.Touch screen display is also connected to microcontroller but on dashboard side.CANH and CANL of motor is joined with CANH and CANL of dashboard side.

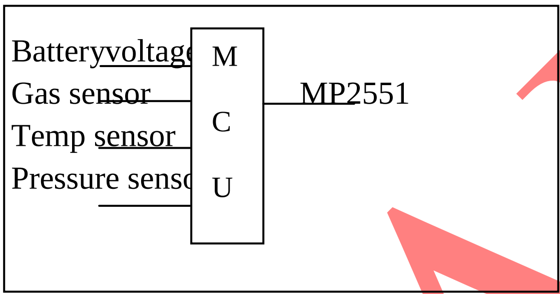

Figure 2: Engine Side Block Diagram

The second MICROCONTROLLER is associated with CAN at the dashboard side. This information can be seen through touch screen LCD. This information will get refreshed every few seconds.

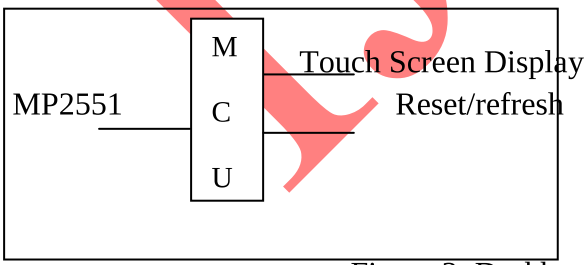

Figure 3: Dashboard side Block Diagram

3. *LM7805:*

LM7805 is a direct voltage controller that delivers a steady voltage of +5VDC. LM7805 is a voltage regulator IC which works for wide rang of input voltages

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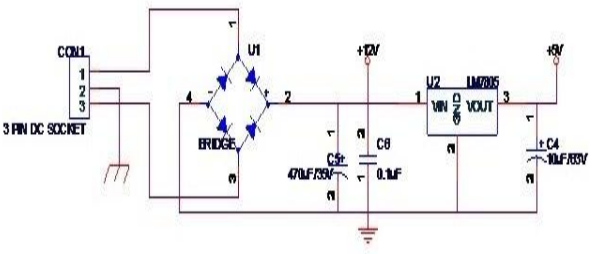

Circuit 1: LM7805 circuit

4. *TEMPERATURE SENSOR LM35*

The LM35 is a temperature sensor which gives output voltage in proportional to the temperature of surrounding. It quantifies temperature more precisely than a thermistor. The sensor hardware is fixed and not subject to oxidation, and so on. The LM35 creates a higher yield voltage than thermocouples and may not require that the yield voltage be increased. It has a yield voltage that is corresponding to the Celsius temperature. Important characteristic of the LM35 is that it draws only 60 micro amps from its supply and possesses a low selfheating capability. The sensor self-heating causes less than 0.1 ^{o}C temperature rise in still air. The sensor has a sensitivity of 10mV / ^{o}C.

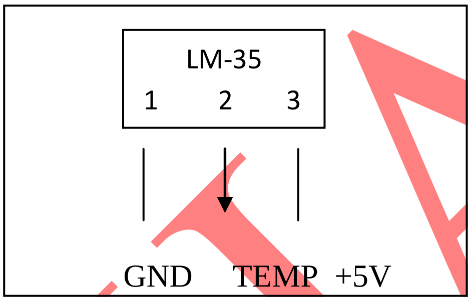

Figure 4:LM35 circuit

5. *LDR CIRCUIT*

When a high frequency light falls on the device the electrons in the semiconductors gains energy by the photons and jumps towards the conduction band. The ejected electrons conduct electricity which in turn reduces the resistance. For the small amount of the photon energy the electrons will excite to the conduction band. Those free electrons in the conduction band conduct electricity. The LM358 IC has two independent, high gain, frequency compensated o-amps which are designed to operate over a wide range of voltages.

One input of the LM358 is light dependent resistor and the other one is a reference voltage. When light fall on the device the decreases and the voltage of the negative terminal becomes less when compared to reference voltage. When the negative terminal voltage is less than the reference voltage then the light emitting diode turns into ON state.

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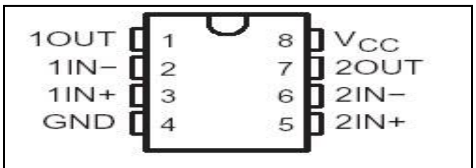

Figure 5: PIN out diagram of LM35

This concept is applied to detect if any fire in the engine occurred or not. If the fire occurred then the variations in the terminal voltages starts then the light emitting diode will turn to ON state. The Gas sensor using in our system setup is MQ-6 which has the high sensitivity to Propane, Butane and LPG, also the MQ -6 responds to the Natural gas. The gas sensor, the name itself defines that it is used for detecting different combustible gases especially methane. Gas sensor output voltage is connected to LM358.

6. *TOUCH SCREEN:*

Touch screen which is an input device that is normally designed on the upmost layer of an electronic visual display of a processing system. The touch screen acts as an interface between the user and the inner processing system. The user can use the touch screen to react to what is displayed and to control how it is displayed. The touch screen replaces a mouse, touch pad and other intermediate devices.
Dashboard in an automobile provides information for the driver about parameters like speed, engine rpm, and distancetravelled engine coolant temperature etc. to the driver. Generally mechanical dashboards are used, but the electronicimplementation of the dashboard provides more flexibility to customers

7. *GAS SENSOR*

The Gas sensor using in our system setup is MQ-6 which has the high sensitivity toPropane, Butane and LPG, also the MQ -6 responds to the Natural gas. The gas sensor, the name itself defines that it is used for the detection of the different combustible gases especially methane with low costand this gas sensor is suitable for various applications. The Sensitive material we are using in this gas sensor is SnO2, which with lower conductivity in clean air is possible. Gas sensor output voltage is connected to LM358. If $V_+ > V_-$,then the output voltage is high and the LED connected to the output is ON. If $V_+ < V_-$,then the output voltage is low and LED is OFF. Gas sensor circuit is shown in Figure..

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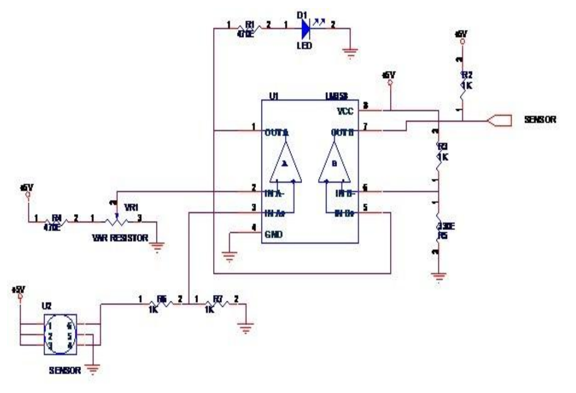

Circuit 2: Gas Sensor Circuit

8. *UNIVERSAL SYNCHRONOUS ASYNCHRONOUS RECEIVER TRANSMITTER*

USART is a standard designed for asynchronous serial transmission. USART can be configured as a full-duplex asynchronous system for communication with CRT terminals and personal computers, or it can be configured as a half-duplex synchronous for communication with A/D or D/A circuits, serial EEPROMs, etc. A MAX232 IC is needed for interfacing all these data and converting it to RS232 standard for communication with personal computers. MAX232 acts as a interface device for this purpose

DESIGN OF CAN-BASED MONITORING SYSTEM

A. *AT THE ENGINE SIDE*

CAN 2.0B is a network protocol that was specially developed for connecting the sensors, actuators and ECUs of a vehicle. CAN 2.0B supports data rates from 5kbps to 1Mbps, which allows the CAN network to be used to share status information and real time control. It can transfer upto 8 data bytes within a single message.

In this paper two nodes are used for monitoring parameters. The various sensors used are temperature, battery voltage, LDR and CO sensors. Temperature and battery voltage are connected to ADC. LDR and CO_2 sensors are connected to digital ports. Values are transferred to microcontrollers in the dashboard from ADC and digital ports via CAN Protocol at an interval of 10 seconds and is displayed in the LCD. Also the message can be seen through computer via UART. If any data is required by the dashboard, the CAN controller at the engine side checks the identifier transmitted by it. After 10 seconds, the engine side controller sends the required data to the dashboard. The flow of processes in the system is illustrated by the figure.

B. AT THE DASHBOARD SIDE

The controller of the CAN checks whether any data is available at the received buffers. If the data is available at the receiver buffers then the value that is present is displayed in the LCD. While pressing the key, which is placed on the dashboard, the data is requested by sending an identifier. Then after 10 seconds the message is obtained from engine section

RESULTS AND CONCLUSIONS

The system will monitors parameters like temperature, battery voltage, light due to spark or fire and CO level in the exhaust etc and provide better support to the mechanics. For monitoring the above parameters, LM35 sensor, 9V battery, LDR and MQ6 sensors are used. The programming of LED, ADC and touch screen LCD interfacing with microcontroller can be done using Embedded C. The temperature of the engine, battery voltage, presence of light and CO level in the exhaust are communicated from engine to touch screen display via CAN Protocol.

SCOPE FOR FUTURE WORK

- This monitoring system is limited to a two node network. And it can be extended to four nodes, eight nodes, 16 nodes etc for vehicle monitoring applications .
- Response time analysis can be done easily.
- Even the analysis of the cost is also accountable .
- Interfacing a device with OBD-II protocol can result into more information flow onto the device which will help the mechanic by providing insight into the faults in the system.

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