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Design and Development of a Vehicle Monitoring System Using CAN Protocol

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Abstract: Nowadays economical automobiles are developed by more of electro mechanical parts with analog interface for efficient & cost effective operation. Generally a vehicle is built with an analog driver-vehicle interface for indicating various vehicle statuses like speed, fuel level, engine temperature etc. This paper presents a design & development of cost effective solution for digital driving interface with a semi-autonomous vehicle improving the driver-vehicle interaction with increase in safety. Our designed system uses a PIC Microcontroller based data acquisition system that uses in built ADC to gather data from analog sensors to digital format and visualize them to the vehicle driver through a LCD display. The communication module used here is an embedded network bus CAN, which has efficient data transfer. Experimental data with a prototype is obtained for various vehicle parameters like vehicle speed, engine temperature and fuel level in the tank which are compatible with a real time system.

Keywords: Controller area network (CAN), Vehicle Sensors, PIC Microcontroller, Communication Module.

I. INTRODUCTION

This paper here aims in designing a prototype system which helps in monitoring the real time parameters of vehicle using CAN protocol. This system helps in achieving effective communication between transmitter and receiver modules using multiple sensors to monitor parameters like engine temperature, fuel tank level indicator, Speed of the vehicle through vehicle speedometer. The modules interfaced with the sensors for this system are, Temperature sensor capable of detecting engine heat, Fuel level indicator using level detecting sensor , IR sensor for speed measuring and a obstacle detection sensor. A CAN transceiver is used to establish communication between two PIC microcontrollers measuring & displaying continuously the above real time parameters on a LCD. This work introduces an embedded system with a combination of CAN bus having high impact on Digital control of the vehicle. With the rapid development of embedded technology, high performance embedded processor is penetrated into the automobiles having low cost, high reliability and other features to meet the needs of the modern automobile industry. The proposed high speed CAN bus system solves the problem of automotive system applications. With PIC as the main controller, it makes full use of the high performance of PIC, high speed reduction of CAN bus communication control networks and instrument control so as to achieve full sharing of data between nodes and enhance their collaborative work. This system features efficient data transfer among different nodes in the practical applications

II. BACK GROUND

A. CAN Protocol

Controller Area Network (CAN) was initially created by German automotive system supplier Robert Bosch in the mid-1980s for automotive applications as a method for enabling robust serial communication. The goal was to make automobiles more reliable, safe and fuel-efficient while decreasing wiring harness weight and complexity. Since its inception, the CAN protocol has gained widespread popularity in industrial automation and automotive/truck applications. Other markets where networked solutions can bring attractive benefits like medical equipment, test equipment and mobile machines are also starting to utilize the benefits of CAN, the goal of this application note is to explain some of the basics of CAN and show the benefits of choosing CAN for embedded systems networked applications

B. CAN Standards & Specifications

The Controller Area Network (CAN) protocol is widely used in low-cost embedded systems. CAN uses ‘‘Non Return to Zero” (NRZ) coding and includes a bit-stuffing mechanism. The CAN is capable of providing a high speed and high capacity data for a large number of parameters with more efficiency.Most network applications follow a layered approach to system implementation. This systematic approach enables interoperability between products from different manufacturers. A standard was created by the International Standards Organization (ISO) as a template to follow for this layered approach. It is called the ISO Open Systems Interconnection (OSI) Network Layering Reference Model. The CAN protocol itself implements most of the lower two layers of this reference model. The communication medium portion of the model was purposely left out of the Bosch CAN specification to enable system designers to adapt and optimize the communication protocol on multiple media for maximum flexibility (twisted pair, single wire, optically isolated, RF,

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IR, etc.). With this flexibility, however, comes the possibility of interoperability concerns. To ease some of these concerns, the International Standards Organization and Society of Automotive Engineers (SAE) have defined some protocols based on CAN that include the Media Dependant Interface definition such that all of the lower two layers are specified. The CAN protocol is an international standard defined in the ISO 11898. Beside the CAN protocol itself the conformance test for the CAN protocol is defined in the ISO 16845, which guarantees the interchange ability of the CAN chips. A principle of data exchange CAN is based on the "broadcast communication mechanism", which is based on a message-oriented transmission protocol. It defines message contents rather than stations and station addresses. Every message has a message identifier, which is unique within the whole network since it defines content and also the priority of the message. This is important when several stations compete for bus access (bus arbitration).

C. Proposed Work With CAN Interface

The Main Objective of this proposed work is to implement and use CAN protocol for communication for a prototype designed and developed for monitoring real time vehicle parameters. The aim here is using CAN buses achieve communication between master & slave microcontrollers to Monitoring different vehicle parameters like speed & temperature of engine, fuel level in the tank & obstacle detection.

III HARDWARE & SOFT WARE DESIGN DETAILS

The Main Blocks of This Prototype are: PIC Micro controller (18F458), Crystal oscillator, Regulated power supply, LED indicator with Buzzer, Fuel Level sensor with Tank, IR obstacle sensor, DC motor, CAN transceiver, Temperature sensor pt 100 and LCD display. This system makes use of two Microcontrollers which are connected using a CAN bus. One of the Microcontrollers (master) has Temperature sensor, Fuel level sensor, IR speed sensor & obstacle detection sensor. This controller gets input from these sensors.

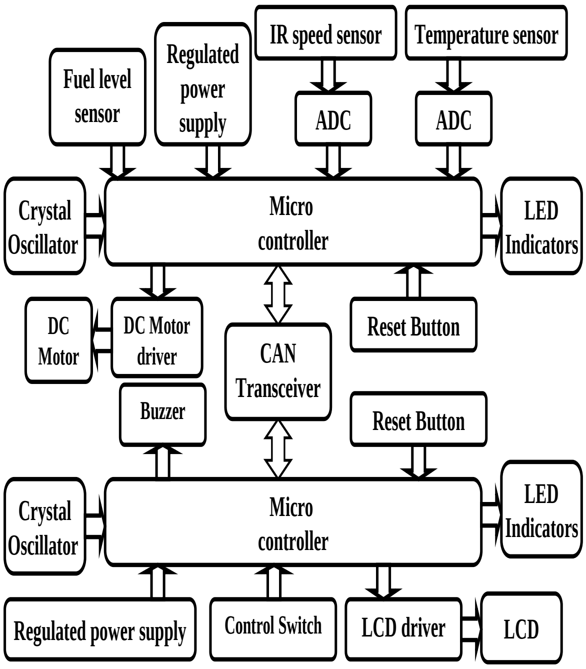

Fig1: Block Diagram of CAN based real time implementation in automobile

These parameters are transferred over CAN bus which is received by the other controller (slave) connected to it. The PIC Microcontrollers used are programmed using Embedded C. Fig 1 shows the block diagram of the Entire setup. Fig 2 & 3 show the schematic diagrams of transmitter & receiver respectively. The schematic diagrams shown below in fig 2 & 3 of CAN based real time implementation in automobile explains the interfacing section of each component with micro controller and sensor module. The crystal oscillator regulated power supply, LED's and LCD interfacing connected to micro controller through resistors and motor driver circuit is clearly depicted in the figures below. Fig 4 & 5 shows the software implementation flowcharts for master & slave communicating with embedded C.

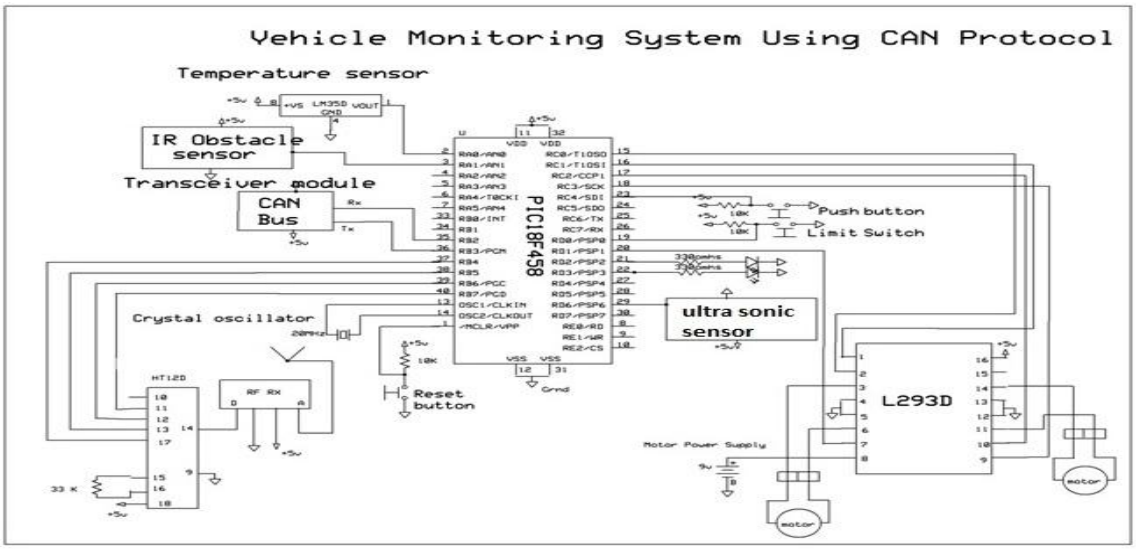

Fig 2: Schematic diagram of transmitter section of CAN based real time implementation in automobile

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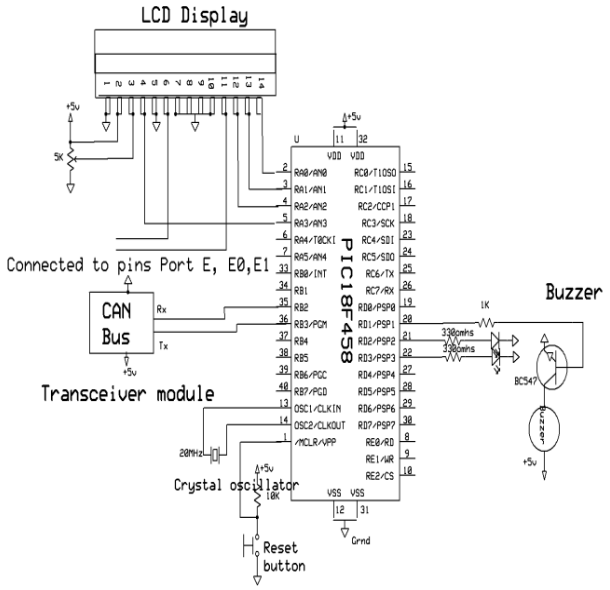

Fig 3: Schematic diagram of receiver section of CAN based real time implementation in automobile

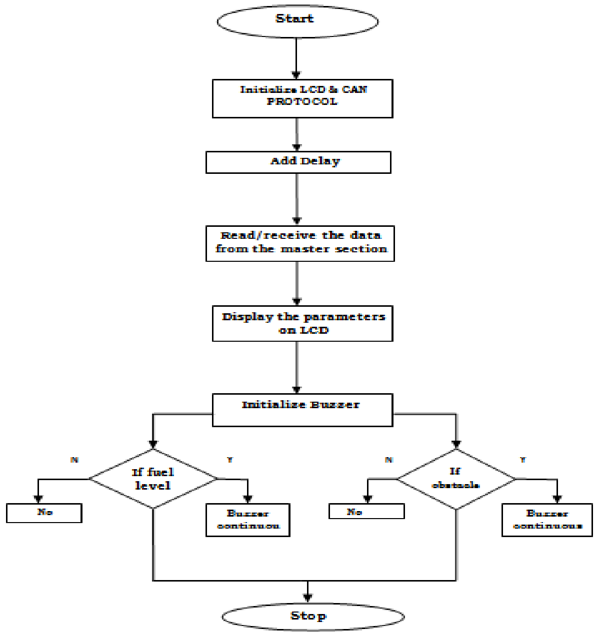

Fig4 Flow chart of the master section

Micro controller PIC 18F458, Crystal oscillator, Regulated power supply operates with a supply voltage of 4.2V to 5.5V at the full speed of 40MHz.

At lower voltages the maximum clock frequency used here is 4MHz, which rises to 40MHz at 4.2V. The RAM data retention voltage is specified as 1.5V and will be lost if the power supply voltage is lowered below this value. In practice, this microcontroller-based system operates with a single 5V supply derived from a suitable voltage regulator.

The system can be resettled through master microcontroller by one of the following operations like Power-on reset (POR), MCLR reset, Watchdog timer (WDT) reset, Brown-out reset (BOR) or using Reset instruction

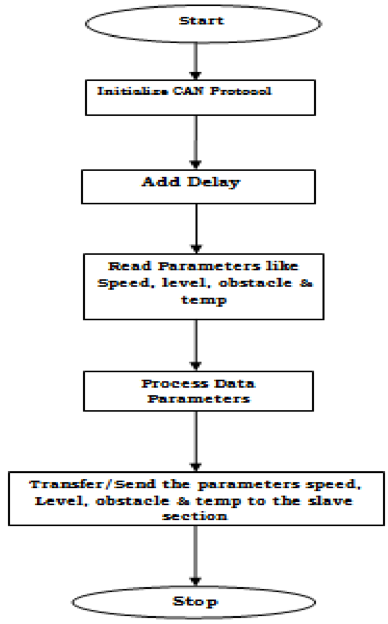

Fig 5.Flow chart of the slave section

IV EXPERIMENTAL RESULTS

Table 1 shows the experimental results obtained by the sensors connected to the prototype. In prototype Engine speed is taken as a fan connected to a 12 V Dc motor whose speed is monitored by its number of rotations per second. A level of tank is calibrated with respect to the maximum & minimum speed of fan as tabulated in table 1. Fig 6 shows graph with the tabulated results

Table1 Experimental Results at variable temperatures

S. No	Temp (°C)	RPS (Sec)	Level 1 (mm)	Level 2 (mm)	Level 3 (mm)
1	25	0	100	100	100
2	25	21	98	95	90
3	25	23	92	90	85
4	25	25	87	80	73
5	25	27	85	80	70
6	25	29	76	70	50
7	25	31	63	60	42
8	25	33	52	40	27
9	25	35	48	40	20
10	27	37	39	35	13
11	27	39	22	20	4

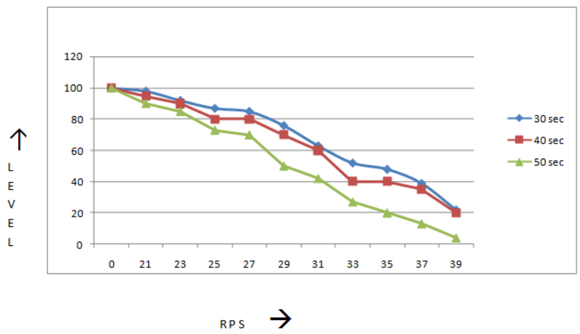

Fig 6 Graph showing the response of tank level and engine speed

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V. DISCUSSIONS ON RESULTS

Above results are obtained on continuously monitoring the varying parameters of the vehicle like, engine speed (RPS) & level of the fuel tank. Calibration is done for the minimum RPS of the engine for 21 & the maximum RPS of 39. For minimum RPS the tank level is considered at 10% and for the max RPS the tank outlet is considered to be 100%.

For the designed prototype the readings are tabulated by increasing the speed of engine (RPS) stepwise from 21-39 with appropriate tank outlet opening with the duration of 30,40, 50 sec (i.e.) when the RPS is 21,the tank outlet is opened at 10% for the duration of 30 sec and the level of the tank is tabulated for different RPS and tank outlet level

The graph shown is the plot of different values of the vehicle (prototype) system such as speed of engine, fuel level in the tank & temperature. The blue line indicates the different RPS taken for different levels in the tank for the duration of 30 sec.

The red line in the graph shown is taken by increasing RPS for different tank outlet openings for the duration of 40 sec. The green line in the graph is taken by varying/increasing the speed of the engine from minimum to its maximum for different percentage openings of the tank outlet for the duration of 50 sec. Fig 7 shows the prototype photograph of the designed vehicle monitoring system.

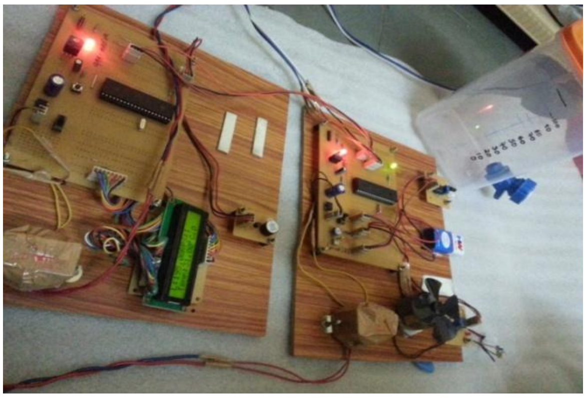

Fig 7 Prototype of the vehicle monitoring system using CAN protocol

VI. CONCLUSION & FUTURE SCOPE

From the above results and discussions we conclude that as the engine speed in RPS & working duration of engine increases the fuel level in the tank decreases which is monitored & successfully communicated through CAN bus. This same technique can be used for a real time vehicle where in the above parameters can be monitored & necessary corrective action can be initiated if it is not under normal operation

As per our main aim we have designed & developed a prototype system for vehicle monitoring using CAN Protocol. Our design here is mainly intended to achieve communication between master and slave modules for monitoring various parameters of the vehicle. This work can further be extended by using IR sensor, GPRS and 3G technologies. Fire sensor alerts in case of fire accidents can also be added. Through GPRS, we can monitor the location of the vehicle and 3G technologies can be used to view the vehicle through video calling option helping to find the vehicle in emergency situation.

Fig 8 and Fig 9 shows the photographs of Master& Slave sections of the prototype respectively. Fig 10 shows the photograph of output display with reading of Level, Speed & Temperature.

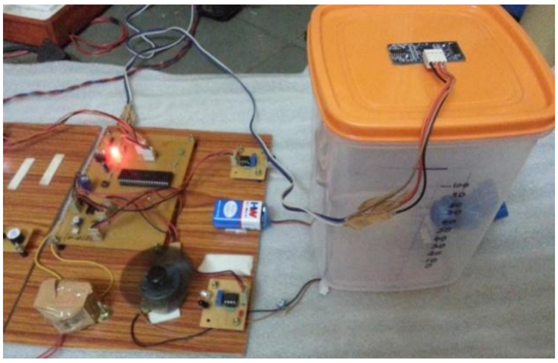

Fig 8 Master Section of the Prototype

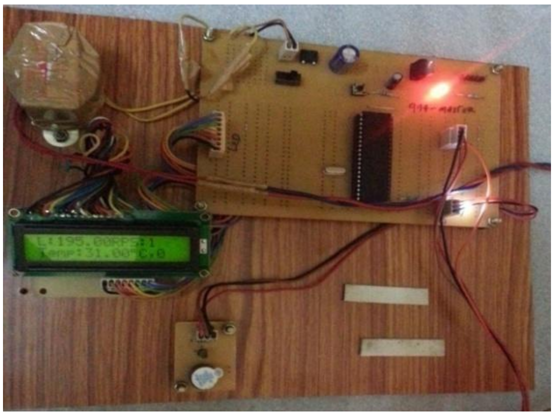

Fig 9 Slave Section of the Prototype

Fig 10 LCD Display showing Level,RPS & Temperature

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BIOGRAPHIES

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