CONTROLLER AREA NETWORK DATA EXTRACTION FOR AUTOMOBILE

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ABSTRACT

Nowadays networked Electronic Control Units (ECU's) are increasingly being deployed in automobiles to realize various functions and Controller Area Network (CAN) is deployed for the communications among ECU's. Our primary objective is to build both hardware and software that interface and communicate directly with CAN network and extract CAN messages for reliable communication between automobile ECU's. The hardware is a circuit board that is capable of extracting CAN messages released from an automobile ECU's which can be used for reliable automobile ECU's communications, for example, as operating engine temperature crossed threshold limit a cooling system can turn on, or cabin temperature increases beyond comfort level, AC can turn on with interface and indication to user. Tests and trials of the completed board are also carried out to ensure that the system is performing decently well.

KEYWORDS: CAN, PIC microcontroller, CAN transceiver, LM 35 temperature sensor

I. INTRODUCTION

In recent years, control systems of cars have moved from the analog to the digital domain. In particular, x-by-wire systems are appearing and drive research efforts of the whole automotive industry for the recent decade. Electronic Control Units (ECU's) are increasingly being deployed in automobiles to controls one or more electrical subsystems to realize the various functions. When a driver drives a car, there are many signals that are passed between the various Electronic Control units embedded inside the car. Output signals from an ECU contain information about the current state of the car as the driver interacts continuously with the car. A modern automobile can consists of up to 70 ECU's [1, 2] sensing and taking tabs of the various parameters of the automobile. This rapid and complex exchange of signals ensures the proper functioning of the car. The Controller Area Network (CAN) protocol was thus introduced to alleviate the problem of sending these signals efficiently in the form of structured message frames called CAN messages. In this we are construction the solutions of extracting needed CAN messages from automobile ECU's to make reliable communication among ECU's and this will also helps to reduce wiring harness in the car. The remainder of this paper is organized as follows: the CAN related information is given in the next subsections. We present our system design and operation in section 2, while results are presented in section 3. Finally we conclude the results in section 4.

1.1. Controller Area Network

In the early 1980s, engineers at Bosch evaluated existing serial bus systems regarding their possible use in passenger cars and found that none of the available network protocols were able to fulfill the requirements of the automotive. In February of 1986, CAN was born at the SAE (Society of Automotive Engineers) congress in Detroit, the new bus system developed by Bosch was introduced as 'Automotive Serial Controller Area Network'. Historical facts and rationales for the CAN protocol are given in [3, 4, 5]. Controller Area Network (CAN) is a serial data communications bus for real-time applications operates at data rates of up to 1 Mbps and has excellent error detection and confinement capabilities. CAN was originally developed for use in cars to provide a cost-effective communications bus for in-car electronics and as alternative to expensive, cumbersome and unreliable wiring looms and connectors. The car industry continues to use CAN for an increasing number of applications, but because of its proven reliability and robustness, CAN is now also being used in many other control applications. CAN is an international standard and is documented in ISO 11898 (for high-speed applications) and ISO 11519 (for lower-speed applications). Low-cost CAN controllers and interface devices are available as off-the-shelf components from several of the leading semiconductor manufacturers. Custom built devices and popular microcontrollers with embedded CAN controllers are also available. There are many CAN-related system development packages, hardware interface cards and easy-to-use software packages that provide system designers, builders and maintainers with a wide range of design, monitoring, analysis, and test tools. CAN network topology is given in Figure1, which gives it the advantage of easily adding new, CAN nodes to an existing network. Furthermore, the standardization of the protocol means all ECU's will conform to the CAN standards while transmitting data. All CAN nodes are fitted with a mandatory CAN transceiver chip that connects it to the CAN bus.

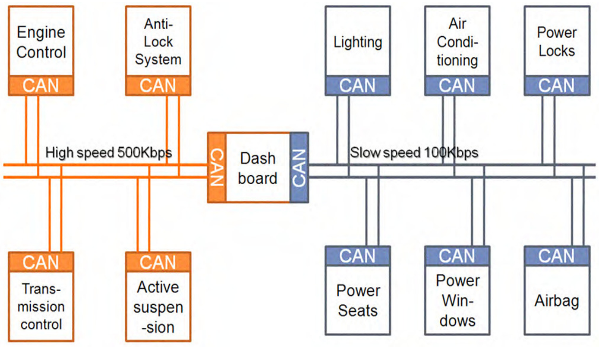

Figure 1.CAN network topology

CAN is based on the "broadcast communication mechanism". This means that all nodes can "hear" all Transmissions. There is no way to send a message to just a specific node; all nodes will invariably pick up all traffic. The CAN hardware, however, provides local filtering so that each node may react only on the interesting messages. Therefore, CAN is based on a message-oriented transmission protocol. Every message has a message identifier, which is unique within the whole network since it defines the priority of the messages.

1.2. CAN in Cars

To satisfy customer requirements for greater safety, comfort, and convenience, and to comply with increasingly stringent government legislation for improved pollution control and reduced fuel consumption, the car industry has developed many electronic systems. Anti-lock Braking, Engine Management, Traction Control, Air Conditioning Control, central door locking, and powered seat and mirror controls are just some examples. The complexities of these control systems, and the need to exchange data between them meant that more and more hard-wired, dedicated signal lines had to be provided. Sensors had to be duplicated if measured parameters were needed by different controllers. Apart from the cost of the wiring looms needed to connect all these components together, the physical size of the wiring looms sometimes made it impossible to thread them around the vehicle (to control panels in the doors, for example). In addition to the cost, the increased number of connections posed serious reliability, fault diagnosis, and repair problems during both manufacture and in service.

1.3. Working Principle of CAN

Data messages transmitted from any node on a CAN bus do not contain addresses of either the transmitting node, or of any intended receiving node. Instead, the content of the message (e.g. Revolutions per Minute, Hopper Full, X-ray Dosage, etc.) is labeled by an identifier that is unique throughout the network. All other nodes on the network receive the message and each performs an acceptance test on the identifier to determine if the message, and thus its content, is relevant to that particular node. If the message is relevant, it will be processed; otherwise it is ignored. The unique identifier also determines the priority of the message. The lower the numerical value of the identifier, the higher the priority. In situations where two or more nodes attempt to transmit at the same time, a non-destructive arbitration technique guarantees that messages are sent in priority order to avoid the loss of messages.

II. System Deployment

The project can be largely divided into three parts: the design and fabrication of hardware main board, Programming of firmware. Figure 2 gives a block diagram of the overall design of the system.

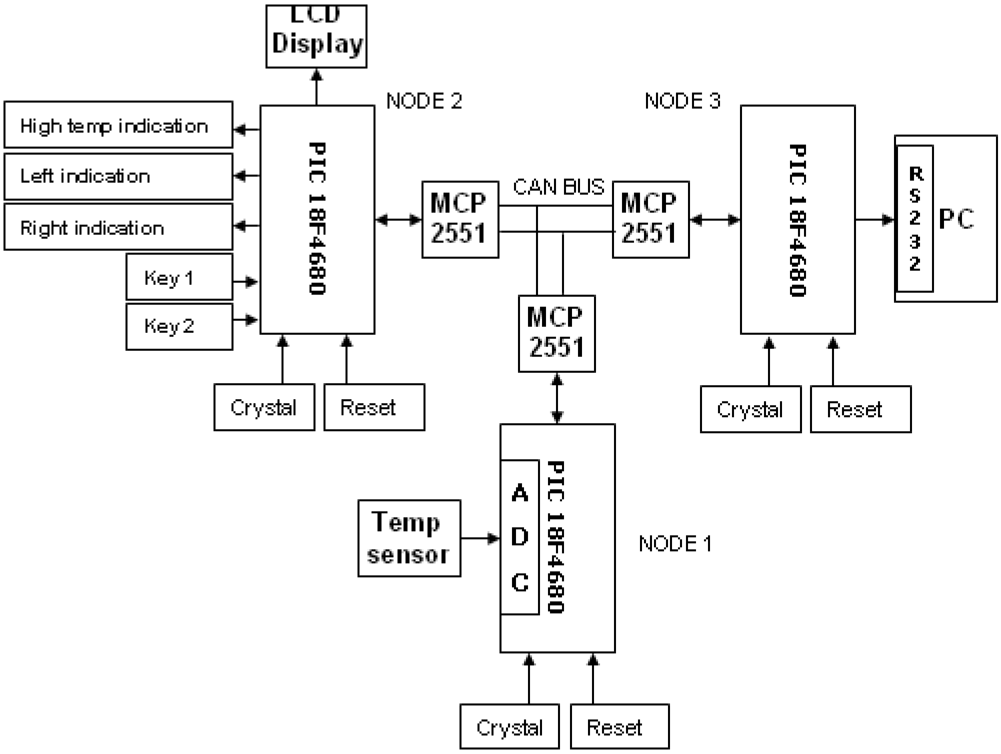

Figure 2. System block diagram

Main board consist of consist of PIC18F4680 flash microcontroller, CAN Transceiver (MCP2551), temperature sensor LM35 and CAN. Essentially, the main board is the one that is receiving input signals from the controller via the CAN interface. These signals are passed via the RS-232 port to the PC and LCD display.

2.1. Temperature Sensor

Various types of temperature sensors are available in the market and sensor depending upon the application can be used. The LM35 has temperature range of −55° to +150°C. It can be used with single power supply or with plus and minus supply. The LM35 output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in °Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient centigrade scaling [6]. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy.

2.2. Microcontroller

It is proposed to use PIC18F4680 is the enhanced flash microcontroller with ECAN™ Technology, 10-Bit A/D and nanowatt Technology. Other family of microcontroller units can also be used depending upon the use. The work of the microcontroller is to control the flow of information according to CAN messages from temperature sensor. The signals sensed by sensor and transmitted through CAN transceiver to LCD [7].

2.3. CAN Transceiver (MCP 2551)

The MCP2551 is a high-speed CAN, fault-tolerant device that serves as the interface between a CAN protocol controller and the physical bus [8]. The MCP2551 provides differential transmit and receive capability for the CAN protocol controller and is fully compatible with the ISO-11898 standard, including 24V requirements. 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 also provides a buffer between the CAN controller and the high-voltage spikes that can be generated on the CAN bus by outside sources (EMI, ESD, electrical transients, etc.).The schematic of CAN transceiver is shown in Figure3.

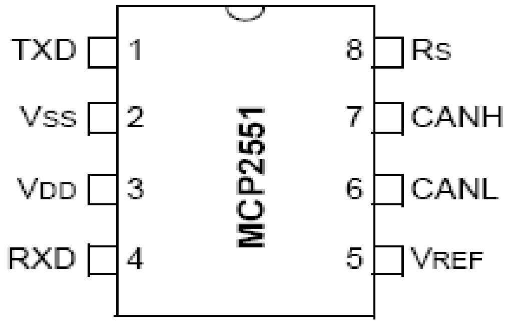

Figure 3. Schematic of CAN transceiver

The CAN bus has two states: Dominant and Recessive. A dominant state occurs when the differential voltage between CANH and CANL is greater than a defined voltage (e.g., 1.2V). A recessive state occurs when the differential voltage is less than a defined voltage (typically 0V). TXD is the transmitter data input pin usually connected to the transmitter data output of the microcontroller to receive the data from the node's on the CAN bus. And RXD is receiver data output usually connected to the receiver data input of microcontroller.

2.4. Display Unit

All the activities which are taking place with CAN messages, sensors and controller will be displayed on the LCD panel connected to Node2.

2.5. System Operation

In this there are three nodes referring to Figure 2. The simplified system flow chart of algorithm in 18F4680 PIC microcontroller is shown in Figure 3.

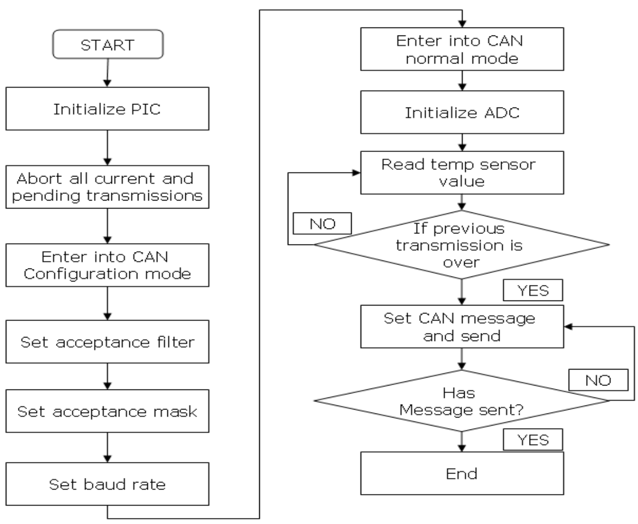

Figure 4. System flowchart for 18F4680 at node 1

The Node-1 is connected to the temperature sensor LM35. The temperature data will be capture by the temperature sensor which gives the analog output. This analog output is given to the ADC which is inbuilt in the PIC microcontroller. This analog output is processed and passed on the CAN bus through CAN transceiver (MCP 2551) to node 2 and 3.This CAN transceiver would be used for TTL/CMOS to CAN Voltage levels and vice versa. The temperature sensor will resemble the engine or car cabin temperature. When the temperature data goes above set value the user get indication by red LED on Node 2 to take necessary action. Node -2 will consist of two LED which would indicate the status of the left indication and right indication done by manually and send the CAN message related to this on Node 3.And LCD display which displays the temperature value received from node 1.The node 3 would be connected PC and display the same temperature value. The PC communication is through RS232. Figure .5 shows the complete main board of the system consisting of three nodes.

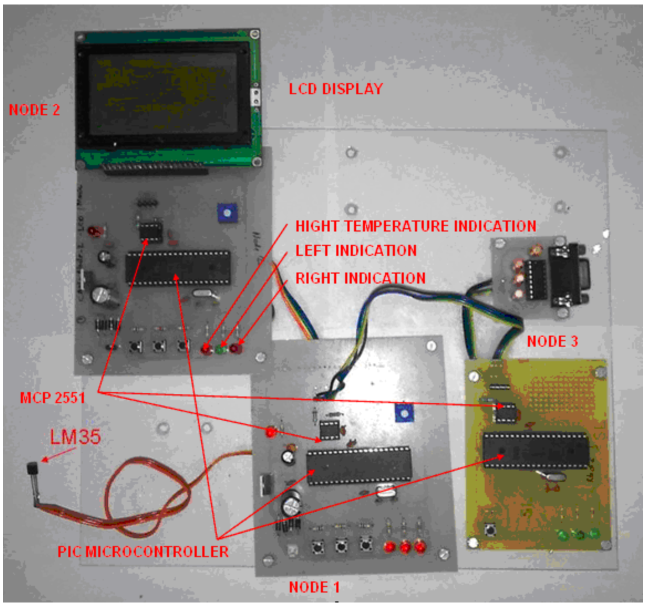

Figure 5. Complete main board

III. RESULTS AND DISCUSSION

Three nodes has been implemented, the temperature data sent by node 1 will be extracted at node 2 and node 3. The LCD display output and the screen output at node 2 and node 3 respectively are shown in Figure 6. When this temperature exceeds beyond the threshold value the red LED on node 2 will glow and then user can take necessary action. Means that using the extracted CAN message us can make reliable communication between ECU's without wiring harness. This information will guide the user to take necessary action.

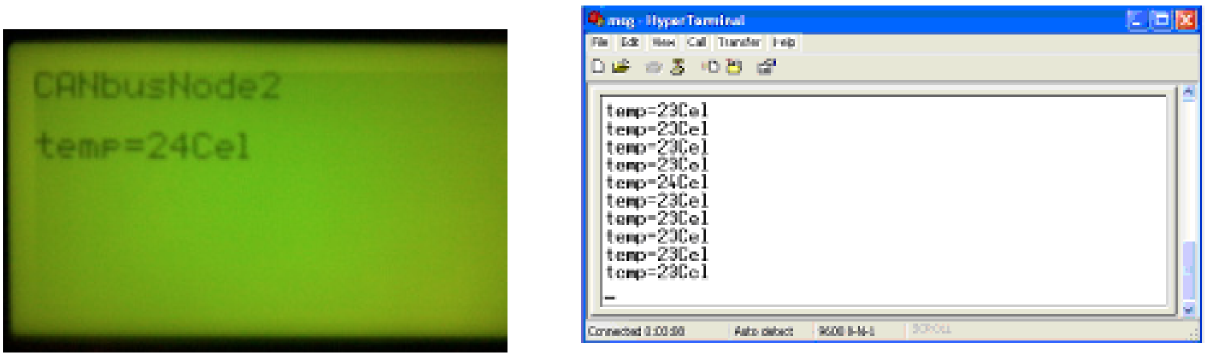

Figure 6.LCD display output at node2 and screen output at node 3

IV. CONCLUSIONS

This paper presents our project that successfully extract CAN messages from automobile ECU's. It presents the details of building both hardware and software that interface and communicate directly with CAN network embedded in the automobile. This extracted CAN Messages can be used for communication among automobile ECU's in order to take necessary action and this data will helps user to keep current status of automobile. Use of CAN to network controllers, actuators, sensors, and transducers we can reduce design time, connection costs because of lighter, smaller cables and connectors and improve reliability due to fewer connections so wiring harness reduces too.

In the future works, we will see towards the prospects of integrating the system with an embedded info-security system for vehicular networks and forward CAN data for reliable car communications. And with the advent of Vehicular Ad-Hoc Network that allows vehicles within reasonable proximity to connect wirelessly to one another via an ad-hoc manner, vehicles are able to share information from extracted CAN messages about their current States to other.

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