Design and Implementation of CAN based Automobile Control System

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Abstract: In controlling the vehicle autonomously using various electronic control modules (ECU’s), usually need to make some decisions with integrated actions in real time with only incomplete information. The CAN (Controller Area Network) serial bus system makes a crucial contribution here with its specific properties. This paper describes about development of CAN based automobile control system which includes Body control and comfort electronics subsystem of automobile to address comfort in drive feature.

Keywords: CAN Bus, ECU, Node, CAN controller, Host controller, CAN transceiver, NHTSA, HMI.

I. INTRODUCTION

The modern automobile has progressed greatly in the last few years. Just as our everyday consumer life has become sophisticated, our transportation has followed suit. Just how complex the modern automobile has become, though, is most likely not known by the average person. Here is an effort made in design and implementation of CAN protocol based Automobile control system for better understanding the automobile system. Automobile instrument assembly consist of various nodes linked with each other by CAN bus. Nodes are nothing but ECU’s(electronic control unit) that consisting of CAN controller and micro-controller to which various I/O devices as sensors, actuators are attached, identifies and processes the required data. Modern motor vehicles can contains over hundred ECUs which are interconnected by the CAN Bus network. The system could be well illustrated by figure 1 below, showing In-Vehicle CAN Bus Network joining various ECUs.

![Figure 1. CAN based Automobile Instrument Assembly](image)

This intensive electronification and higher complexity in vehicles necessitates the use of data buses in vehicles for information exchange between various control units. Using a digital network controller (ECU) can efficiently and with the desired speed of data exchange can be possible. CAN bus (Controller Area Network) is the most widely used data bus in formation of internal digital network in vehicle [14]. It assures reliable data exchange even under harsh environmental conditions for example. The data transmission over CAN bus takes placed using CAN protocol specified by the CAN standard ISO-11898 [15], [16]. Information on the CAN bus is in the form of data messages whose structure is defined by the CAN protocol [16]. The data on the communication line contain commonly information about a vehicle operating parameters such as vehicle speed, fuel consumption, engine performance etc.
II. LITERATURE SURVEY

A. Problem Formulation
According to NHTSA figures, since 1994 seat-belt-use in India increase steadily has been accompanied by a comparably steady reduction in daytime passenger-vehicle fatalities. In 2010, the last year for which fatality data was available, the number had been reduced by 42% fatalities among 76% front seat passengers while 59% rear seat passengers that use seat belt in India [17]. In the present automobiles the number of facilities is much higher. The National Highway and Transportation Safety Association reports [17] that 26% of all car accidents are caused by distractions due to talking on cell phones, eating while driving, and other similar distractions that take a driver’s focus off the road. The driver has to concentrate on road while driving, and with increased traffic, things get frustrating. The distraction considered in this project is for wiper on/off and dome light on/off. While increasing vehicle theft is another important issue needs to be addressed. In 2012 Times of India reported [18], out of 16 crore vehicles registered in the country, 1.7 lakh got stolen. On an average, there were 98 thefts per one lakh registered vehicles during the same period.

The characteristic of the automobile buyer has undergone a rapid change in the last few years. Good fuel efficiency along with high speed, Comfort in drive and lastly Cost consideration are the new variables that are influencing the buyer. Comfort in drive is a feature that comprises of many other features itself that assist the driver by not only making driving simpler but also assist to increase vehicle safety and security. Cost is always been a matter of concern and efforts are to be made in designing to decrease the cost. Electronics plays decisive role here to increase comfort level and decrease the cost of vehicle. Our proposed model will implement the comfort in drive feature and provide solution over the problems identified in the area.

B. Related Work
Thomas Nolte and Hans Hansson [1] stated historical perspective for development of automotive systems, Communication requirements, typical subsystems and automotive communication technologies. How communication over automobile instrument assembly takes placed using CAN Bus is analyzed in [11]. Jadsonlee da Silva Sá , Jaidilson Jó da Silva, Miguel Gonçalves Wanzeller and José Sérgio da Rocha Neto [2] implemented Monitoring of Temperature Using Smart Sensors Based on CAN Architecture in which they monitored and displayed temperatures of two different places and accordingly made auto-cooler on/off at the places. Similarly in [3], [4], [5], [7] and [8] implemented system is based on CAN along with embedded system, to monitor and control of different vehicle parameters addressing vehicle safety issue mainly but many of these parameters are not driver friendly so our proposed prototype model is designed considering this prospect with similar objective but different parameters as per requirement of the model.

III. PROPOSED MODEL
Body control and comfort electronics subsystem of automobile system includes climate control, cruise control, locks, window lifts, seat control and Human Machine Interfaces (HMI) etc [1]. Vehicle security can be increased by using Anti-Theft Devices. Anti-theft device used here is GSM interfaced and alarm equipped electronic locks key that not only cut fuel supply but also alarm owner about probable vehicle theft by sending massages so by use of physical as well as electronic key security level increases. Passenger’s safety is been increased by making seat belt use mandatory for passengers and making use of HMI that shows important massages alert driver for driver each time. Also driving is made simpler and enjoyable by making environment control as dome-light, wiper etc. auto on/off to avoid driver’s distraction.
After initialization of module display connected to the node 1 shows massage as ‘Design and Implementation of CAN based Automotive Control System’. System would check for Authorized person entry or not by validation of both of RF based electronic key and traditional physical key used by the respected person at node 2. If the entry is authorized then display at node 1 will show massage as ‘Key is detected Authorized entry’ along with its massage id otherwise it will show massage as ‘Key not detected Your entry is discarded’ and system will automatically disable the connection to engine motors while node 2 will activate the alarm and send owner massage of probable vehicle thief via GSM module. Then system will check for presence of light in car if it is not there then system will automatically make dome light on showing massage as ‘Light not detected Dome Light ON’ or else system will automatically make dome light off showing massage as ‘Light detected Dome Light OFF’ and if not. Most importantly after that system will check for seat belt lock/unlock if it is being locked then only display will show massage as ‘Push Start button to start the car’ or else it will display ‘wear seat belt or car stop’ so that the seat-belt is made mandatory. Finally system will start motor engine after start button is being pushed. Rain Sensor present at node 2 continuously track presence of moisture and will make wiper motor on or off accordingly and also it will send massage to node 1 to display the massage of rain detection and wiper on and vice versa otherwise. LCD at node 2 is used to check whether the same massages would be received by node 1 that would had transmitted from node 2.

**IV. HARDWARE AND SOFTWARE REQUIREMENT**

1. **ATMega 16**

   Host Controller over the CAN controller is programmed to decide what the received messages mean, what actions are to be taken and what messages it wants to transmit. ATMega 16 is to be used here as host controller as per requirement of the system.

2. **MCP 2515**

   The CAN controller stores the received serial bits from the bus until an entire message is available which can then be fetched by the host processor. MCP2515 is a CAN Controller used for the proposed system that meet the entire system requirement. CAN Controller is also responsible for error handling and fault confinement. MCP 2515 supports CAN 2.0B protocol and compatible with ISO 11898 CAN standard. MCP 2515 interfaces with host microcontroller via industry standard Serial Peripheral Interface.

3. **TJA1050**

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**Figure 2. Block Diagram of Proposed System**

- Node 1: Host Controller, CAN Controller, LCD Display, Motor Engine, Dome Light
- Node 2: Host Controller, CAN Controller, Rain Sensor, RF based Electronic Key
- CAN Bus
- A - Push Button, B - Dimmer, C - Physical Key

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The TJA1050 is the third Philips high-speed CAN transceiver fully compatible with ISO 11898 CAN standard. The transceiver is a transmitter and receiver amplifier. It converts the serial bit stream of the CAN module into electrical voltage values and vice versa. CAN bus uses two dedicated wires for communication. The wires are called CAN high and CAN low. When the CAN bus is in idle mode, both lines carry 2.5V. When data bits are being transmitted, the CAN high line goes to 3.75V and the CAN low drops to 1.25V due to the resistance of 120ohm used at the termination thereby generating a 2.5V differential voltage between the lines. A dominant bit is represented by CAN_H going to about 3.5 V and CAN_L going to about 1.5 V and recessive bit when voltage difference is zero. TJA1050 supports CAN 2.0B protocol.

4. LDR Sensor

A photo-resistor or light-dependent resistor (LDR) or photocell is a light control variable resistor. The resistance of a photo-resistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. LDR sensor is used in system for detection of light or dark in order to automatic dome light on.

5. Limit Switch

Limit switch is a switch operated by the motion of a machine part or presence of an object to make or break an electrical connection. They are used for controlling machinery as part of a control system, as a safety interlocks, or to count objects passing a point. Here limit switch is used for indication of seat belt lock or unlock.

6. Rain Sensor

It was found that the rain sensor is the expensive unit in the present system so an effort is done in making a sensor which is reasonable by price, the Cup Sensor. The sensing device used here is basically a conical shaped cup with a tray on the top of the cup to collect maximum possible amount of water. Based on level of water in the cup wiper will be operated.

7. GSM Module

SIM900D GSM Module uses AT commands for sms, calls and gprs. Here GSM Module will send owner massage of probable vehicle thief in case of unauthorized person’s interference is detected.

8. LCD

There are two LCD (Liquid Crystal Display)Modules are required in system in which one is 16*8 matrix attached at node 1 display data received at node 1 and other 16*2 matrix display at node 2 to display data received at node 2. Also communication over CAN Bus also can be verified using LCD displaying CAN massages transmitted or received via CAN Bus.

9. DC Motor

There are three DC Motors are to be used in the system in which two for driving vehicle used as engine motor prototype and one for wiper to wipe rain water present on windshield.

10. Locks

Two types of key as electronic and physical key i.e. traditional key are required to validate the entry. Electronic key used here is based on RF module consisting of transmitter chip embedded at the physical key and receiver chip fixed on door. After validation of both key persons entry will get authorized.

11. Dome light

Series LED’s are used here as a dome light having advantage of energy efficiency and additional feature as light dimmer over the existing system in which Florescent tube used for dome light.
12. Proteus
Proteus software is to be use to design circuit diagram for the system.
13. AVR Studio 4
AVR Studio version 4 software is to be use to develop code for the system. Embedded C is the coding language use for coding in AVR Studio.

V. CONCLUSION
When taken into account that CAN is still at the beginning of a global market penetration, even conservative estimates show further growth for this bus system for the next ten to fifteen years [6]. So the project on CAN implementation makes major significance here. Proposed system is designed in a way having advantage of feasibility, expandability, energy efficiency, cost effectiveness and reasonable data speed upto 1MBPS with the only limitation of regulation of cable length as data transmission rate decreases with increase in cable length. This paper describes about design and development of automobile control system using CAN protocol which will not only make driving simpler but also increase vehicle safety and security.

REFERENCES