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Automatic car AC control using CAN protocol

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Abstract: *Present Automobiles are being developed by more of electronic parts for efficient operation. Generally a vehicle was built with an analog driver-vehicle interface for indicating various vehicle status like speed, fuel level, Engine temperature etc., CAN-Control Area Network is a serial communication bus protocol designed to allow microcontrollers and devices to communicate within vehicle without host computer. It's a multimaster broad cast serial bus standard for connecting Electronic control units. The devices connected by CAN network are typically sensors, actuators, transmitters, airbags, antilock braking/ABS, cruise control, electric power steering etc.,the biggest processor being the engine control unit.This paper presents the development and implementation of AC control using CAN protocol.It takes feedback of sensors like temperature, position, fuel sensors and controls car AC with CAN protocol.Additionally the AC is cut off during vehicle collision with the help of a microcontroller.*

***Key words*— CAN, MCP2510, AC, Engine control Unit , ABS**

I. INTRODUCTION

The air conditioning system in a vehicle has three stages of developments. They are:
1 Conventional AC system
2. AC system with integrated electronics
3. AC control using CAN protocol
Traditional air conditioning system did not utilize ECUs for temperature modulation inside the car cabin. They were basically open loop control systems which lacked the utilization of many sensors and provided a direct output without any feedback. Modern air conditioning systems are evolved in terms of the technology used and rely heavily upon a multitude of sensors for effective climate control. This requires microcontrollers, ECUs to analyze the input from sensors and provide a suitable output.
A modern automobile may have as many as 70 electronic control units for various subsystems. Typically the biggest processor is the engine control unit, others are used for transmission, airbags, antilock braking/ABS, cruise control, electric power steering etc. Some of these form independent subsystems, but communications among others are essential. A subsystem controls actuators or receive feedback from sensors. The CAN standard was devised to fulfill this need. CAN is a message based protocol, designed specifically for automotive applications.

II. LITERATURE SURVEY

Vehicle control system implementation using CAN protocol discussed in [1]emphasizes the development and implementation of a digital driving system for a Semi-autonomous vehicle to improve the driver-vehicle interface. It uses an ARM based data acquisition system that uses ADC to bring all control data from analog to digital format and visualize that through LCD. The communication module used here is an embedded networking by CAN which has efficient data transfer. It also takes feedback of vehicle conditions like Vehicle speed, Engine temperature etc.,The development of such a control framework for the vehicle which is called the digital-driving behavior, consists of a joint mechanism between the driver and vehicle for perception, decision making and control.
In [2] CAN has been used as a device which can enhance the utility, performance, speed & security of a system. Two CAN nodes are connected by 2 Mbps CAN bus. Temperature & voltage sensor at one node called as NODE A is connected to CAN through Microcontroller A. The other node called NODE B is connected to Microcontroller B through CAN controller. In Microcontroller B an IR sensor & machine control is attached to exchange the automatic of automobiles. When the sensor at NODE A senses the change in temperature it captures the information and passes it to CAN connected at NODE A. CAN transfers this data to NODE B of CAN and then the NODE B microcontroller displays it on LCD. Similarly the IR sensor is used to sense the light and increase or decrease the speed of motor based on intensity of light.
Furthermore, there is another feature that clearly distinguishes
In [3] CAN protocol differs from other protocols with respect to time-triggered communication.CAN reduces communication overhead and supports a high efficiency and flexibility in the time-triggered traffic.

III. CONTROL AREA NETWORK (CAN)

CAN is a serial communication bus protocol defined in International Standards Organization (ISO). A serial communication bus is basically used to transfer data from one network or point to another point in duplex mode. It was developed for the automotive industry as an alternate to the complex wiring with a two-wire bus. CAN greatly reduces the electrical interference. Noise interference is the transferred signal in the network. CAN introduces an error detection and correction mechanism in the network which is very effective in transferring the correct data and authenticate data through the network. CAN is very popular in industries including building automation, medical, and manufacturing. The CAN communications protocol, ISO-11898: 2003 explains how information is passed between devices on a network. CAN follows OSI model that is defined in terms of different layers.CAN uses only Physical and data link layer of OSI model as shown Fig 3.1. Physical layer of the CAN and OSI model explains the actual communication between devices connected.Two nodes are connected to each other via a physical wired connection. The ISO 11898 architecture defines the lowest two layers of the seven layer OSI/ISO model as the data-link layer and physical layer. Fig 3.1 shows in detail the usage of DLL and Physical layer in CAN.

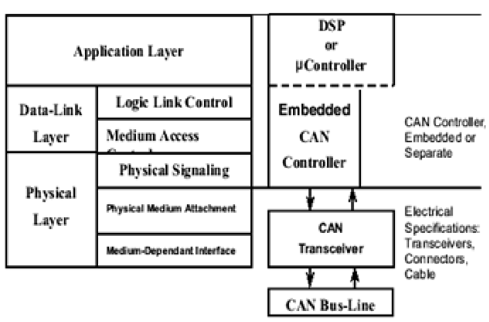

Fig 3.1 AC with integrated electronics

IV. INTEGRATING CAN WITH AC

The control of the car AC system using integrated electronics concept is shown in figure 3.2. This was the second stage of improvement done in control of the car air conditioner system. In the fig 3.2 the control of car AC was mainly based on the following signal status:

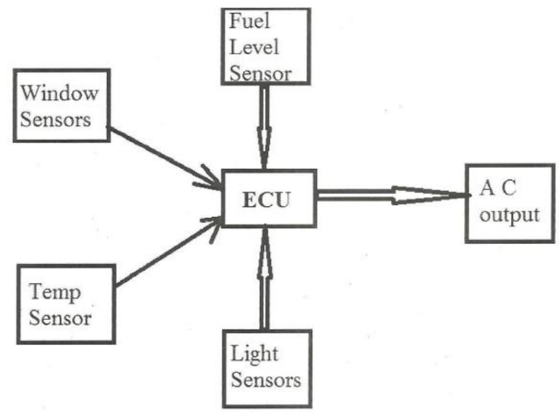

Fig 4.1car AC system using integrated electronics concept

Fuel sensor: This was used to indicate the level of the fuel in the tank. This message was transmitted to the ECU which does the signal processing and sends appropriate commands to control the AC.

Window Sensor: This was used to register the position of all the windows in a car and this signal was sent to ECU which does the processing of the signal and sends appropriate commands to control the AC.

Temperature sensor: This was placed in the car cabin and was used to register the temperature of the car cabin and this signal was sent to ECU.

ECU: Stands for electronic control unit. After receiving the electronic signals transmitted by the sensors, the ECU processes these data in order to generate the control signals for the actuators.

The ECU data transmission took place in the following stages:

Input signals: Analog signals from various sensors are converted to digital signal with the help of AID convertor in ECU microprocessor. Digital signals can be directly processed by a ECU. So it is directly inputted to ECU. The pulse shaped signals are conditioned by special circuits in ECU and converted into square wave form.

Signal conditioning: The effective signal is freed almost completely from superimposed interference signals by the means of filtering and amplified to match the ECU's input voltage. The microcontroller processes only digital signals and hence special program is stored in ROM, The microcontroller consists of EPROM, flash EPROM, nonvolatile read/write memory where relevant data will be stored, Based on these information the ECU processes the input signals from various sensors.

Output signal: The microcontroller triggers the output signals which are powerful enough to drive the actuators.

A. CAN working

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The demand for amount of data exchange between ECUs continues to climb steadily. The conventional data transmission system is unable to handle the increasing exchange of data between electrical components in the vehicle today. It is characterized by binary signals with its own individual conductors. Binary signals can only be transmitted by "one" & "zero". For instance, air conditioner on/off is denoted by either one &zero. On/off ratios cannot be used to transmit continuously changing parameters such as change of acceleration pedal, travelling sensor for instance.

B. Layout of electrical connections before CAN

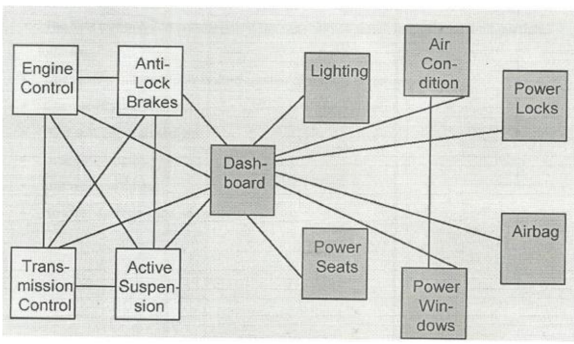

Fig 4.2 The layout of electrical connections in a car before implementation of CAN

The increasing exchange of data between electrical components in the vehicle today makes it difficult to handle via conventional wiring harness and plug-in connectors. Also , the demands of the amount of data exchange between ECU's continues to climb steadily.

B. Layout of electrical connections after CAN

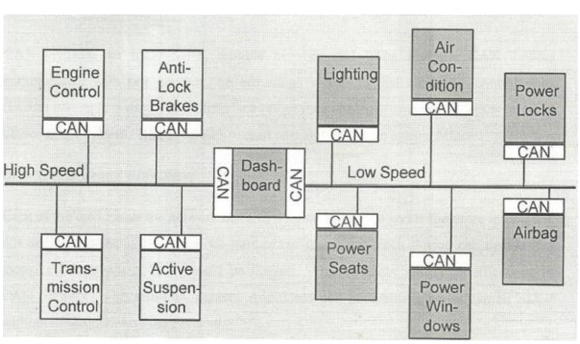

Fig 4.3 The layout of electrical connections in a car after the implementation of CAN

Bus CAN system is specifically developed for automotive application as a replacement for conventional data transmission system. Here, the electronic systems such as engine management system EMS,TCS,ABS are networked with each other. The ECU's are assigned equal priority and connected together using linear bus structure. If one of the station fails all the remaining station will continue to have full access in the network. The probability of the total failure is very much low. Instead of addressing individual stations the addressing scheme used by CAN assigns a label to every message. Each message has its own unique 11 or 29 bit identifiers which identifies the content of message. The given station processes only those messages whose identifiers are stored in its acceptance list ignoring all other messages. The identifier labels both data content & priority of message sent. A signal changes quickly for instance, the signal of engine speed must be transmitted immediately & is therefore allocated a higher priority than a signal which changes relatively slow.

C. CAN format

CAN Frames an entire CAN transmission: arbitration ID, data bytes, acknowledge bit and so on. Frames are also referred to as messages.

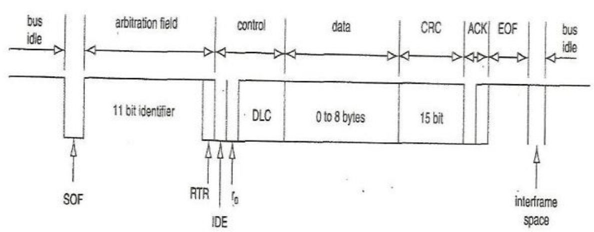

Fig 4.4 CAN message format

The abbreviation of the fields of Figure 4.4 is:

- SOF (start of frame) bit indicates the beginning of a message with a dominant (logic 0) bit.
- Arbitration ID identifies the message and indicates the messages priority. Frames come in two formats - standard, which uses an 11 bit arbitration ID, and extended, which uses a 29 bit arbitration ID.
- The standard CAN frame format IDE (identifier extension) bit — allows differentiation between standard and extended frames.RTR (remote transmission request) bit — serves to differentiate a remote frame from a data frame. A dominant (logic 0) RTR bit indicates a data frame. A

recessive (logic 1) RTR bit indicates a remote frame.

- DLC (data length code) indicates the number of bytes the data field contains. Arbitration field control has 11bit identifier.
- CRC (cyclic redundancy check) contains 15 bit cyclic redundancy check code and a recessive delimiter bit. The CRC field is used for error detection.
- ACK (Acknowledgement) slot — any CAN controller that correctly receives the message sends an ACK bit at the end of the message. The transmitting node checks for the presence of the ACK bit on the bus and re attempts transmission if no acknowledges are detected.
- EOF indicates end of message.

CAN Signal — an individual piece of data contained within the CAN frame data field. Because the data field can contain up to 8 bytes of data, a single CAN frame can contain 0 to 64 individual signals (for 64 channels, they would all be binary).

V. MODEL TO IMPLEMENT CAN WITH PIC

To implement CAN, the following components are connected to CAN-L and CAN-H.

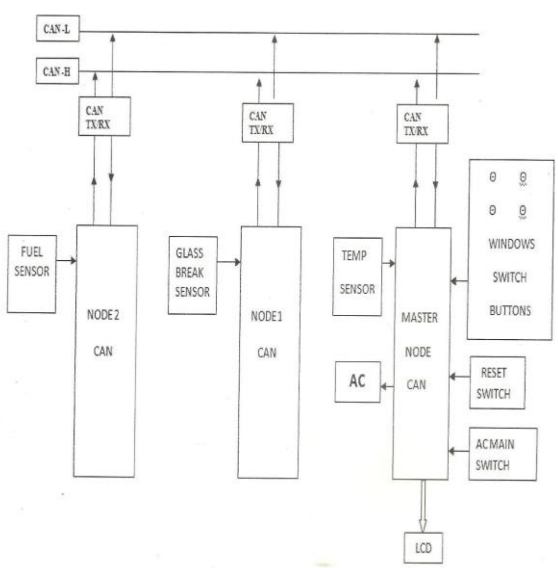

Fig 5.1 Layout to implement CAN

A. Microcontroller (PlC 18F458)

The micro controller is the central component of a control unit and controls its operative sequence. Apart from the CPU, the micro controller contains not only the input and output channels but also timer units, RAMs, ROMs and further peripheral assemblies, all of which are integrated on a single microchip.

B. CAN Transceiver/Receiver

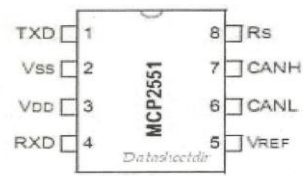

Fig 5.2 CAN Transceiver/Receiver

Transceiver **:** A unit originating a message is called transceiver of that message. The unit stays as transceiver until the bus is idle or the unit loses arbitration.

Receiver :A unit is called receiver of a message, if it is not transmitting any message and the bus is not idle.

C. Liquid crystal display

A liquid crystal display (LCD) is a flat panel display, electronic visual display that uses the light modulating properties of liquid crystals.LCD is used to display any message.A typical LCD display consists of two lines with 8 characters in each line making a total of 16 characters.LCD is used to clearly indicate the status of AC. The different status are as follows:

-AC is on when fuel level is more than 1 .5 liters
- AC is off when fuel level is less than 1.5 liters
- AC is off when windows are open
- AC is on when windows are closed

D. Sensors

A *float sensor* is attached to the fuel tank. The float sensor consists of a float which moves according to the fuel level in the tank. This float is usually attached to a potentiometer or a LVDT which sends the appropriate output signal according to the fuel level. When the output voltage from the sensor reaches a predetermined value, the car AC is switched off and it is displayed on the LCD.

Window position sensors are used to indicate the position of the windows and provide a binary output signal to microcontroller. Toggle switches are simple mechanical devices which are used to convert mechanical action into electrical signals.Toggle switches indicate the position of four windows. These switches are connected to the master node CAN as indicated in the layout.

Temperature sensor is used to sense the cabin air temperature and provide an input to the ECU. The temperature sensor used here is LM35 along with an amplifier LM324.LM35 is a sensor which registers temperature of the vehicle cabin and this gives the output voltage as a function of temperature. LM324 is an amplifier which amplifies the output voltage of the sensor so that it can be matched with input voltage of the ECU micro controller.

Glass break sensor employs a piezoelectric crystal. Piezoelectric crystals have a unique property that they produce electric voltage when they are subjected to severe vibration or shock.Glass break sensor activates when vehicle's front windscreen breaks and this message will sent to ECU micro controller which displays the signal as accident in the LCD.

VI. RESULTS AND DISCUSSIONS

"Control of car AC using CAN protocol" aims to achieve complete automation of car air conditioning using CAN bus standard. The various components are linearly connected on a CAN bus. The CAN bus consists of two CAN lines CANH and CANL (CANHigh and CANLow). In the ideal state the system stays in the CAN-H state, but when a message needs to be transmitted, the CAN transceivers pull the signal to a CANL state. All in all three microcontrollers, PIC 18F458 are used, one host which is the master node and two other microcontrollers which act as slave nodes. Each of the nodes are connected to the CAN bus using CAN transceiver/receivers - MCP2551.The temperature sensor- LM35 and amplifier- LM324 detects the temperature and feeds input to the master node. A buzzer is programmed to beep in case of an accident. Four window position switches are provided for each of the windows which indicate the position of windows. A float sensor is connected to a slave node which indicates the amount of fuel present in the tank and provides a suitable voltage signal if the fuel drops below a specific level. A glass break sensor is connected to another slave microcontroller which sends a stop signal in case of accident.

A. Results

1. Signals from the float sensor are given the highest priority amongst the messages from various inputs. The fuel sensor is calibrated for a 25 litres fuel tank, If the volume of fuel drops below 1 .5 litres, the microcontroller has been programmed to switch off the air conditioner while displaying the remaining fuel quantity.

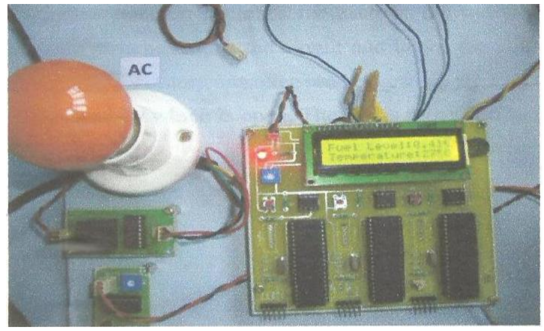

Fig 6.1 LCD indicating low fuel level

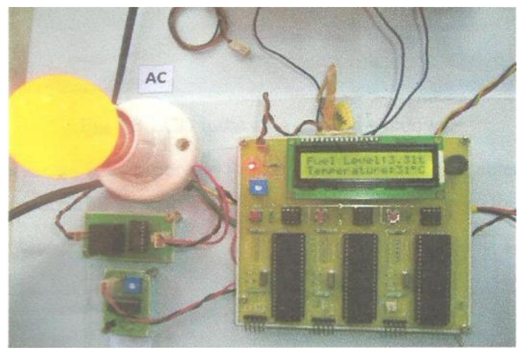

Fig 6.2 LCD indicating high fuel level

2. The temperature sensor is given the second highest priority. It has been adjusted to provide a step voltage if the temperature exceeds 30 degrees centigrade. The microcontroller starts the AC when it receives this step voltage input. In case the cabin air temperature drops below 30 degrees, it automatically stops the compressor and there by the AC as well.

3 There are four window position switches for each of the individual windows The electromechanical toggle switch breaks the circuit and hence the voltage, in case if any of the windows are opened. The master controller sends signal to the LCD, which displays a message indicating the window which is open. The AC is turned off to prevent the loss of power as well as cooling effect.

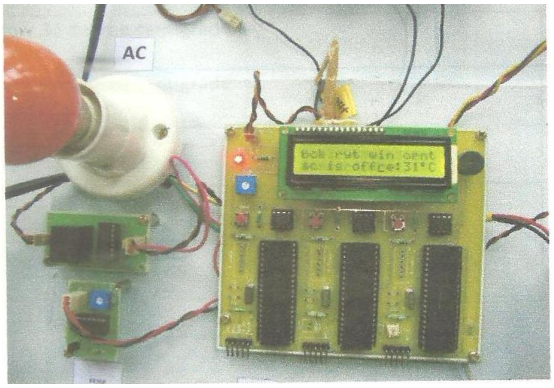

Fig 6.3 LCD indicating opened windows

4. A glass break sensor is incorporated for the purpose of collision detection. In case of accident, the microcontrollers set off the buzzer and cut off power to the air conditioner.

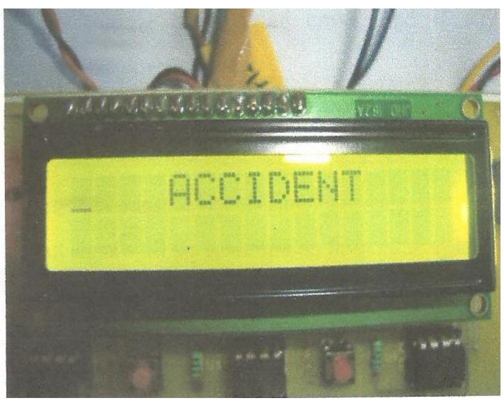

Fig 6 .4 LCD indicating accident

Table 1- List of Results

Sl.No	Parameters	Results
1	Fuel level below 1.5 liters	AC off
2	Fuel level above 1.5 liters	AC on
3	Temperature below 30°C	AC off
4	Temperature above 30°C	AC on
5	Windows open	AC off
6	Windows closed	AC on
7	In case of an accident	Indication/ AC off

B. Advantages

1. The prioritization of messages enables the system to give high priority to the fuel sensor, which is of importance if the fuel level is running low, as the air conditioning system draws engine power which in turn consumes more fuel, which is critical.

2. The system is capable of detecting errors and if any error occurs, the microcontroller shuts down the AC.
3. The master and slave microcontrollers can exchange the information about various parameters with each other.
4. Various systems can transmit signals simultaneously i.e., each system need not wait to transmit signals till the transmission from other systems is complete.
5. Additional microprocessors and sensors could be added to the existing system without any additional modifications.

VII. CONCLUSIONS

To satisfy customer requirements for greater safety, comfort, 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. The complexity of these controls systems and the need to exchange data between them means that more and more hardwired, dedicated signal lines has to be provided. Apart from the cost of the wiring looms needed to connect all these components together, the physical size of the wiring looms sometimes makes 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 poses serious reliability, fault diagnosis, and repair problems during both manufacture and in service.

The problems faced by the previous air conditioning systems were numerous and the AC control based on CAN protocol eliminates all of these drawbacks. CAN protocol helps run the system in an efficient manner, reducing the losses, while taking into account the various system parameters such as temperature, fuel quantity, window position etc. The self diagnostic capability is an added advantage which prevents the system malfunctions. The linear bus transmission coupled with its inherent capability allows other multiple systems to be conjoined to the existing system so that it may carry out multiple functions which may be of need in the future. Further application of CAN includes Engine control such as control of exhaust emissions, power, ignition timing, injector control, valve timing control, control of anti-lock braking system, traction control system.

REFERENCES

[1] “Implementation Of CAN Protocol In Automobiles Using Advance Embedded System” Vikash Kumar Singh, Kumari

Archana- International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 10- Oct 2013
[2] **"**Vehicle control system implementation Using CAN protocol " S. Vijayalakshmi-International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol. 2, Issue 6, June 2013
[3] "The FTT-CAN Protocol: Why and How", Luís Almeida IEEE transactions on industrial electronics, vol. 49, no. 6, december 2002
[4] BOSCH CAN Handbook,4th edition,volume 1,volume 2
[5]An overview of Control Area Network by K.Ratcliff
[6]Internal Combustion Engines by V.Ganeshan

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