DESIGN AND IMPLEMENTATION OF CAN COMMUNICATION SYSTEM FOR AUTOMOTIVE APPLICATION USING HIL

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Abstract- Controller Area Network (CAN) is an effective choice for the automotive industries due to its simplicity, low cost nature, and in addition to that it provides connectivity with multiple nodes with single wiring pair. This paper aims in describing an ARM 7 LPC 2129 based Vehicle Monitoring System with Controller Area Network (CAN) bus. Objective of this paper is to construct a hardware proposal for communication between nodes with CAN bus. A Node to Node communication link has been established which are connected via CAN bus so as to observe and control the different parameter values, transfer on the CAN bus and send the control signals onto the another node. This Hardware is connected in loop with the help of LABVIEW HIL capable of Monitoring and Controlling different signals on CAN.

The system describes the EMS and vehicle monitoring system using CAN interface. The communication between two ECUs through CAN bus. It Senses all the parameters like temperature, Pressure, coolant level, Fuel Level, speed and Lightening from main Sensors of the Vehicle and sends it to the LABVIEW Frontend via HIL. So if there is any fault occurrence, then it can be removed easily and hardware can be tested more effectively.

Keywords- CAN Bus, ARM-7 LPC2129, Vehicle monitoring Parameters, LABVIEW HIL.

I. INTRODUCTION

The main concept of using CAN bus is to enabling any system to communicate with other system without giving too much load to the main controller. CAN bus is a fast serial bus up to the speed of 1 Mbps that is designed to provide an efficient, reliable and economical link between various CAN systems, sensors and controllers.

CAN Benefits

Low-Cost, Lightweight Network

CAN provide an inexpensive, durable network that helps multiple CAN devices communicate with one another. An advantage to this is that electronic control units (ECUs) can have a single CAN interface rather than analog and digital inputs to every device in the system. This decreases overall cost and weight in automobiles.

Broadcast Communication

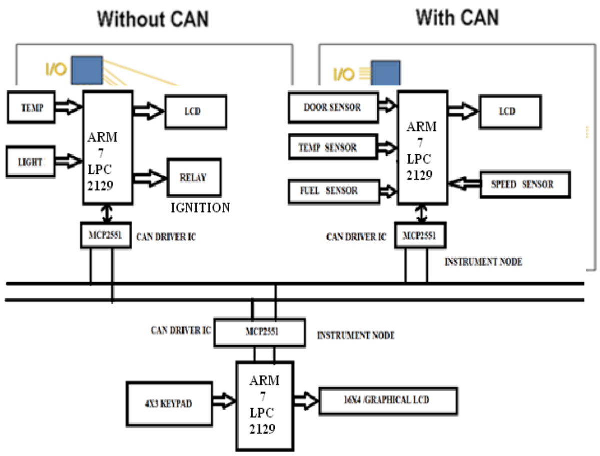
Each of the devices on the network has a CAN controller chip and is therefore intelligent. All devices on the network see all transmitted messages. Each device can decide if a message is relevant or if it should be filtered. This structure allows modifications to CAN networks with minimal impact. Additional non-transmitting nodes can be added without modification to the network.

Priority

Every message has a priority, so if two nodes try to send messages simultaneously, the one with the higher priority gets transmitted and the one with the lower priority gets postponed. This arbitration is non-destructive and results in non-interrupted transmission of the highest priority message. This also allows networks to meet deterministic timing constraints.

Fault-tolerant

If any node has failure then it can removed directly without affecting the other nodes and network operation



before and it was not possible to recognize the problem in any one part and also it was difficult to correct the specific problem.

II. PROJECT CONCEPT

In the proposed system CAN BUS is used for the faster communication among the nodes. It's simple structure which widely reduces the previous complexity problems. Here in the CAN protocol it has two wires for communication, named as CANH and CANL . Different vehicular units can be attached to the High speed or Low speed Bus depending upon the requirement. So it will widely reduce the complexity of the vehicular unit. If any part has failure then anyone can access it without depending upon other parts of the vehicle.

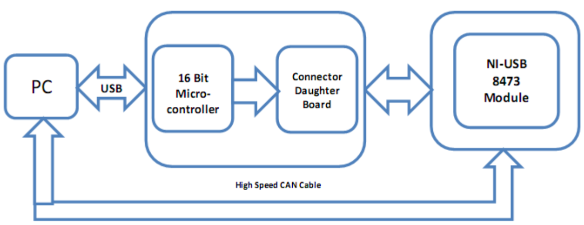


Fig.2:- Block diagram of proposed system

In this project intent is to implement that how to transmit the standard and extended message over the CAN BUS. Message publishing on CAN Bus either 11bit address. or 29bit address .ARM (LPC 2129) Hardware Paired with lamp load profile tailoring, these switches address the requirements of modern lighting systems. LABVIEW is used as HIL system. LABVIEW PXI system is used for communication between the controller and PC

III. HARDWARE IN LOOP -HIL CONCEPT

Hardware-in-the-loop (HIL) simulation is a technique for performing system-level testing of embedded systems in a comprehensive, cost-effective, and repeatable manner.

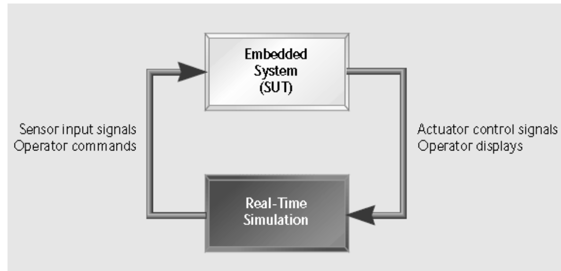


Fig.3:- high-level view of an example HIL simulation

The system is composed of ARM controller, CAN controller, Sensors, LABVIEW HIL and PC and .ARM microcontroller is the key element in processing module which keeps on monitors the Vehicle parameters through HIL System.

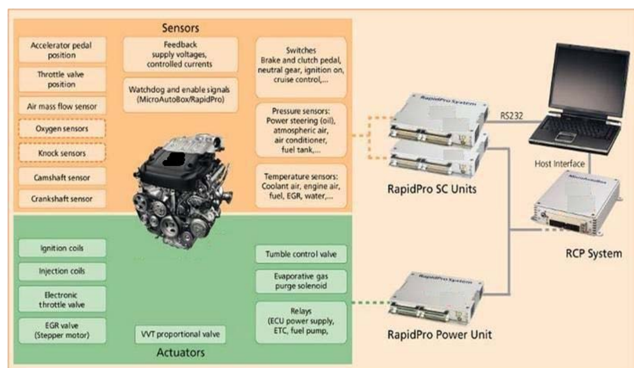


Fig.4:- Generic example of EMS - HIL simulation

IV. THE DESIGN OF HARDWARE

In this project mainly design of the hardware and software Programming for the CAN BUS communication network is done for Automotive Application. Hardware interface circuit mainly consist of CAN communication controller, CAN BUS driver MCP 2551, and design schematic circuit diagram for CAN bus system hardware.

Fig.5:- Block diagram of proposed Hardware

The block diagram in Fig.5shows the hardware components which are placed in the Vehicle ECU. In this system the sensor sense the parameters values and send the data to the ARM controller. The ARM is based on RISC architecture, it's simple design enables more efficient multi-core CPUs and higher core counts at lower cost, providing higher processing power and improved energy efficiency for servers and it reduces costs, heat and power usage [5] this makes data acquisition and processing from the sensor and send it to the PC via HIL.

CAN INTERFACE MODULE:-

CAN interface module is used to communicate between different CAN Nodes. The CAN interface module consists of CAN Transceiver (MCP 2551) and ARM LPC2129.The MCP2551 is a high-speed CAN, fault-tolerant device that serves as the interface between a CAN protocol controller and the physical bus. The MCP2551has differential transmit and receive capability for the CAN protocol controller. It will operate at speeds of up to 1 Mb/s. CAN transceiver is required to shift the voltage levels of the microcontroller to those appropriate for the CAN bus. This will help to create the differential signal CAN High and CAN Low which are needed in CAN bus. This device must be able to withstand voltage tolerance which may be caused by noise pickup.

When data is transmitted from one node to the other node disturbances are occurred. Therefore to avoid these disturbances, to monitor and to identify the fault, CAN protocol is used. CAN is a Message based protocol designed especially for Automotive. CAN interface module is used to communicate the monitored parameters between ECUs

ARM PROCESSING MODULE-ARM Microcontroller LPC2129:-

The data from different sensors is collected at the ARM Processor. The microcontroller used here is LPC 2129.

The LPC2119/LPC2129 are based on a 16/32 bit ARM7TDMI-S™ CPU with real-time emulation and embedded trace support, together with 128/256 kilobytes (kB) of embedded high speed flash memory. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at maximum clock rate. For critical code size applications, the alternative 16-bit Thumb® Mode reduces code by more than 30 % with minimal performance penalty. With their compact 64 pin package, low power consumption, various 32-bit timers, 4-channel 10-bit ADC, 2 advanced CAN channels, PWM channels and 46 GPIO lines with up to 9 external interrupt pins these microcontrollers are particularly suitable for automotive and industrial control applications as well as medical systems and fault-tolerant maintenance buses. With a wide range of additional serial communications interfaces, they are also suited for communication gateways and protocol converters as well as many other general-purpose applications.

KEYPAD

Keypad is basically used to provide the input to the microcontroller. the keypad consist of micro switches which are connected to the microcontroller pins in a matrix format

LIQUID CRYSTAL DISPLAY:-

LCD is used in a project to visualize the output of the application. We have used 16x2 lcd which indicates 16 columns and 2 rows. So, we can write 16 characters in each line. So, total 32 characters we can display on 16x2 lcd.

LCD can also used in a project to check the output of different modules interfaced with the microcontroller. Thus lcd plays a vital role in a project to see the output and to debug the system module wise in case of system failure in order to rectify the problem. The display unit is placed to show the parameters details which acts as the reference for operator in case of checking the working condition

TEMPERATURE SENSOR:-

Temperature sensors are used for sensing the temprature,
Temperature sensor is an analog sensor and gives the output into form of analog signal. This signal is feed to ADC which will convert it into digital form. Once converted into analog form, the microcontroller can process the digital temperature signal as per the application.

FUEL LEVEL SENSOR:
Fuel sensor is used to calibrate the fuel available in a fuel tank. The AKCP Fuel Level Sensor is a float-type liquid level Sensor, used to monitor the fuel level in your storage tank.
Float sensor is used to sense the level of Coolant and level of Fuel.

V. SOFTWARE DESIGN

The software designs for CAN BUS network are mainly the design of CAN BUS data communication and exchange between nodes, and communication processing for switch-signal, analog signal. The design of software communication module includes CAN initialization unit, message sending unit, message receiving unit . Also Labview Hardware in loop System is implemented by designing different Virtual Instruments (VI`s)

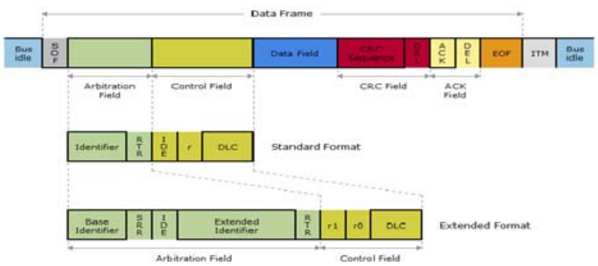
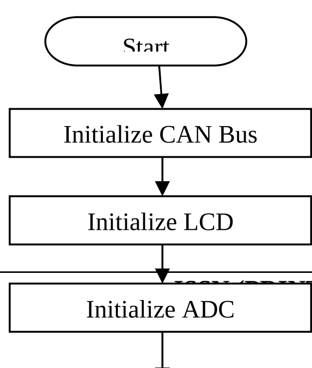


Fig.6:-CAN Message Format

Fig. 6 shows Standard and Extended CAN Message Format



No **Yes**

Fig.7:- Flowchart of CAN Transmission

Fig.7 shows the flowchart for the process of accepting the values from different sensors & transmitting them to CAN

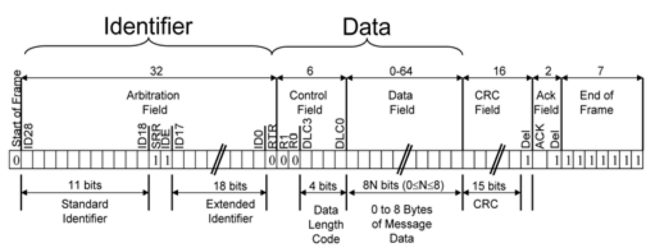


Fig.8:-Extended CAN Message Frame

Fig.8 shows Extended CAN Message Frame structure
Each message has an ID, Data and overhead.
Data –8 bytes max and **Overhead** – start, end, CRC, ACK

VI. RESULTS OF EXPERIMENT

As shown in below images implementation of system is done. In order to check if the hardware is working as per the requirement, an experimental setup is done. In this, system is continuously monitored on the display unit which is on LCD module. Also Set up for LABVIEW HIL is also shown. Below Image.1. shows Hardware Implementation

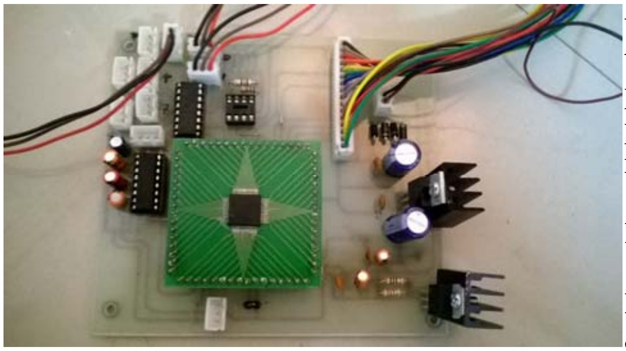


Image. 1:-results of hardware implementation

Below image shows build of a HIL setup demonstrating a Message transfer through CAN and actuating the Pins on NI PXI.

Image. 2:-LABVIEW HIL setup Demonstration

Below image shows the Actual output of CAN Message communication on LABVIEW GUI .The frame is set to received Frame so that the input from the GUI loop module HIL can be verified by checking on the front panel.

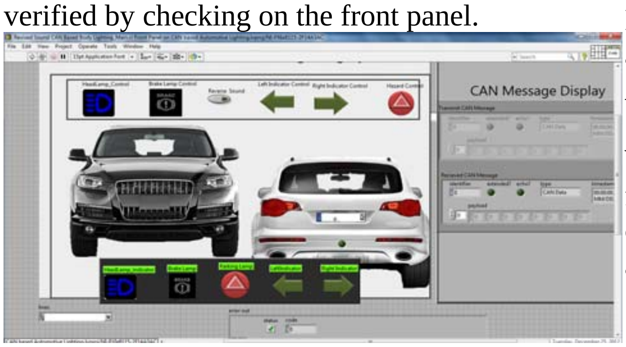


Image. 3:- Output of CAN communication on LABVIEW

VII. CONCLUSION

The project deals with the data transmission between two ECUs using LABVIEW HIL System.The main basic concept of this technique is to reduce the testing cost of ECUs.

In this paper we present the system with ARM and CAN protocol to monitor and control and analysis the problems in the Automotive application. The fault identification is done using HIL and the parameters are measured through the CAN interface module. The CAN protocol is used for serial communication which provides high data transmission rate and reliability.

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