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Design and development of embedded system using CAN Protocol

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Abstract- Automobiles have been an inextricable feature of daily life. The impacts that cars with improved safety systems require in order to compensate for deadly fiascos. Therefore, the present work cites a system based on the protocol Controller Area Network (CAN) which provides an effective and real-time information transfer solution between nodes, is used for preventing vehicle failures and assists drivers with information and message-based instructions. The proposed framework, which uses the CORTEX ARM LPC 1768 chip, specifies four key objectives related to automobile protection in this article. The proposed device uses the CAN protocol, which only requires two wires to communicate, rather than complex wiring.

Keywords— *CAN (Controller Area Network), Embedded C, GSM (Global System for Mobile (communication)), Sensors.*

1. INTRODUCTION

Vehicles are changing these days, with higher speeds and technical advances, as well as more serious accidents. Automobile producers were more focused on improving vehicle safety and avoiding accidents and deaths. People generally prefer automatic transmission vehicles because of the ease with which they can operate. Four safety measures are incorporated in our project.

An obstacle detection system employs ultrasonic sensors located on the front and/or rear bumpers. Ultrasonic sensors assess the distance between the driver and surrounding obstacles immediately around the front or rear bumper, and the vehicle's speed decreases. Beeps or the dashboard monitor notify the driver. When the vehicle approaches the barrier, the vehicle's speed decreases. The speed can vary depending on the distance between the obstacle and the driver. If a crash is inevitable, the vehicle will come to a complete stop. Our first safety measure in this project is a speed limit based on obstacle detection.

Increased engine temperature is the second safety factor. Increased engine temperature may be caused by a broken thermostat or a failed water pump gasket. If the temperature rises too high, the engine could be overheating. A temperature sensor may be used to verify this.

Auto headlight ON/OFF is the third safety feature. Headlights are not needed during the day, but they will turn on automatically at night. When someone driving in the opposite direction uses a high, light beam while driving at night, a sudden glaring impact occurs for a brief period of time. As a result, depending on the light intensity of the opposite vehicle, the driving car's headlights can dim automatically.

CAN (Controller Area Network) is a LAN (Local Area Network) controller that can transfer serial data one by one. The construction of an automobile is seen in Fig 1. Both representatives of the CAN bus subsystems send and receive data via the control unit on the CAN bus interface. A multi-channel transmission scheme, the CAN bus. When one device crashes, it has no bearing on the rest of the system. In a vehicle configuration, the data transmission rate of the CAN bus varies. For e.g., In real-time control mode, the engine control system and ABS run at a high rate of 125Kbps to 1Mbps. The rate of movement change, on the other hand, is slow, with a transmission rate of 10 to 125K bits per second. Others, such as video networks, operate at a medium-speed rate in between the two. This method distinguishes multiple channels and improves transmission reliability.

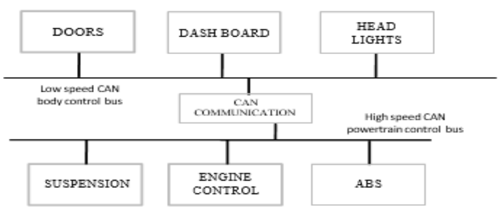


Fig 1. CAN bus system in an Automobile

2. PROPOSED SYSTEM

The goal is to develop a CAN protocol for automobiles that will help to improve vehicle safety and reduce accidents and deaths. The aim of this proposed system is to convert a wired link package into a two-wire connection.

A. Objectives

- The first objective we have considered in our project is the obstacle detection and controlling of speed of the vehicle.

This can be achieved using ultrasonic sensor. The communication between the nodes is done using CAN protocol which is further discussed. The distance between an obstacle or a vehicle in front of our car is measured and according to the distance reduction, the speed also will reduce. If the distance is too small, the car will automatically stop.

- The second objective considered is temperature sensing using a temperature sensor. The temperature from the surroundings is sensed which has applications in controlling the engine compartment temperature.
- The third objective considered is the light dimming using a LDR sensor. This is done to control the glaring effect. When the light intensity level of the headlight is at a high value, a signal is communicated using CAN to reduce the level of light intensity.
- The fourth objective considered is to get the average fuel consumed using fuel level sensor. The fuel level sensor detects the level of fuel and indicates when the fuel reduces to a very low value.

C. Organization of The Paper

The paper is organized as follows: Section III explains system design. Section IV provides results and analysis. Section V the conclusion and future work.

3. SYSTEM DESIGN

This section covers the block diagram, flow chart, reference model, data flow diagram, and the hardware implementation process for the design and development of embedded systems using CAN protocol.

A. Block Diagram of Proposed System

The CAN vehicle control scheme is depicted in block diagram form in Fig 2. One master node and two slave nodes make up this network. The master controller (Engine Control Module) of the ARM is in charge of monitoring the vehicle's status using different sensors. For receiving vehicle status inputs, two PIC ICs are used as slave nodes. A CAN controller is used to communicate with these sensors. The slave controller receives signals from vehicles such as friction, temperature, fuel level, IR obstacles, and GSM, and transmits them to the master controller at a high rate. By providing digital information through LCD monitor and alarms, the master monitors the status of the vehicle and sends input to the operator panel. The operator interface is of the digital kind in this case. The user can clearly see the signs and monitor the car as a result of this. The presence of obstacles around the vehicle is detected by the IR obstacle sensor.

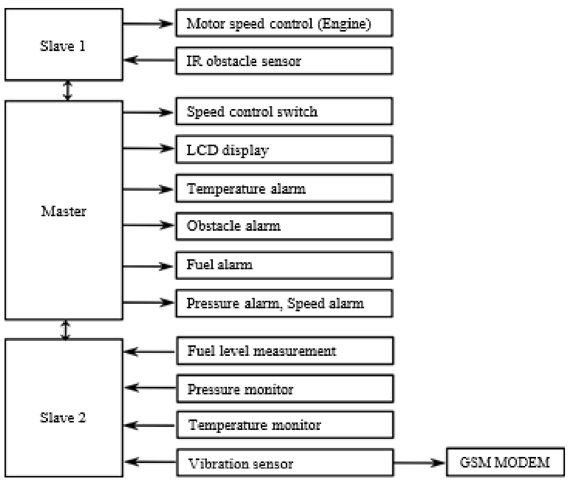


Fig 2. Block diagram of proposed system

B. Flow Chart of Proposed System

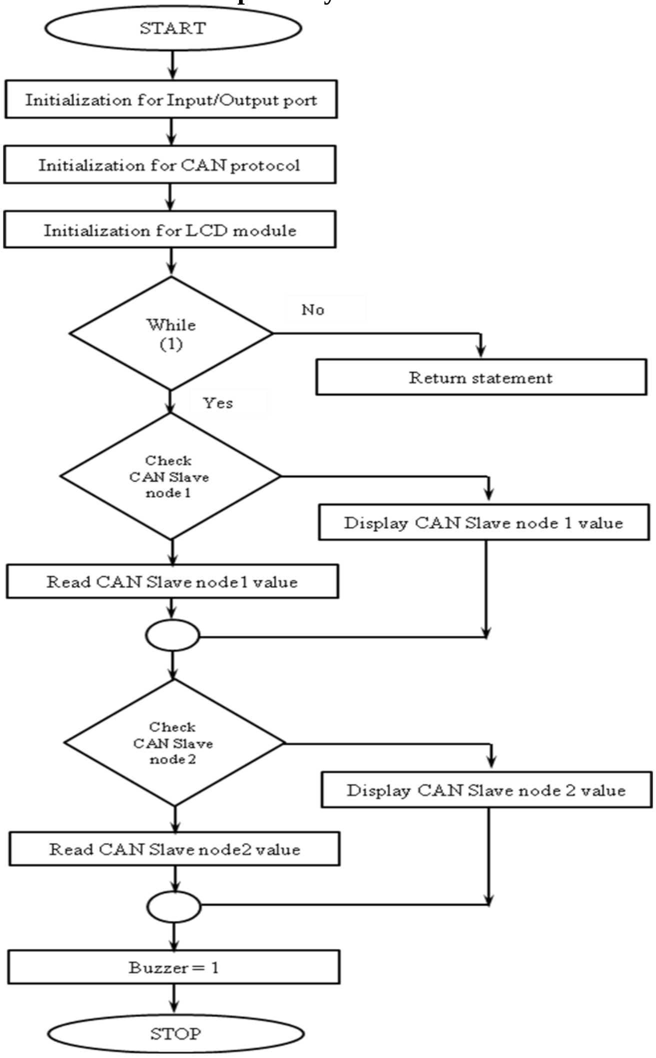


Fig 3. Flowchart for program

The CORTEX ARM LPC 1768 is used to debug the vehicle control mechanism, which is coded in Embedded C. The flowchart for an embedded C application for a vehicle control system using the CAN protocol as shown in Figure 3.

C. Reference Model of Proposed System

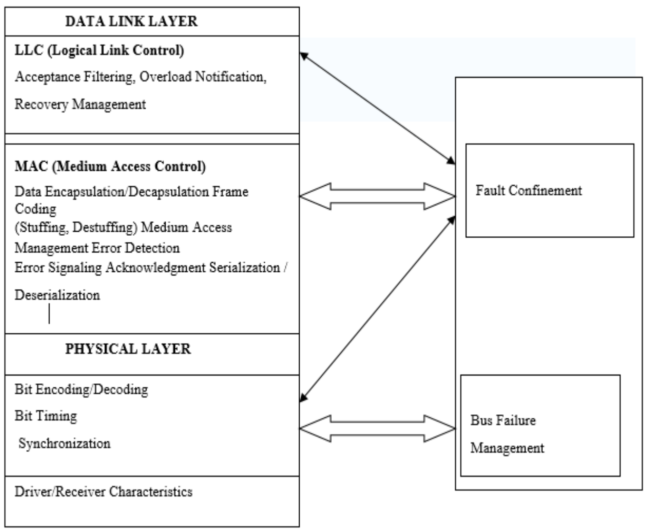


Fig 4. Reference model for CAN protocol

The Physical Layer is in charge of defining Bit Timing, Bit Encoding, and Synchronization, as well as how signals are sent. The Physical Layer Driver/Receiver Characteristics are not defined in this specification, enabling transmission medium and signal level implementations to be tailored to their needs. Message Filtering, Overload Notification, and Recovery Management are all handled by the LLC (Logic Connection Control) sublayer.

The MAC (Medium Access Control) sublayer specifies the kernel of the CAN protocol. It shows LLC sublayer messages and recognises them for transmission to the LLC sublayer. The MAC sublayer is responsible for message framing, arbitration, acknowledgment, error detection, and signalling.

The MAC sublayer is overseen by Fault Confinement, a self-checking method for distinguishing short disturbances from lasting faults.

The aim of this specification is to describe the Data Link Layer as well as the effects of the CAN protocol on the layers above it.

D. Data Flow Diagram of Proposed System

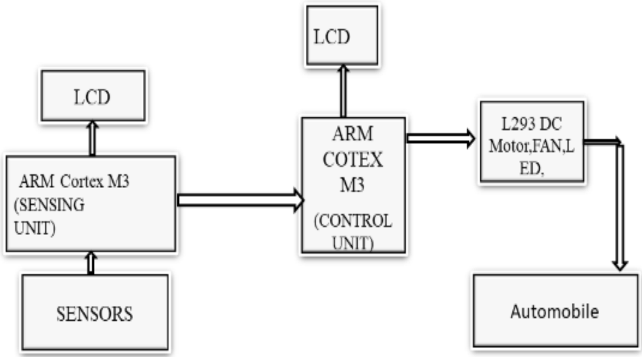


Fig 5. Data Flow Diagram

The data flow diagram for vehicle monitoring and control is shown in Figure 5. It is made up of two controllers (ARM Cortex M3). One is referred to as a master controller, and the other is referred to as a slave controller. The master controller tracks the sensors, while the other controls the actuators (slave controller). All sensors are connected to the master controller, which tracks each sensor every 10 microsecond and updates the slave controller with the results. The slave controller sends signals to the appropriate actuator based on the status information obtained from the master controller.

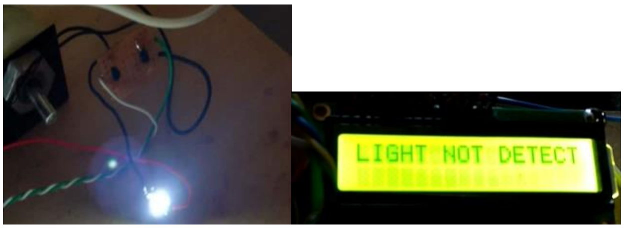
E. Hardware Implementation

The CAN protocol must include the hardware components that must be installed.

- Arm Cortex M3 (LPC1768)
- Ultrasonic Sensor (HC-SR 04)
- Temperature Sensor (LM35)
- Light Dependent Resistor
- DC Motor
- LCD

4. RESULT AND ANALYSIS

The project was designed to address the majority of the problems that could arise in any device and was optimised for scalability. The sensors are set up and connected to the ARM Cortex M3 controller to receive data such as distance, temperature, fuel level, and light indication. This controller is set up to process data from the vehicle's parameters and display it on the LCD.



In the above result as shown in the figure, we observe that when there is no light around, the headlight intensity will be at a high level depicts LCD which displays “LIGHT NOT DETECT” according to the LDR monitored values.

In the above result as shown in the figure we observe that when there is light around, the headlight intensity will automatically get dimmed depicts LCD which displays “Light detected” according to the LDR monitored values.

Fig 6. Ultrasonic sensor and object at 7 cm distance which is displaying in LCD

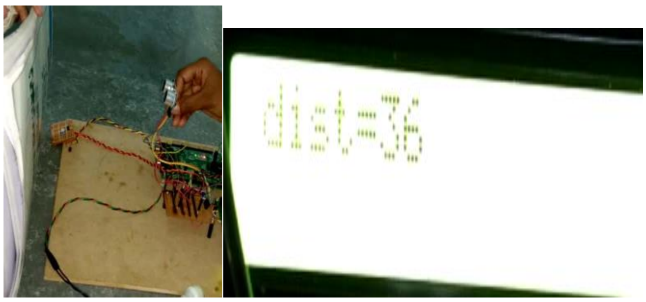


Fig 7. Ultrasonic sensor and object at 36 cm distance which is displaying in LCD

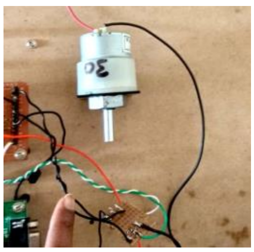


Fig 8. DC Motor

The speed of the automated vehicle increases/decreases/stops according to the distance between vehicle and vehicle/obstacle.

A threshold value is set for 16 cm. Fig 7 shows an ultrasonic sensor and object are at 36 cm distance, hence the motor runs at a high speed. The value of the distance is displayed on LCD in fig 7. Fig 6 shows an ultrasonic sensor and object are at 7 cm distance, hence the motor runs at a low speed. As the distance is decreased to a value less than 5cm, we observe that the motor stops running. The value of the distance is displayed on LCD in fig 6. The motor is displayed in the fig 8.

Fig 8. Temperature sensor and LCD displaying surrounding temperature

The fig 8 depicts a temperature sensor. This temperature sensor is placed near the engine to sense its temperature and shows LCD which displays the value of the surrounding temperature.

5.. CONCLUSION AND FUTURE WORK

Instead of complex wiring, the suggested device communicates using the CAN protocol, which only needs two wires. The parameters in a vehicle are managed using the CAN protocol, and appropriate controls are made for each parameter. We can use the automatic car parameters in any vehicle because they are very inexpensive. CAN is the best protocol for communicating between multiple controllers.

Various conditions, such as automatic horn volume change, wheel pressure and temperature, automated fuel indicator with mileage display, automatic exhaust gas controller, and so on, will be monitored and controlled in the future. This process can be used in businesses to simplify them. Our project focuses on vehicle-to-vehicle connectivity, although it can be extended to include vehicle-to-vehicle (V2V) communication (vehicle to vehicle communication). Protection precautions could be added to car communication in order to render it driverless.

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