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A detailed review on self propelled safety monitoring system using can protocol

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Abstract. The vehicles are commonly used for transportation in everyday life. The safety is more important for automotive vehicles. In existing system the main snags are the vehicles should maintain an normal distance among them, closer the distance may leads to accidents. The fault occurs due to short circuit in electrical line in the vehicle. Gas leakage in vehicle cause severe accidents. Faults due to increase in temperature on engine. Higher sound in horn which cause disturbance in restricted surroundings. The readings are monitored by using GSM (Global System for Mobile Communication) and GPS (Global Positioning System)modules for accessing the location and sends the alert message to the user .In unexpected situations if accidents occur it alerts the rescue person or trusted persons by sending an alert message to them. The proposed method contains two modules Master and Slave and they are communicated using CAN (Controller Area Network).The hardware of these two modules are developed and the active safety system was achieved with high performance and less cost.

Keywords: Controller Area Network, automotive safety, fuel level monitoring, GSM, accident detection, temperature, gas leakage prevention

1 Introduction

The proposed system is mainly used for the monitoring and alerts the driver and the rescue or other persons during the abnormal conditions in the automotive vehicle. The CAN protocol is mainly used for communicating the Master and Slave modules. Each module contains sensors for monitoring and information's are displayed in LCD screen. During abnormal conditions it send message to the other trusted person.

In this proposed system the included measures are,

- The first one is to maintain the distance among two vehicles. If the vehicles are too closer may leads to damages or accidents. It can be overcome by IR (Infra Red) sensors which actively monitors the distance.
- The second one is to reduce the short circuit faults at the vehicle wiring connections.
- The third one is the gas leakage detection and prevention.
- The fourth one is a temperature monitoring in an automotive engine location.
- The fifth one is to automatically adjust horn sound for the respective surroundings.
- To rescue the persons in vehicle during accidents or abnormal conditions.

2 Literature survey

Farsi et al.[13] made an overview about control area network. Tao et al.[38] discussed about the principle and applications of CAN field bus, Jimenez et al.[24] made a design regarding top down design for the train communication network. Young in[10] proposed a research application using CAN bus in fault detecting system

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of locomotives. Richardson et al.[41] introduced an adaptive real time intra vehicle network protocol for intelligent vehicle systems. Johansson et al.[26] introduced vehicle application of controller area network. Chen pu in [8] developed a CAN protocol for railway locomotives. Steve corrogan in [9] made an introduction regarding controller area network. Matthew Jensen et al.[23] observed the steering wheel haptic feedback will be provided to increase the drivers' knowledge of the roadway and driving conditions. This increased knowledge should enable the driver to avoid obstacles presented in the roadway earlier than without any feedback.

It uses a high - fidelity driving simulator to introduce supplemental feedback to the driver as part of an obstacle avoidance steering based warning system. Seongwoo Kim et al.[30] reported a new methodology for the optimal VCN design. The VCN design was first defined as the temporal and spatial joint optimization problem, and some of the challenges in solving the problem were presented. To meet the challenges, an analytical model for examining the fundamental characteristics of the problem was derived. A repeated matching-based fast solution method was next provided to optimize the VCN design. Seongjin Yim[50] designed a preview controller method for rollover prevention has been proposed. Differential braking and active suspension have been adopted as actuators. Under the assumption that the steering input is previewable, the rollover prevention controller has been designed with LQ SOF preview control. Goh Chin Hock et al.[19] developed a wireless controller area network (CAN) using low cost microcontroller. The system is low cost and low power consumption for CAN application in order to receive data such as velocity, temperature and batteries power from Maximum Power Point Tracking (MPPT). Jankovic et al.[21] approached the CAN based monitoring the vehicles mechatronics systems can significantly reduce time for vehicle instrumentation and enable development engineers to conduct testing in already existing vehicle before making the prototype of the new vehicle or system under development. Piao Chang-haol et al.[36] developed a net monitor system used to real-time monitor the state of the Controller Area Network bus was designed.

In the system, two while loops compose a producer consumer pattern which is the main program structure. Chuliang Wei et al.[48] introduces a built network for data CAN transmission after the data acquisition (DAQ) from the required temperature sensors mounted on a car engine and a train bogie in two respective tests. LabVIEW is the only applied software throughout this network design based upon the industrial widely use. Chuliang Wei et al.[47] present a virtual instrument based control system for research and development of the automotive and railway industries. This creative, low cost, efficient, and practical system contains the applications of data acquisition, controller area network ,harmful engine exhaust emissions reduction, and spot welding. The system should be able to be employed in various automation industries due to its flexibility. Ge Guo and Wei Yue[15] investigate a control design for the platoon of automated vehicles whose sensors have limited sensing capability. A novel hybrid platoon model is established, in which actuator delay (e.g., the fueling and braking delay) and the effect of sensing range limitation are involved. Ramya and Palaniappan [37] design an embedded system for a vehicle cabin, which senses the gases like carbon-monoxide and oxygen and displayed at each and every second. If the level of the CO increases than the normal level (30ppm) or the level of the oxygen decreases than the normal level (19%) then an alarm is generated automatically and also ventilation is provided immediately. A warning message is sent to the authorized user via GSM. Matthew et al.[18] implemented a simple linearly scalable 1-W infrared (IR) transmitter, which is centrally located on the ceiling of a sports utility vehicle (SUV), and for 15 passenger configurations, an analysis into the received power, power deviation, minimum bandwidth, and maximum root-mean-square (RMS) delay spread is provided for the regions of the vehicle most likely to benefit from the deployment of intra vehicle optical wireless (OW) communication systems. Seok-Chul Kwon et al.[32] proposed a new geometry-based channel model for wide-band polarized body area network channels consisting of four propagation modes: cylindrical-surface-scattering (CSS) for above ground off-body scattering, body-scattering (BS) for body diffracted and on-body scattering, ground-scattering (GS), and line-of-sight. Amrutha et al [2] focuses on building an user-friendly device that specializes in detecting intrusions besides doing close range obstacle detection. Automobile safety can be improved by anticipating a crash before it occurs and thereby providing additional time to deploy safety technologies. Sudharshan Reddy et al[40] developed an Advanced SMART Automobile Safety Information System. By using MEMS accelerometer and GPS tracking system we can get the information of accidental occurrence through GSM module. MEMS is a Micro electro mechanical sensor which is a high sensitive sensor and capable of detecting the tilt. The device is capable of performing all the tilt functions like forward, reverse, left and right directions. Vikash Kumar(1) Singh and Kumar(1)i Archana[3] describe the benefit of control systems with network architecture over traditional systems with a central processor.

A suitable standard protocol, CAN, is briefly presented and its current and future use in automobile machines is discussed. An important task is to find a way to make it possible to use standard network modules from different producers in a network specially designed for a specific machine. Paolo Giani et al.[14] describe one of the first contributions in this area, analyzing all the aspects related to this control problem. Specificall, this work provides two main results: an objective quality assessment of the gear-shifting performance and a new gear shift control strategy that optimizes the tradeoff between duration and comfort. Elbert et al.[12] analyzed the globally optimal engine ON/OFF conditions are derived analytically. It is demonstrated that the optimal engine ON/OFF strategy is to switch the engine on if and only if the requested power exceeds a certain non constant threshold. By iteratively computing the threshold and the power split using convex optimization, the optimal solution to the energy management problem is found. Joerer[25] defines a collision probability estimation scheme that allows assessment of the criticality of an intersection approach based on exchanged beacons, such as CAMs or BSMs. Given information about two approaching vehicles (such as their current position and speed), we are able to derive potential future trajectories and calculate the probability of a crash. Pushkin Kachroo[27] presents the overall framework for high performance vehicle streams that integrates the transportation and the communication layered architectures together. It shows the process in establishing an infrastructure for high-performance vehicles and the theoretical development and deployment of cooperative adaptive cruise control (CACC) for heterogeneous vehicles that is integrated with lateral control. Song[43] proposed a feature points are extracted using an improved Moravec algorithm.

A specially designed template is used to track the feature points through the image sequences. Then, trajectories of feature points can be obtained, whereas unqualified track trajectories are removed using decision rules. Finally, the vehicle behavior analysis algorithms are applied on the track trajectories for traffic event detection. Deng and Zhang[11] focuses on technologies still can't prevent the traffic accident very well, this brings new study on the active safety technology based on various factors of traffic accidents .It focuses on how to prevent the collision and accidents and look on the human condition, road condition monitoring. Jayapriya and Prabhakaran[22] developed a system is fully prevent accident in real time. It will be fully automatic control. It saves time as well as control this also helps to maximize profit margin in utility company working in vehicle manufacturing. In future enhancement will be provided for safety and security of vehicle. It will fully avoided for vehicle theft. It will by passing of vehicle when the collision of traffic occurring in it. Ashwini et al.[4] describes the basics of CAN Bus protocol can be understood. The software and hardware can be used to construct a fully working CAN bus for vehicle automation, at various levels of complexity. We can adapt GUI design to make CAN Analyzer more powerful, versatile tool for the development, testing and servicing of Controller Area Net-work based systems. Kumar and Ramesh[31] proposed a protocol has its own advantage and disadvantage but one common problem faced by vehicle OEMs is the significant increase of Electronic control units leading to chocking problem in power train network. TTCAN, FTTCAN are new concept proposed for improving the speed of power train network. Lu et al.[35] presented an overview of the state-of the-art wireless solutions to vehicle-to-sensor, vehicle-to vehicle, Vehicle -to- Internet, and vehicle-to-road infrastructure connectivity. The biggest challenge for efficient and robust wireless connections is to combat the harsh communication environment inside and/or outside the vehicle. Vivek et al.[46] developed an applications both in lab and real field environment. The applications include speed limit and driver advisory. This can be overcome by extracting the speed from a Controller Area Network bus. This can be further improved upon by using Differential GPS (DGPS) so that we can get micro level position information targeting lanes, road intersections. Khosravani et al.[28] describe a new formulation of the problem that involves a driver model and a linear vehicle model is proposed. The proposed controller provides the desired values for a torque distributor and each tire force is calculated by the former controller using torque vectoring technique. Kim et al.[29] developed a novel tire-road friction coefficient estimation method based on 6-DoF acceleration measurement was proposed and validated under longitudinal emergency braking maneuvers. Experimental results indicated that tire-road friction coefficient could be estimated by the proposed method accurately in real-time during longitudinal emergency braking, and its relation to tire slip was consistent with the anticipated physical trends. Liu et al.[34] focused on improving positioning accuracy in vehicular networks using GPS pseudo range measurements. Two algorithms, namely WLS-DD and DLEA, are proposed to enable the cooperative positioning. An extensive simulation study demonstrates that the proposed solutions can effectively improve the positioning accuracy under a variety of conditions. Belyaev et al.[5] proposed a low-complexity unequal packet loss protection and rate control algorithms for a scalable video coding based on the three-dimensional discrete wavelet transform. IEEE 802.11p communication technology makes it possible to introduce new automotive applications, which make use of broadband vehicle-to-vehicle and vehicle-to-roadside connectivity. We have developed and evaluated a new surveillance system aimed at improving public transport security and road traffic control. Shih and Tsai[42] proposed a convenient indoor vision-based parking lot system using wide-angle fish eye-lens or catadioptric cameras. This is easy to set up by a user with no technical background. Easiness in the system setup mainly comes from the use of a new camera model that can be calibrated using only one space line without knowing its position and direction, as well as from the allowance of convenient changes in detected parking space boundaries. Albesa, and Gasulla[1] observed the use of inductive links to wirelessly power an autonomous sensor in a vehicle application. The selected application is intended for occupancy and belt detection in removable vehicle seats, where wiring the seat detectors from the vehicle chassis is impractical. The autonomous sensor includes seat detectors and a wireless transceiver to transfer the data on the state of detectors. Zhang et al.[51] present VProof, which is a vehicle location proof scheme that enables a vehicle to prove that its location claims match its historical locations. With VProof, vehicles construct their location proofs by simply extracting relevant contents from the packets received from road side units. Dnyandeo et al.[20] analyze a vehicle control system Implementation Using CAN Protocol. In this paper we have given an effective way by which we can increase the car safety. This paper presents the development and implementation of a digital driving system. The ARM based data acquisition system that uses ADC to bring all control data from analog to digital format. Narasimha et al.[7] presents two Electronic locking Systems. First system uses Radio Frequency (RF) module to unlock the door from remote control. Where in if user presses the remote key to unlock the door of car signal transmitter in the Remote transmits the signals to the RF Receiver which is at the door of the car. The Signal sent by the RF Transmitter to the RF Receiver is unique code so the door cannot be either locked or unlocked without this remote. Sreevishakh and Dhanure[44] made a detailed survey various technologies used for automatic accident prediction as well as notification system.

For accident prediction system, the excellent features of AMR and sonar sensor leads to the development of a vigilant module.Radar and laser sensors need to be replaced because of their high cost and will not work at short distances. Magneto-resistive sensors are previously used for traffic intensity measurements,vehicle detection in parking applications,they are used for the first time in combination with sonar sensors for automotive crash prediction and notification system. Tuohy et al.[45] present a comprehensive overview of current research on advanced intra-vehicle networks and identifies outstanding research questions for the future. Current vehicles generally employ a number of different networking protocols to integrate these systems into the vehicle.

The introduction of large numbers of sensors to provide driver assistance applications and the associated high-bandwidth requirements of these sensors have accelerated the demand for faster and more flexible network communication technologies within the vehicle. Vaghela and Shah[39] describe an efficient usage of available bandwidth and achieve a low-latency in delivering realtime information in various situations in VSN. One of the most prominent issues in vehicular networks regards the quick and scalable delivery of data among all participants that share the same application. Mingchang Zhao et al.[52] design a systems and use in smart vehicles. Particular attention is given to vision-based techniques because they are considered among the most accurate systems used to identify targets and to measure the distance from them to a vehicle. Alin Mihai Cailean and Mihai Dimian [6] focused on the design of the VLC sensors intended for vehicular communication applications, offering a review of the solutions found to mitigate the effect of the problematic conditions. Furthermore, summarizes these solutions and proposes an environmental adaptive VLC receiver that would be capable to optimally adjust its settings in order to maximize the communication efficiency, but without affecting the communication robustness to noise. Chiyoung Lee et al.[33] proposes and implements VADI, (Virtualized Automotive Display) which is a new architecture to support the digital cluster on the consolidated hardware. VADI concurrently processes graphic commands for two isolated execution domains using one GPU device and draws their frames in one display device. Moreover, VADI protects the GPU and display device from non trusted software using Trust zone and indirect GPU access mechanism. Samuel Woo et al.[49] propose security architecture for in-vehicle CAN-FD as a countermeasure (designed in accordance with CAN-FD specifications). We considered the characteristics of the International Organization for Standardization (ISO) 26262 Automotive Safety Integrity Level and the in-vehicle sub network to design practical security architecture. Harwich et al.[16, 17] discussed about CAN network which is used for time triggered communication and flexible data rate. The literature survey reviles few recent papers on CAN protocol and automotive vehicle safety.

3 Can protocol and standards

The CAN is a serial bus communication protocol developed by Bosch in early 1980's.The CAN protocol is based on bus topology that needs two wires for communication over a CAN bus. The bus structure is a multi master, where each device on the bus can receive or send data. One device can send data at any time while all others listen. If more devices try to send data at the same time, the device which has highest priority is allowed to transmit the data while the others return to receive mode. Fig. 1 shows the block diagram of CAN protocol. The CAN protocol is based on collision detection method CSMA CD + AMP (Carrier Sense Multiple Access/Collision Detection with Arbitration on Message Priority protocol, which is similar to Ethernet LAN (Local Area Network) protocol. When Ethernet detects a collision, the nodes simply stop sending and it wait for a random time period before trying to transmit again. However, the collision problem can be solved by using the principle of arbitration, where only the node having highest priority is given the right to send data. Device connected to the bus have no address, which means messages are not sent from one node to another node based on the addresses. Instead, all nodes in the system receive every message transmitted on the bus, and each node will decide whether the received message should be saved or discarded. The CAN bus offers, remote transmit request (RTR) that means one node can able to request information from the other nodes in the CAN bus. Thus waiting for a node to send data continuously a request for data can be sent to the node. For example, in a where the engine area temperature is an important parameter for the system and it can be designed so the temperature is sent periodically over the bus. The Fig. 2 shows the implementation of CAN protocol. The CAN bus also contains bit stuffing, it is a method which periodically synchronize the transmit - receive operations and to prevent timing errors between receive nodes. After every 5 continuous bits with the same level, one bit of inverted data is added to the sequence. The physical layer of the model is used to communicate devices that have connected physically. The ISO 11898 architecture defines the lowest two layers of the seven layer OSI/ISO model as in the data-link layer and physical layer in Fig. Fig. 3 The ISO-11898 CAN bus specifies that a device on that bus must be able to drive a forty-meter cable at 1Mb/s. A much longer bus length can usually be achieved by lowering the bus speed.

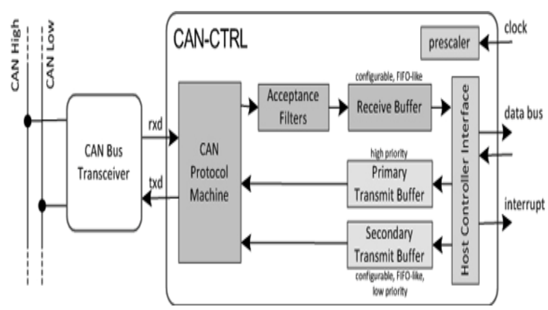

Fig. 1: Block diagram of CAN protocol

Actual communication between devices connected by the physical medium is defined by the physical layer of the model. The ISO 11898 architecture defines the lowest two layers of the seven layer OSI/ISO model as the data-link layer and physical layer in Fig. 3.

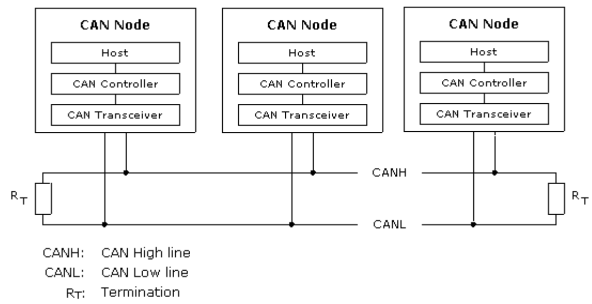

Fig. 2: Implementation of CAN protocol

In the application layer establishes the communication link to an upper-level application specific protocol such as the vendor-independent CANopen^{TM} protocol. This protocol is supported by the international users and manufacturers group, CAN in Automation (CiA).

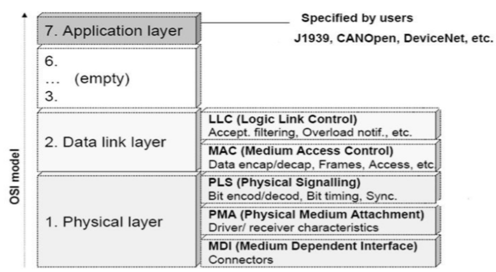

Fig. 3: The layered ISO 111898 standard architecture

4 Proposed work

In this proposed work, the main objective is to monitor and alert the driver and the rescue persons by monitoring the various parameters such as distance among two vehicles, gas leakage detection, automatic horn volume adjustment according to the surroundings, monitoring the engine area temperature and accident detection and alert the rescue persons by sending message which contains the information like.

Latitude and Longitude and fault information's during abnormal situations like gas leakage detection etc.

It contains Master and Slave Modules, the sensors are connected to each module separately. The Master Module contains GSM, GPS for communication, sensors like Gas sensor, IR sensor and Accident detection switch are interfaced. In Slave module, Temperature sensor, RF transmitter and receiver and current sensor are interfaced.

5 Sensor operation

In this proposed work seven sensors are used for monitoring. The sensors presented in slave module are temperature sensor, current sensor, RF transmitter and receiver and in Master module, GSM, GPS, gas sensor, IR sensor and a switch which is used for activate during the accident. The each sensor has a separate working principles and operating ranges and it is described below.

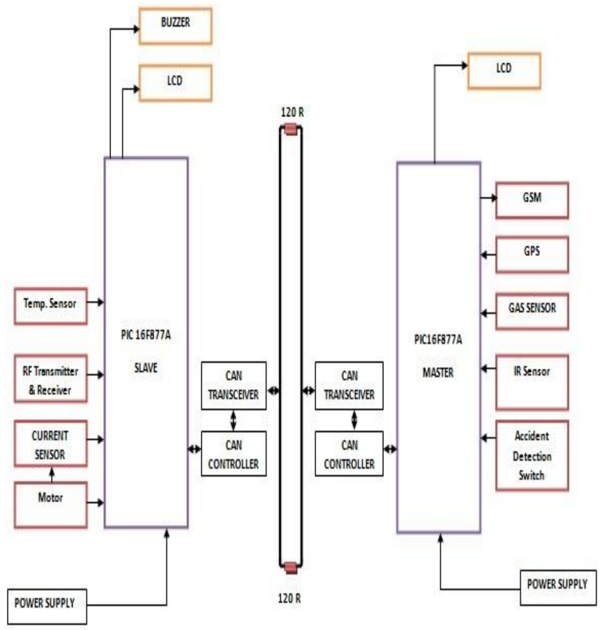

Fig. 4: Block diagram of proposed work

5.1 Temperature sensor

The temperature sensor used here is LM35.It is used to monitor the temperature on the engine area location. The operating range of LM35 is from 0'C - 100 'C. In this proposed work the temperature limit for normal value is set to 35'C.If the temperature exceeds the limit it warns the driver by indicating a beep sound in buzzer and sends the message to the rescue person about the abnormal changes in the temperature. Fig. 5 shows the LM35 temperature sensor.

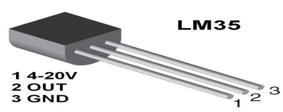

Fig. 5: Temperature sensor

5.2 Current sensor

The current measurement is more important in the electrical wirings in the vehicle. Fig. 6 shows the current sensor. If there is any fault in wiring may cause damages to the circuit in vehicles. The current sensor used in this proposed work is used to monitor the current level of a DC motor which is 1 Amps in rating. If there is any change or no power supply is detected in current sensor it alerts the driver.

5.3 Rf transmitter and receiver

The RF transmitter and Receiver is the EM18 receiver and RFID tag for transmitter. Fig. 7 shows RFID receiver .The main objective of this sensor is receive the magnetic signal whenever the tag is placed near by it and changes the mode of operation according to the condition. This sensor is used for changing the volume of the vehicle according area zone and to reduce the noise pollution.

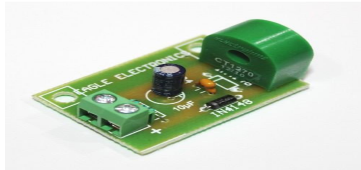

Fig. 6: Current sensor

Fig. 7: RF transmitter and receiver

5.4 Gas sensor

Many of the vehicles uses GAS as an alternative energy for driving the vehicle.GAS leakage in vehicle may cause severe damage to the vehicle. Fig. 8 shows the MQ4 gas sensor. The MQ4 gas sensor is used to monitor the leakage of gas and if there is any leakage it alerts the driver and it sends the message to the rescue person during the abnormal condition.

Fig. 8: MQ4 gas sensor

5.5 Ir sensor

The IR sensor is operates during the object detection when the IR signal reflects back to the sensor. The distance between two vehicles should maintain 10 m and above, if it is lesser there may be chance of accidents or damage to the vehicle. The Fig. 9 shows the IR sensor. The IR sensor placed in the vehicle continuously monitors the distance and it alerts when the distance is below 10 m in range.

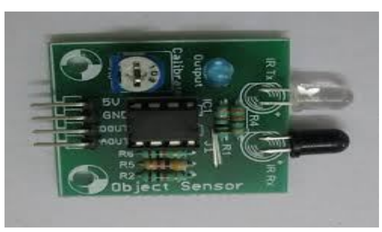

Fig. 9: IR sensor

5.6 GSM

The GSM is the Global System for Mobile Communication is commonly used for transmitting the messages from one device to the another mobile devices.GSM is used to send the alert message during in abnormal conditions and during accident occurs to the rescue persons. The Fig. 10 shows the GSM module.

Fig. 10: GSM module

5.7 GPS

The GPS is the Global Positioning System which is mainly used to detect the Latitude and Longitude of the particular location. During the abnormal changes in sensors and on the accident period it detects the location and send the information to the PIC microcontroller and the information is send to the rescue persons to easily finding the exact location. The Fig. 11 shows the GPS module.

Fig. 11: GSM module

6 Sample results

This sample result shows some of the simulation outputs of temperature sensors, gas sensor and RF transmitter and receiver.

6.1 Temperature sensor

In this result shows, during Normal condition $28'$C the temperature near engine is normal, if it increases $32'$C it detects and warns abnormal and buzzer beeps and alert the driver.

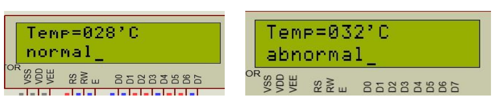

Fig. 12: Temperature during normal and abnormal

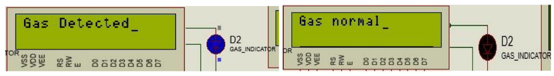

Fig. 13: Gas during normal and abnormal

6.2 Gas sensor

When there is any leakage in gas is detected it sense and alerts the driver and sends message to the rescue person about the leakage of gas.

6.3 Rf transmitter and receiver

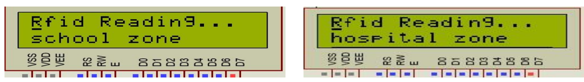

Fig. 14: RFID school and hospital zone

The sample results show the operating in various zones and the horn volume is adjusted according to the school and hospital zone.

Fig. 15: CAN output

6.4 Current sensor

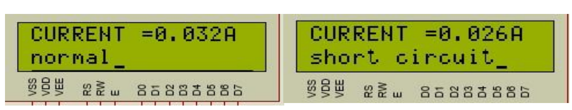

Fig. 16: Current during normal and short circuit

The Fig. 16 shows the current level during normal and abnormal conditions. The current value lesser than 0.28A will be considered as a short circuit. From the result it shows current flow is 0.26A and it is considered as short circuit. If the current is greater than 0.28A it will be normal flow of current.

Table 1: Simulation Results

Sensor	Temp Sensor LM35	Current Sensor	Gas Sensor MQ4
Normal Condition	Below $30'C$ D1 OFF	Below 0.32 Amps D4 OFF	Above 15 Ltrs D3 OFF
Abnormal Condition	Above $30'C$ D1 ON	Above 0.32 Amps D4 ON	Below 15 Ltrs D3 ON

7 Conclusion

It is clear from the body of work in the literature and from the CAN protocol analysis, The Controller Area Network is reliable, cost effective and improved network speed of 1 Mb/s, and has excellent error detection, confinement capabilities and reduced hardware size. Hence the CAN protocol along with various sensors is proposed in this work and it can provide the safety monitoring and alert system.

In future, this proposed system can be extended to monitor the additional functions like monitoring of Anti-skid braking, automatic manual transmission, gearbox control, traction control and door control.

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