SELF PROPELLED SAFETY SYSTEM USING CAN PROTOCOL

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Abstract: *The vehicles are important part in our life for transportation. In existing system the main drawbacks are glaring effect accidents due to opposite vehicle headlight illumination at night driving, short circuit fault in automotive wiring, perceive gas leakage fire accidents, faults due to increase in temperature on engine, higher sound in horn which cause disturbance in restricted surroundings, inaccurate fuel level monitoring in analog meter and accidents due to unequal wheel pressure. The above mentioned problems are identified. The proposed system with CAN (Controller Area Network) will reduce the disadvantages. The Simulation has been developed using Proteus simulation. The proposed system will be in cost effective safety system, more reliability and hardware size will be small.*

Key words: *Controller Area Network, Automotive Safety, Fuel level monitoring, Wheel pressure, Adaptive headlight, Gas leakage prevention.*

1. Introduction.

Automotive electronics is a rapidly expanding area with an increasing number of safety, driver assistance, and infotainment devices becoming standard in new vehicles. Current vehicles generally employ a number of different networking protocols to integrate the 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. In this proposed system there are seven safety measures are included in this system. These safety measures are the most common reasons for road accidents during day and night time driving.

In this proposed system the included measures are,

- The first one is to reduce night time driving accidents due to opponent headlight illumination by AFHAS (Automatic Front Headlight Adjustment System) because most of the accidents arisen at night time driving.
- The second one is to reduce the short circuit faults at the vehicle wiring connections.
- The third one is to detect gas leakage and prevention.
- The fourth one is to monitor the temperature near engine location.
- The fifth one is to automatically adjust horn volume for respective surroundings.
- The sixth one is to display accurate fuel level.
- The seventh is monitoring the wheel pressure.

Controller Area Network was initially created by German automotive system supplier Robert Bosch in the mid-1980s for automotive applications as a method for enabling robust serial communication. Thereafter, CAN was standardized as ISO-11898 and ISO-11519, establishing itself as a standard protocol for in-vehicle networking in the auto industry. By networking the electronics in vehicles with CAN, however, they could be controlled from a central point. By this it could arbitration increase the functionality add modularity and end of diagnostic process more efficient. The Main motivation of this proposed system is to reduce driving accidents for automotive.

Alberto Broggi [1] et al., proposed a method for extensive tests with autonomous driving technologies. Ashwini [2] et al., suggested a controller area network for vehicle automation. Beying Deng and Xufeng Zhang [3] introduced a car networking application in vehicle safety. Che Soh [4] et al., made a study regarding vehicle gas leakage detector. Donghyuk Jang [5] et al., discussed about communication channel modeling of controller area network. Hyeryun Lee [6] et al., discussed about CAN packets into automobiles. Pradhan suvendu kedareswar [7] et al., introduced CAN protocol based embedded system to avoid rear-end collision of vehicles. Sathya narayanan in [8] made a design and implemented ARM microcontroller based vehicle monitoring and control system using Controller Area Network(CAN) protocol. Jaimon Chacko Varghese [9] suggested a low cost intelligent real time fuel mileage indicator for motorbikes. Vijayalakshmi [10] at al., introduced a vehicle control system implementation using CAN protocol.

Jin Ho Kim [11] et al., proposed a gateway framework for in vehicle networks based on CAN, flexray and Ethernet. Tuohy [12] et al., made a review on Intra-vehicle networks. Imine [13] et al., suggested a robust observer design of tire forces in heavy-duty vehicles. P.S. Kedareswar [14] et al., proposed a CAN protocol based embedded system to avoid rear-end collosion of vehicles. Jadhav [15] et al., made a review on control area network based intelligent vehicle system driver assistance using advanced RISC machines. Jifang zhang [16] et al., proposed a automatic detection and management system of vehicle heater based on CAN bus. Szalay [17] et al., introduced ICT in road vehicles – reliable vehicle sensor information from OBD versus CAN.

2. CAN Architecture and Protocol

The CAN bus is a serial Communications bus for real-time control applications, Operates at data rates of up to 1 Megabits per second, and has excellent error detection and confinement capabilities. CAN was originally developed by the German company, Robert Bosch, for use in cars, to provide a cost-effective communications bus for in-car electronics and as alternative to expensive, cumbersome and unreliable wiring looms and connectors in fig 1.The car industry continues to use CAN for an increasing number of applications, but because of its proven reliability and robustness, CAN is now also being used in many other control applications. CAN or Controller Area Network is a robust industrial strength hard and software protocol used to communicate between microcontrollers, Data messages transmitted from any node on a CAN bus do not contain addresses of either the transmitting node, or of any intended receiving node in fig 2. Instead, the content of the message (e.g. Revolution per Minute, Hopper Full, X-ray Dosage, etc.) is labeled by an identifier that is unique throughout the network.

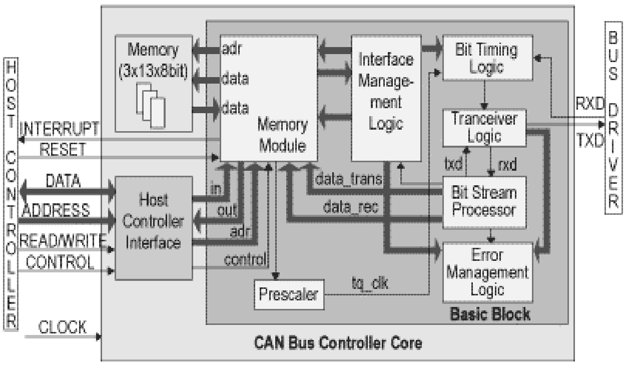

Fig. 1. Block diagram of CAN Protocol.

All other nodes on the network receive the message and each performs an acceptance test on the identifier to determine if the message, and thus its content, is relevant to that particular node. If the message is relevant, it will be processed; otherwise it is ignored. The unique identifier also determines the priority of the message. The lower the numerical value of the identifier, the higher the priority. In situations where two or more nodes attempt to transmit at the same time, a non-destructive arbitration technique guarantees that messages are sent in order of priority and that no messages are lost.

CAN use Non Return to Zero (NRZ) encoding (with bit-stuffing) for data communication on a differential two wire bus. The use of NRZ encoding ensures compact messages with a minimum number of transitions and high resilience to external disturbance. The two wire bus is usually a twisted pair (shielded or unshielded).Flat pair (telephone type) cable also performs well but generates more noise itself, and may be more susceptible to external sources of noise. CAN will operate in extremely harsh environments and the extensive error checking mechanisms ensure that any transmission errors are detected. There are two types of CAN implementations depending in the size of the identifier fields are, The Standard CAN protocol (version 2.0A), also now known as Base Frame Format, supports messages with 11 bit identifiers. The Extended CAN protocol (version 2.0B), also now known as Extended Frame Format, supports both 11 bit and 29 bit identifiers. Most 2.0A controllers transmit and receive only Standard format messages, although some (known as 2.0B passive) will receive extended format messages - but then ignore them. 2.0B controllers can send and receive messages in both formats.

The CAN communications protocol, ISO-11898: 2003, describes how information is passed between devices on a network and conforms to the Open Systems Interconnection (OSI) model that is defined in terms of layers.

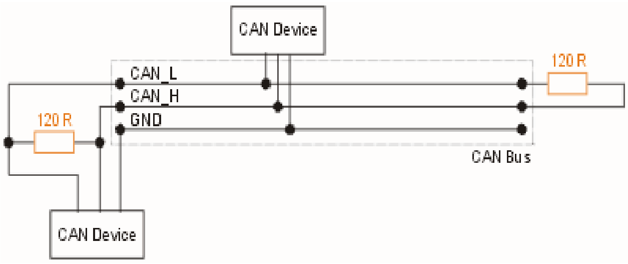

Fig. 2. Implementation of CAN Protocol.

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.

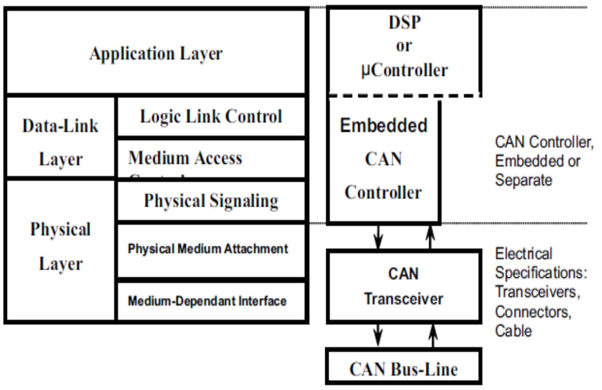

Fig. 3. The layered ISO 111898 Standard Architecture.

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

3. Proposed Work

In this proposed work, these seven measures are converted into two modules one is master module another one is slave module. The master module shown in fig.4 it has LPG gas leakage sensor and exhaust gas control unit and temperature monitoring unit and automatic front headlight adjustment system .The slave module shown in fig.4 it has digital fuel level sensor, short-circuit identification unit, wheel pressure monitoring sensor and Radio Frequency transmitter and receiver for horn volume automatic adjustment. These two modules are designed in double layer PCB. This proposed system has hardware and software. Surface Mount Device Hardware used in this proposed system. Both master and slave modules are communicating through vehicle communication bus CAN Protocol.

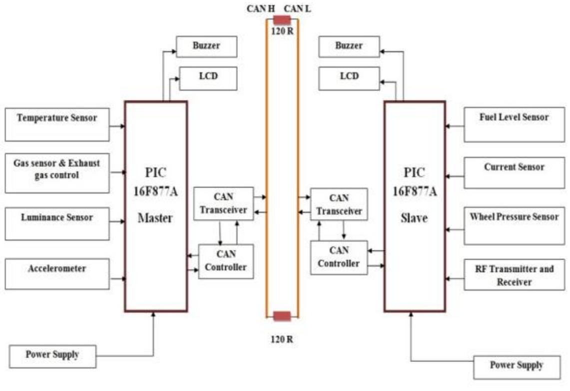

Fig. 4. Block Diagram

3.1. Master Module

PIC is a family of revised Harvard Architecture Microcontrollers made by Microchip Technology. PIC referred to “Peripheral Interface Controller” but now it’s fully called as PIC microcontroller. PICs are popular with both industrial The PIC 16f77A is an 40 pin IC (Integrated Circuit)it have 14k program memory and 368 Bytes of SRAM(Static Random Access Memory. And also it has 256 Bytes of EEPROM (Electrically Erasable Read Only Memory.

The master module have temperature monitoring unit, automatic front headlight adjustment system, LPG gas leakage sensor and exhaust gas control, which are connected to an PIC 16f877A microcontroller.

It has 5 I/O (Input /Output) Ports for connecting to the sensor modules. The sensor modules are connected to the PIC 16f877A through I/O ports in fig 5.

The sensors used are:

1. Temperature Sensor – LM35
2. Light Sensor – LDR and BH1750FVI
3. Gas leakage sensor-MQ6
4. Accelerometer – ADXL335

Each sensor is connected to the I/O ports on the PIC microcontroller. The temperature sensor LM35 which is used to monitor the temperature on the engine. When the heat of an engine exceeds to a certain level the LM35 detects the increase in temperature and it transmits the signal to the PIC microcontroller for the abnormal condition in the engine temperature. The PIC microcontroller sends the information to the LCD1 and enables the LED D1 to alert the user.

The Automatic Front Headlight Adjustment System is mainly reduce the glaring effect during night time driving .The LDR is used to detect the light intensity of the opposite vehicle and it adjust the intensity of the vehicle to lower level which makes the driver safely. The accelerometer is used to adjustment of the headlight according to the steering wheel position.

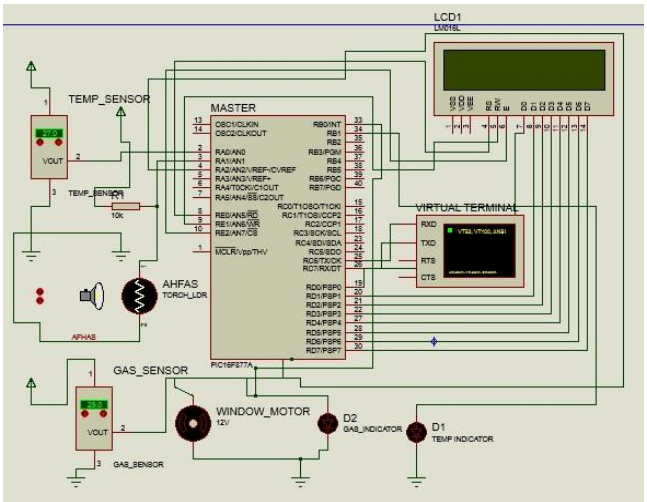

Fig. 5. Master Circuit Diagram

The gas leakage sensor MQ6 detects the LPG gas and other gas leakages and sends the information to PIC microcontroller to drive the motor connected to the vehicle window to exhaust the harmful gas outside and it activates the warring signal through LED D2 and the LCD displays the Gas leakage detected.

3.2. Slave Module

The Slave module has four sensors connected to the slave PIC16f877A microcontroller. The sensors used are:

1. Fuel level sensor- LLS 20160
2. Current Sensor - ACS712-053
3. RFID (Radio Frequency Identification)
4. Wheel Pressure Sensor – TPMS(Tire Pressure Monitoring System)

The analog sensors are normally used for fuel level monitoring .This method displays the fuel level inaccurately. To overcome the digital fuel level sensor is used. This method displays the exact value of available fuel digitally. This makes the user to know the fuel level in the tank. If the fuel level decreases the LED D3 alerts the user as low fuel. The fuel level is displayed in LCD2

The short circuit in electrical connections is detected by using current sensor ACS712-053. It continuously monitors the current flow in the wires. If the current level reduces by certain level it sends the warning signal to the PIC microcontroller and LED D4 warns the user and current flow information is displayed in LCD2 as shown in fig 6.

The volume from the horn is increased rapidly this cause the disturbance to the surroundings and for hospital and school zone areas. The volume level can be reduced at this area to reduce the sound pollution and disturbances. The RFID is used to sense the zone of the particular area and automatically adjusts the volume on the horn. The slave module recognizes whether the vehicle is driving in general zone or school zone or hospital zone and the area is displayed.

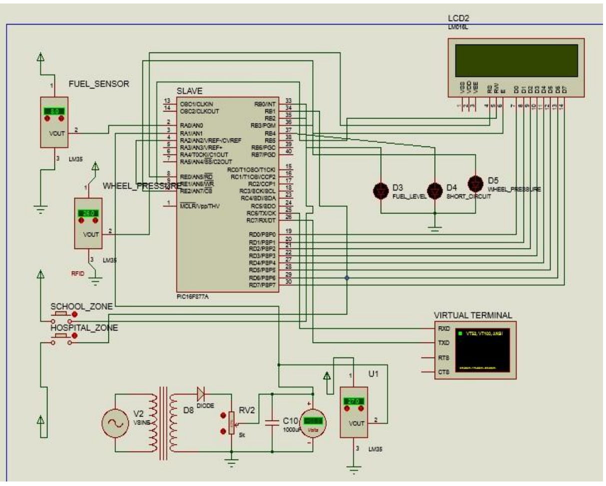

Fig. 6. Slave Circuit Diagram

The wheel pressure is the important factor for increasing the performance of vehicle and fuel efficiency. Low wheel pressure may leads to increase in temperature in wheel and cause accidents. The TPMS provides the information about the pressure in the each wheel. The user can easily monitor the wheel pressure through LCD2.

3.3. CAN Protocol Implementation

The two modules Master and Slave are operated separately. This modules can be interfaced with the help of CAN Protocol. This provides the monitoring and controlling of the each module at a single monitoring system. The CAN protocol has CAN Bus, CAN Transceiver MCP2551 and CAN Controller MCP2515. The CAN Controller provides the connection to the modules connected to it. The speed of a CAN controller is 1Mb/s The CAN Transceiver MCP2551 provides the interface between CAN controller and to the CAN bus. CAN Transceiver which is a high speed CAN. This MCP transceiver will act as conduit between physical buses and CAN protocol. It provides differential transmit and receive competence for the CAN protocol controller and it is fully attuned with the ISO11898 standard. This CAN transceiver supports 1Mbps speed and CAN nodes can be connect up to 112 nodes.

It is used to transmit as well as receive the signal. The two modules are connected to the Can bus through the CAN Controller and CAN Transceiver to the Master and Slave Module. The monitored information of the slave module is transmitted to the CAN Bus to the Master module. The monitored information of Master module along with Slave module are passed to the UART(Universal Asynchronous Receiver Transmitter).The UART protocol is a point to point communication and it transmits one data at a time. The UART has one master and one slave module.

The Output of both the modules are transmitted through the UART protocol on the master module to the virtual terminal. The implementation of CAN protocol along with two modules are shown in fig 7.

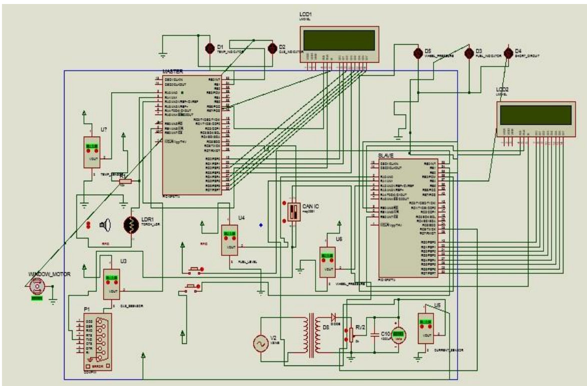

Fig. 7. CAN Protocol Module Circuit Diagram

4. Output

The output of each sensor is monitored through the LCD display. The sensors operate in two ways during normal and abnormal conditions.

4.1Master Module Output

The Master module during normal and abnormal conditions are:

4.1.1. Master During Normal Condition

Table 1. Master during Normal Condition

Sensors	Range	LED	Motor	Intensity
Temp sensor	Below 30	D1-OFF	-	-
Gas Sensor	Below 30	D2- OFF	OFF	
luminance sensor	Below 92	-	-	Low

Temperature on engine is below 30'c which is normal condition

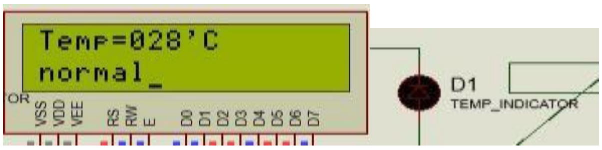

Fig. 8. Temperature during Normal

Front Light Adjustment for shorter range

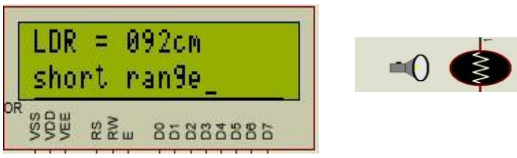

Fig. 9. Luminance during Short Range

Gas level which detects the gas leakage ,gas level is normal which shows no leakage.

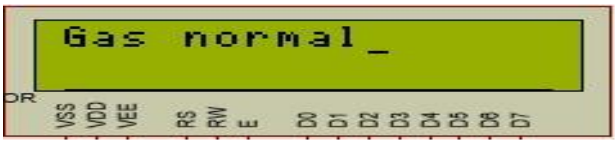

Fig.10. Normal Gas Level

4.1.2. Master During Abnormal Condition

Table 2. Master during Abnormal Condition

Sensors	Range	LED	Motor	Intensity
Temp sensor	Above 30	D1-ON	-	-
Gas Sensor	Above 30	D2- ON	ON	
Luminance sensor	Above 92	-	-	High

Temperature on engine area is abnormal

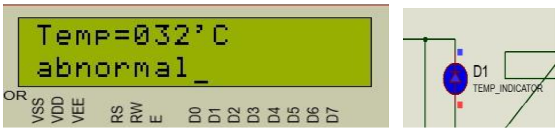

Fig. 11. Temperature during Normal

Front Light Adjustment with long range

Fig. 12. Luminance during Long Range

Gas level has been detected and windows automatically open to exhaust the gas.

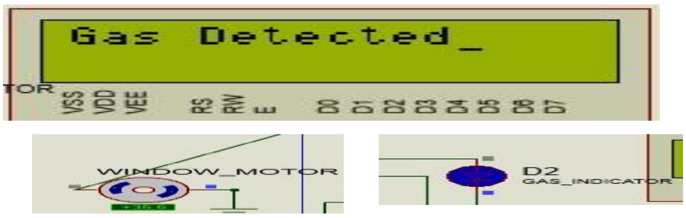

Fig.13. Abnormal Gas Level

4.2. Slave Module Output :

The Slave module during normal and abnormal conditions are:

4.2.1 Slave during Normal Condition

Table 3. Slave during Normal Condition

Sensor	Range	LED	Zone
Fuel sensor	Above 15 ltr	D3 – OFF	
Current Sensor	Above 30 w	D4 – OFF	
RFID sensor	Below 30 Mtr	-	General
Wheel Pressure Sensor	Above 30	D5 - OFF	

Fuel Level with above 15 ltr

Fig. 14. Normal Fuel Level

Current Sensor reading current flow in electrical wirings it shows normal

Fig. 15. Normal Current

RFID Sensor reading general zone here the volume is higher

Fig. 16. General Zone

Wheel Pressure Sensor monitoring the pressure in tires and it have normal air pressure

Fig. 17. Wheel Pressure Normal

4.2.2 Slave during Abnormal Condition

Table 4. Slave during Abnormal Condition

Sensor	Range	LED	Zone
Fuel sensor	Below15 ltr	D3 – ON	
Current Sensor	below 30 w	D4 – ON	
RFID sensor	Below 30 Mtr	-	Hopital/ Schooll
Wheel Pressure Sensor	Below 30	D5 - ON	

Fuel Level detects the level there is lesser below 15 ltr and warns by glowing LED D3.

Fig. 18. Abnormal Fuel Level

Current Sensor detects there is a short circuit in electrical wirings and it warns short circuit.

Fig. 19. Short Circuit

RFID Sensor reading school and hospital zone

Fig. 20. School Zone

Fig. 21. Hospital Zone

Wheel Pressure Sensor monitoring tire pressure and detected low air pressure which shows abnormal and warns driver by glowing LED D5.

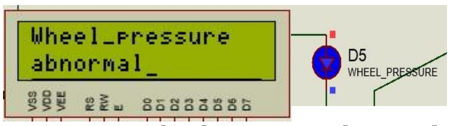

Fig. 22. Wheel Pressure Abnormal

4.3 CAN Implementation Output

The output of each module is connected to the CAN protocol through SPI on the Master module. The output is transmitted to a virtual terminal placed on the vehicle dashboard to monitor both the modules data on a single display window and the sensors can be controlled through the terminal.

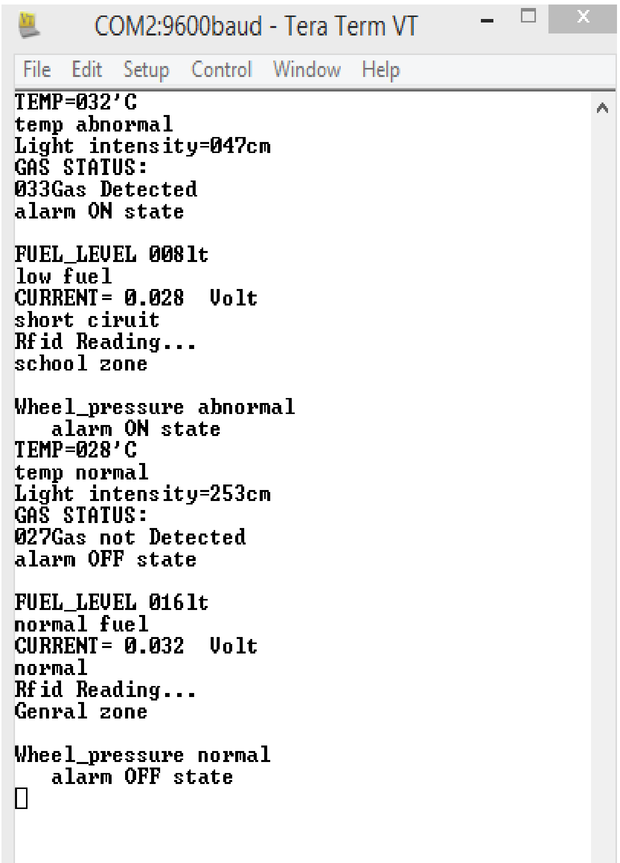

Fig. 23. CAN Output

5. Conclusion

The proposed system has been designed and this system has two modules namely master and slave which takes required action for the night time driving accidents due to glaring effect of headlight luminance, to provide clear vision for vehicle driver, short-circuit fault line detection, Gas leakage detection cum prevention action and monitoring the engine area temperature by an analog and digital sensor ,horn volume level adjustment through RFID for reducing the noise pollution and disturbance to the surroundings and wheel pressure monitoring to know the pressure on the wheel are above stated in this paper. The communication between master and slave module through Controller Area Network serial communication protocol has been implemented and it precedes required actions, values displayed in dashboard for driver assistance. This proposed system achieved the active safety system with low cost.

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