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RESEARCH ARTICLE



Designed Automotive Telematic Unit for Incessant Fuel Analysis

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Abstract—Telematics is an eminent technology which merges telecommunications and informatics. This blending of wireless telecommunication technologies along with computers is done ostensibly with the goal of conveying information over vast networks to handle vehicle information. The entire system consists of TeCU Telematics Control Unit, server and webpage application to monitor and to sense ample information's received from vehicle over the air. Telematics Control Unit (TeCU) has to be designed and developed, which could be used in real time and off time monitoring, tracking and reporting system. TeCU is mounted in the vehicles and it's implemented with GSM/GPRS for tracking to communicate with server. The user can create a webpage application and monitor the vehicle update information's and mappings with fine precision. Thus, system provides adequate information to fleet operator regarding route/direction taken by driver, stoppages, high acceleration, vehicle location, speed, idle mode, AC ON or OFF, vehicles unit information's, RPM, sudden braking, date, time, etc. All these vehicle information's from TeCU could be updated to the Server; this is possible through GPRS communication. Thus server dispatch's all information's completely to end user webpage. This system could be extensively used in commercial vehicles and in constant equipments. In this paper fuel sensor and TeCU is interfaced, and then fuel status of vehicle is monitored predominantly on the webpage. Then the implementations will be done to administrate the system. This core endeavor of the paper is to identify and manage the fuel pilfering.

Index terms— TeCU-Telematic control unit, GSM/GPRS, Server, Webpage

I. INTRODUCTION

Telematics is the blending of computers and wireless telecommunications technologies, efficiently conveying information over vast networks to improve a host of business functions or government-related public services. Telematics is an interdisciplinary field encompassing telecommunications, vehicular technologies, road safety, electrical engineering (sensors, instrumentation, wireless communications, etc.), computer science (multimedia, Internet, etc.).

II. NECESSITY OF VEHICLE TELEMATICS

The convergence of telecommunications and information processing, the term refers to automation in automobiles. The science of Telecommunications and Informatics applied in wireless technologies and computational systems. More universally applicable technology as a superset of M2M (Machine to Machine) connectivity, and as part of an "intelligent network of connected things", associated with the vehicle market. Telematics enables you to get information about location information and

state of your vehicle. It also enables wireless communication to the vehicle, which opens up a wide range of services, information about that vehicle (i.e.)

- When the vehicle was last started and shut down
- Where it is at any point in time
- When it is sitting idling
- What speed its being driven

It looks for many different signs of bad behavior like: Sharp turns, Tailgating, Sudden stops, Speeding. Telematics is enabling it's users to take advantage of a wide range of useful features.

III. SENSORS AND GPRS MODULE

A Sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. A thermocouple converts temperature to an output voltage which can be read by a voltmeter. For accuracy, most sensors can be calibrated against known standards.

A. Study on Automotive Fuel Sensors

The main types of fuel level indicative sensors are:

- Wire wound
- Thick Film Resistor
- Tubular with wire resistance
- Tubular with Reed Switch
- Capacitance

B. Benefits

- Contacts hermetically sealed.
- Most economic non touch switching solutions
- Various methods of actuation principles
- Magnetic and electric pole independent
- Various sensitivity ranges available.

C. Applications

- Four Wheelers, Two Wheelers

D. Fuel Level Sensor – Using Reed Switch:

A Fuel level sensor incorporates a reed switch in a stem. An external float with a magnetic inside passes and actuates the reed switch depending on the liquid level.

E. Reed Switch

It is a small electro mechanical device having two ferromagnetic reed blades sealed in a glass envelope. When a magnetic field is brought near to this, reeds will close creating the switching functions.

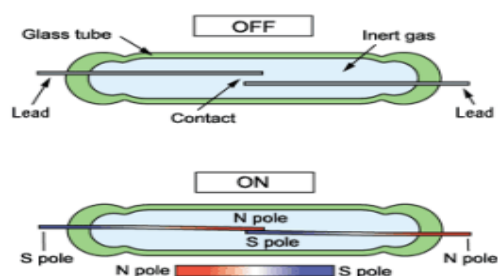


Fig.1 Working mechanism of reed switch

F. Working of Reed Switch

A reed switch consists of a pair of ferromagnetic reeds, hermetically sealed in a glass tube. Their free ends overlap at a very small distance. A magnetic field (from an electromagnet or a permanent magnet) will cause the reeds to get closer, thus closing an electrical circuit. The hardness of the reeds causes them to separate, and open the circuit, when the magnetic field ceases. One important quality of the switch is its sensitivity, the amount of magnetic necessary to actuate it. In Ampere-turns sensitivity is measured, in relevant to the coil current which is multiplied by the number of turns. 10 to 60 AT range are sensitivities for commercial devices. The lower the AT, the more sensitive the reed switches.

G. GSM/GPRS Module

GSM/GPRS module is used to establish communication to a computer. Global System for Mobile communication (GSM) is an architecture used for mobile communication in most of the countries. GSM/GPRS module consists of a modem assembled together with power supply circuit and communication interfaces like RS-232, USB, etc to connect with computer. The MODEM is the soul of such modules.



Fig.2 GSM/GPRS module/modem

H. Wireless MODEMS

Wireless MODEMS are the MODEM devices that generate, transmit or decode data from a cellular network, for establishing communication between the cellular network and the computer. These are manufactured for specific cellular network (GSM/UMTS/CDMA) or specific cellular data standard (GSM/UMTS/GPRS/EDGE/HSDPA) or technology (GPS/SIM). Wireless MODEMS like other MODEM devices use serial communication to interface with and need Hayes compatible AT commands for communication with the computer. GSM/GPRS MODEM is a class of wireless MODEM devices that are designed for communication of a computer with the GSM and GPRS network. It requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network.

A GSM/GPRS MODEM can perform operations like:

- Receive, send or delete SMS messages.
- Read, add, search entries of the SIM

IV. IMPLEMENTATION

This paper, serves as the purpose of stating the overall functionality and hardware requirement of the fuel level to be interfaced to the telematics. GSM/GPRS module information is forwarded to server and to the user webpage.

A. Power Supply Unit

A power supply is a device that supplies electric energy to and load. The primary function of a supply is to convert one form of electrical energy to another and, as a result, referred to as electric power converters. Some supplies are stand-alone devices, whereas it's built into larger devices along with their loads. Initially, 12 volt power supply unit are connected to the vehicles fuel level sensor. The schematic of power supply unit is as follows,

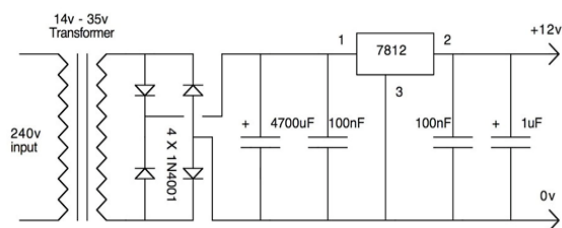


Fig.3 Circuit diagram of 12v power supply

The power supply unit could be interfaced with fuel level sensor and its relevant level changes in the tank could be measured.

B. Fuel Level Indicative Sensor

Fuel level sensor chosen is resistive type where it contains series of reed switches are connected to indicate the liquid level in resistance range. Resistive fuel level indicative sensors are similar to magnetic float level sensors in that a permanent magnet sealed inside a float moves up and down a stem in which closely spaced switches and resistors are sealed. When the switches are closed, the resistance is summed and converted to current or voltage signals that are proportional to the level of the liquid. The choice of float and stem materials depends on the liquid in terms of chemical compatibility as well as specific gravity and other factors that affect buoyancy.



Fig.4 Resistance type fuel sensor

Fuel level sensor is widely used for trucks and construction machinery. This structure can achieve the precise measuring in shaky condition. With the electromagnetic induction principle, it can output signal stably and continuously. The sensor also has the characteristics of long using life, anti-vibration and anti-corrosion.

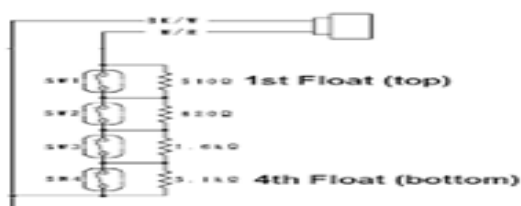


Fig.5 Circuit diagram of fuel sensor

Observation of fuel level sensor output from a passenger car

TABLE 1 FUEL LEVEL SENSOR OUTPUT

Fuel capacity	Ohms Ω	Tolerance
Empty low (3lit)	10	±3
Empty high(6lit)- Reserve	30	±3
¼ position tank(10lit)	60	±6
½ position tank(20lit)	100	±6
¾ position tank(30lit)	140	±8
Full tank(38lit)	190	±8

Then the resistance values need to be calibrated between the ranges of (0-5) volt, in order to feed into TeCU controller. Thus calibration is done using potential divider calculation. Initially worst case range has been fixed using trial and error method and then voltage calculations are proceed for all the above assigned resistances of the fuel capacity. Changing the value of the variable resistor R-2 changes the output voltage V-OUT.

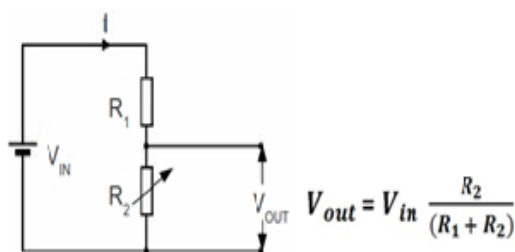


Fig.6 Potential Divider Circuit and Formula

Calibrated output readings

TABLE 2 CALIBRATED OUTPUT READING

V _{in} (volt)	R1(ohms)	R2(ohms)	Verified V _{out} (volt)
12	300	10	0.387
12	300	30	1.091
12	300	60	2
12	300	100	3
12	300	140	3.818

V. TELEMATICS CONTROL UNIT

Hardware unit to be installed in the vehicle for should operate for both 12V system, shall continue to operate during cranking voltage of 6.0V complaint with IP67 standard, sleep current should not exceed 4mA. The TeCU functionality should not get affected by any of mechanical or environmental aspect of the vehicle and should not cause any kind of electrical interference to any other electrical/electronic components in the vehicles.

TeCU should have the capability of capturing the following inputs

TABLE 3 TeCU SIGNAL INPUTS

S.No	Signal type	No. of signal to be captured
1	Digital-active High	3
2	Digital-active low	6
3	Analog signal	3
4	PWM signal	1

The TeCU circuitry used for tapping active low digital signal should not cause any leakage current to flow in the shared circuitry in the vehicles. All the analog signals are shared only. It should have a quad band GSM modem which can do the functions: Send GPRS data packet to a valid, Receive incoming GPRS data packet URL address, Receive incoming data, should have internal antenna for its GSM functionality.

The TeCU should be equipped with LED to show status of the GSM signal. Also there should be another LED which shows status of the TeCU. When the vehicle is in ignition ON condition, the TeCU should send data packet on the server periodically which should contain the location information of the vehicle at the moment. This data packet will be termed as tracking data here onwards. Periodicity for tracking the data is mentioned in the table. These parameters are configurable Parameter and configured over the air by sending GPRS data packet or SMS from server to TeCU.

The TeCU should detect the alert conditions occurring in the vehicle is given below

TABLE 4 TeCU ALERT CONDITION

Alerts	Signal types
Ac ON	Active high digital
Lift axle position	Active high digital
Twin axle usage	Active high digital
Battery not charging	Active low digital
E call	Active low digital
Air filter clog	Active low digital
PTO switch	Active low digital
Tipper body clog	Active low digital
Low oil pressure	Active low digital
Fuel level	Analog signal
High engine temperature	Analog signal
Low brake air pressure	Analog signal
High engine RPM	PWM signal
Excessive idling	Based on engine RPM and time
Fuel theft	Based on fuel level value and time

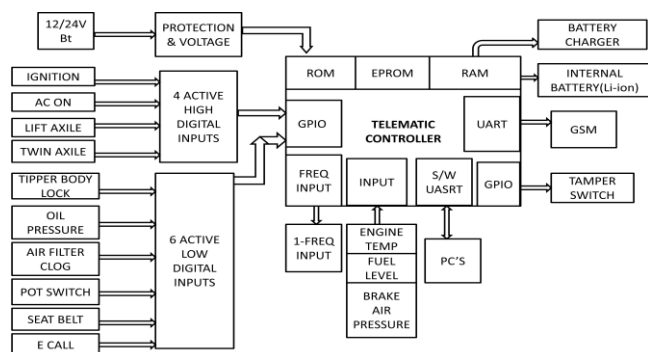


Fig.7 Block of TeCU

The TeCU should send data packet to the server whenever it detects an alert, informing the same. These data packet will be termed as alert data packets will be termed as alert data packet here onwards. These parameters to be considered for detecting the alerts should be configurable parameter which can be configured over the air by sending GPRS data packet from the server to TeCU. In case of no GSM/GPRS signal availability the TeCU should store the periodic tracking data in a separate memory as a stack. This memory is termed as Backlog memory. The Backlog memory should be sized in such a way that it can store 20hrs of tracking data.

During the condition mentioned, if an alert is also occurring in the vehicle, then the corresponding alert data packet also has to be stored in the backlog memory with the tracking data. All data packets stored in the backlog memory is termed as backlog data. Whenever the TeCU detects the availability of GSM/GPRS signal after the occurrence of the backlog conditions, the TeCU should send the backlog data in FIFO manner. At the same time TeCU should store the live tracking data in the backlog memory.

Three particular live alerts will have more priority when the TeCU is engaged in sending Backlog data, TeCU will stop sending it and will send these alert data packets to the server, and then it will resume sending of backlog data. While the TeCU is engaged in the emptying of backlog memory by sending the backlog data, if an alert occurs other than the 3 alerts, it will also be stored in the backlog memory with the live tracking data. The periodicity of sending the backlog data should be less than that of sending live tracking data packet.

This time period will be configurable parameter which can be configured over the air by sending GPRS data packet from, the server to TeCU. Even if the vehicle is in ignition OFF state, the TeCU should send backlog data to server if there is any data present in backlog memory. Once the TeCU empties the backlog memory it will continue to send the live tracking and alert data packets to the server.

In any circumstances, if the backlog memory gets fully filled, then the TeCU should delete the oldest data packets in the backlog memory if it has to store new live data packets, once the backlog memory is full, then the backlog has to be cleared in first in first out manner (FIFO) and it should be done only if a new data packet is created to be stored. The TeCU has to send data packet containing the location and time details of its current position for every particular period of time when the vehicle is in ignition OFF state. This data packet will be known as beacon signal data. This time period value should also be a configurable parameter which can be configured over the air by sending GPRS data packet or SMS from server to TeCU.

A server is a running instance of an application (software) capable of accepting requests from the client and giving responses accordingly. Servers operate within a client-server architecture. Many generic web servers also support server-side scripting using Active Server Pages (ASP), PHP, or other scripting languages. This means that the behaviour of the web server can be in separate files, while it remains unchanged the actual server software.

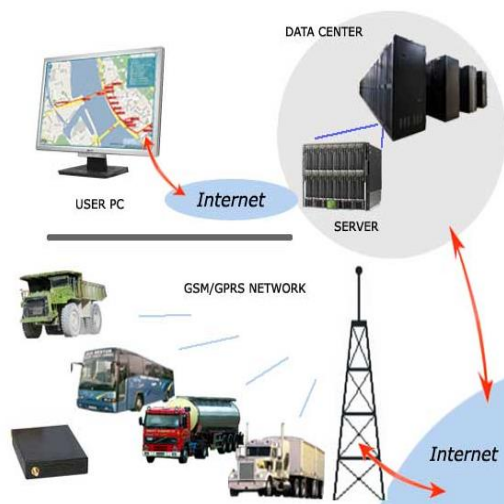


Fig.8 General server mechanism along with TeCU

In a general network environment the following types of servers may be found.

- Application server, a server dedicated to running certain software applications
- Communications server, carrier-grade computing platform for communications networks
- Database server, provides database services to other computer programs or computers Name server or DNS
- Web server, a server that HTTP clients connect to in order to send commands and receive responses along with data contents

Database and application server could be used to receive data from the TeCU and to provide web hosting. Data from the vehicle is through SMS or GPRS it's collected in database server which is having static IP. In web application server domain name is kept and accessed with webpage login.

VI. SIMULATION RESULT

Proteus design suite 8 professional software is used to verify the simulation result. The fuel level indicative sensor is interfaced to the pretended TeCU controller and its output results are verified. Thus (0-5) V is given to the ADC 0808- analog to digital controller and then it is connected to the ATMEGA16 control along with some basic connections. Thus resultant outputs are been verified.

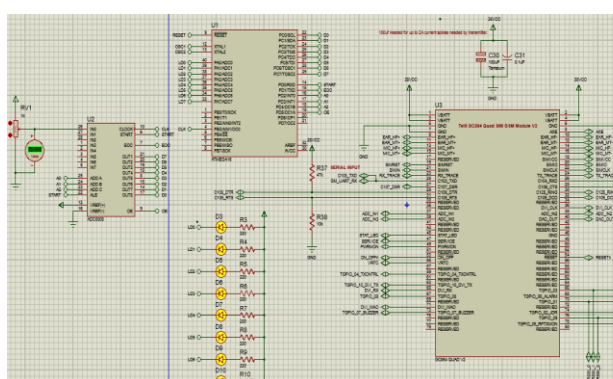


Fig.9 Fuel level- tank is full

When the fuel tank capacity is full all the reed switches will be closed and then the resultant signal is represented.

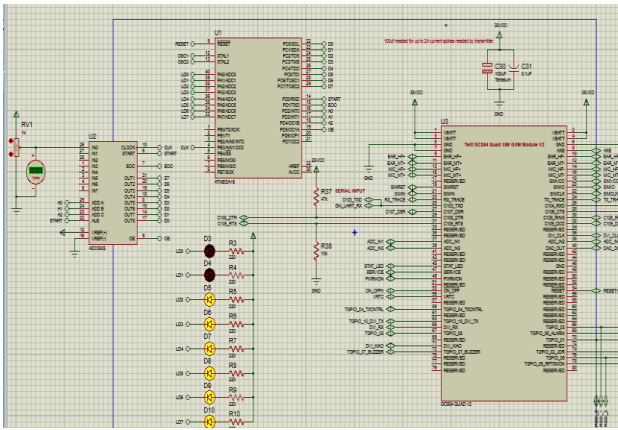


Fig.10 Fuel level- tank $\frac{3}{4}$

When fuel level gets reduced the reed switches get opened relevantly the output signals are obtained.

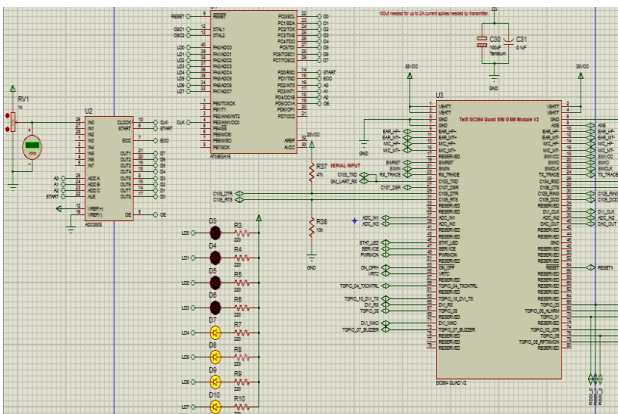


Fig.11 Fuel level- tank $\frac{1}{2}$

When the fuel capacity is half in the tank according the led glows and indicates the signal outputs.

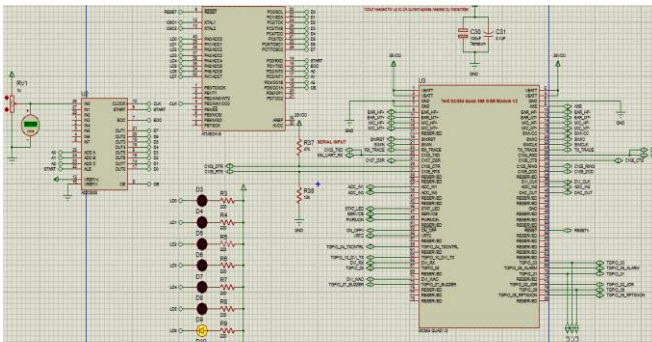


Fig.12 Fuel level- tank minimum (reserved)

Minimum or empty level of the tank could be ensured from few led glow. Thus figures listed mainly describes that the variation in fuel capacity is interfaced with the controller.

VII. CONCLUSION

Fuel sensors input has been fed into controller and its output response is analyzed. This process is done by using Proteus design suite 8 professional software. Thus result is observed that, whenever the resistance value is altered in the reed switch of the fuel level indicative sensor which is kept inside the fuel tank of the vehicle, its relevant voltage is indicated through calibration; accordingly output varies in the TeCU.

Future Work

The current output information obtained from the TeCU has to be given to server using GSM/GPRS module. Then a webpage has to be created according to fetch the live information from the vehicle and to be monitored.

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