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Design and Fabrication of Automated Re Fuelling System for Automobiles with Real - Time GPS Alerts

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Abstract – *There is a lot of news regarding the petrol pump frauds, which leads to corruption. We don't get the exact amount of fuels shown by the filling machine and another problem faced is misfuelling. Most of the times the fuel filled is less than the displayed value because of the arrangements made in the filling machine which leads to the benefit of the owner. Another main problem faced by the society is the wrong fuel filling system occurred due to manual errors. By considering all the above facts, we have designed and fabricated an automated fuel quantity measuring system along with a fuel type detection system in automobiles, mainly four wheelers.*

This paper presents the impulsive type microcontroller based digital flow meter, along with real time information, location and bypassing of wrong fuel while refuelling. This prototype is developed for diesel engine passenger car. Design and fabrication of this prototype, fuel management system comprise of flow meter, fume sensor, development board Arduino and a GSM-GPS module .The flow meter measures the quantity of fuel with the rotation of turbine, sensor and with microprocessor display the quantity digitally on LCD unit. At the time of wrong fuelling caused by manual error the fuel is bypassed to a separate reservoir by a solenoid valve, which is detected by the fume sensor. The sensor is interfaced with the Arduino UNO microcontroller which is interfaced with a GSM-GPS module. This module sends a text message at the time of wrong fuel and helps the owner to know the location, where vehicle is filled with wrong fuel using GPS (global positioning system) and GSM (global system for mobile communication) services. It overcomes the problems faced by other gauges and is suitable for the non-contact measurement of the fuel inside the tank.

This prototype measures in the range of 0 – 120 litres per minute with accuracy of ± 1% which is acceptable in comparison with commercial analogue or digital fuel gauge. The module meets its objective of being low-cost, accurate in real time tracking

Key Words: *(Fuel management system, reservoir, sensors, non-contact measurement & GPS –GSM Modules)*

1. INTRODUCTION

Automobile vehicles use fuel as a basic source of energy. Many technologies, over a period of time have been evolved for proper efficient consumption as well as for predicting and accurately concluding the fuel harnessed at each stage of its use in any system. The amount of fuel is indicated in analog form, which does not give exact idea of amount of fuel present in the tank. Thus, it is necessary to give exact level of fuel that may give the exact information to the driver of vehicle about the amount of remaining fuel in the storage tank so that the driver can judge the remaining driving distance. A fuel gauge is a device that measures the amount of fuel still in the vehicle. This type of system can be used to measure the amount of gasoline or some other type of liquid. A fuel gauge can be designed in number of ways and many gauges have several flaws that can make readings less accurate.

In accordance with the needs, a literature survey was conducted and many such projects were found, but they all had many disadvantages and demerits. Hence we designed a new system to which many features were added. It comprises of the following: a system which could display the amount of fuel flowing into the fuel tank, a solenoid valve which helps to bypass the wrong fuel being fueled to the tank and a sensor setup to sense the smell of the fuel and alarms if the fuel is wrong. It also includes a *GSM-GPS* module which enables the system to send text message regarding the wrong fuel to the owner of the vehicle whenever the vehicle is filled with wrong fuel. The *GSM-GPS* module also enables the owner to find the location of the fuel station from where wrong fuel is filled. All these add on features make the system more useful and worth than the other types of systems.

This paper mainly deals with the design of various components used in this system, programming of Arduino board for fuel detection, programming of *GSM-GPS* module and fabrication of automated re fueling system for automobiles.

2. LITERATURE REVIEW

Nitin Jade, Pranjal Shrimali, Asvin Patel, Sagar Gupta et al described about a technique to measure the amount of liquid available in tank, chemical composition as well as purity level of fuel. This device digitally displays the level of liquid inside the tank, fuel composition & running capability of vehicle by using load sensors

J. Vignesh, V. Nijanthan, J. Venkateshwaran K Suresh Kumar and Mrs. B. Vidhya et al investigated in detail about a new technique which can measure and verify the fuel present in the vehicle with high degree of precision. This technique manly deals with the use of two sensors which are connected with an Arduino uno microcontroller. This technique can also detect the petrol theft.

T. Kammerer, M. Engel, A. Schutze et al proposed a system which is based on the temperature cycling of semiconductor gas sensors and is used as a very powerful tool for developing gas detection systems with high selectivity and stability. For this purpose, they introduced a gas sensor. For efficient evaluation of these systems, they developed a versatile hardware platform which provides accurate control for arbitrary temperature cycles and fast, high resolution data acquisition either in stand-alone operation or connected to a PC. Based on this platform, they demonstrated a system for fast discrimination between gasoline and diesel vapors based on a single micro sensor and intelligent signal processing. This system is also applicable to integrated pump nozzles at filling stations. The system would allow to prevent the car tank from being filled with the wrong fuel by detecting the type of fuel inside the tank in seconds. For this application micro pellistors are also suitable, which have shown superior stability compared to semiconductor gas sensors.

Abdussamad Hmar, Jibia, Aliyu, Abdullah et al discussed in detail about a microcontroller - based petrol level gauge for a horizontally mounted underground cylindrical tank. The output of the sensor is an analog signal, which is fed to the microcontroller. In order to determine the contents of tank fitted with petrol level sensor, the microcontroller is programmed with an algorithm employing a mathematical expression for computing data value based on petrol level sensor output and tank dimension. The output of the programmed microcontroller is read out to give the height in meters and volume in litres via an LCD display.

Raj Pate, Hitesh Pungalia, Saurabh Mahajan et al investigated in detail about the design and implementation of digital fuel gauge which measures the accurate level of fuel adding while fuel filling process. In this paper they had proposed a technique to measure the amount of fuel available in tank during static as well as dynamic condition. This system digitally displays the level of fuel inside the tank by using load sensor, flow meter and vibration sensor and these sensors are interfaced with a development board-Arduino. Thus, it is an efficient system to detect the fuel volume in the fuel tank, to get instantaneous reading of fuel volume and to avoid petroleum thefts at various petrol pumps at the time of filling of tanks.

Rahul Gogawale, Sumit Sonawane, Om Swami, Prof. S.S. Nikam et al proposed a technique that detects exact amount of fuel available in the tank and displays it digitally using an Ultrasonic sensor. The ultrasonic sensor is a non-contact sensor, with low power requirement and good accuracy. It overcomes the problems faced by other gauges and is suitable for the non-contact measurement of the fuel inside the tank. This paper mainly concentrates on the digital indication of fuel in vehicle's tank. From security point of view, fuel level indication and alarm system will be used to indicate fuel level. It gives an audiovisual indication to the customer. Whenever fuel level will drop below the reserve level, alarm will be activated.

3. PROBLEM IDENTIFICATION

From the literature review, it is observed that there are a lot of problems in the present re fueling system. After further investigation on various intelligent re fueling methods, the following conclusions were drawn.

a. There is a lot of news regarding the petrol pump frauds which leads to corruption. There is huge difference in the amount of fuel after re- fueling from fuel stations
b. Most of the time the fuel filled is less than the displayed value because of the arrangements made in the filling machine which leads to the benefit to the fuel station's owner.
c. Miss- fuelling is increasing today which causes many serious problems in vehicles
d. For modern diesel engines with high pressure fuel pumps for direct injection, even small amounts of gasoline in the fuel can destroy the fuel pump within a very short time.
e. The problem with digital fuel indicator is that, due to best quality assurance it is costly and only favorable for luxury vehicle. It is not suitable for low & medium class vehicle. Thus, it increases the cost of luxury vehicle and in case of sensor failure of any one of them, it can stop the working of the whole system.
f. The major problem of using the ultrasonic sensor is that, if proper connection is not done then due to short circuit there will blast in petrol tank. Also, observation and regular maintenance will be required for this system.
g. In present systems, it will be difficult for the owner to identify the location of the fuel station from where wrong fuel is filled in the vehicle.
h. There is no facility in presently available methods to bypass the wrong fuel to a separate auxiliary fuel tank.

4. METHODOLOGY

Design of automated re fuelling system for automobiles requires the knowledge of fluid mechanics, flow measuring methods, Arduino microcontroller, Programming of microcontrollers and programming of GSM GPS module, Solenoid valves and basic machine design. The purpose of this paper is to describe the function of each component used in the system and the guidelines for designing and fabricating an automated re fuelling system for automobiles. This paper also deals with the programming of Arduino

microcontroller, GSM GPS modules and design of various components used in fabricating the automated re fuelling system. The methodology used for designing the automated re-fuelling system and programming adopted for the Arduino microcontroller and GSM GPS module are discussed here.

4.1 Working of automated Re- Fuelling system with Real –Time GPS Alerts

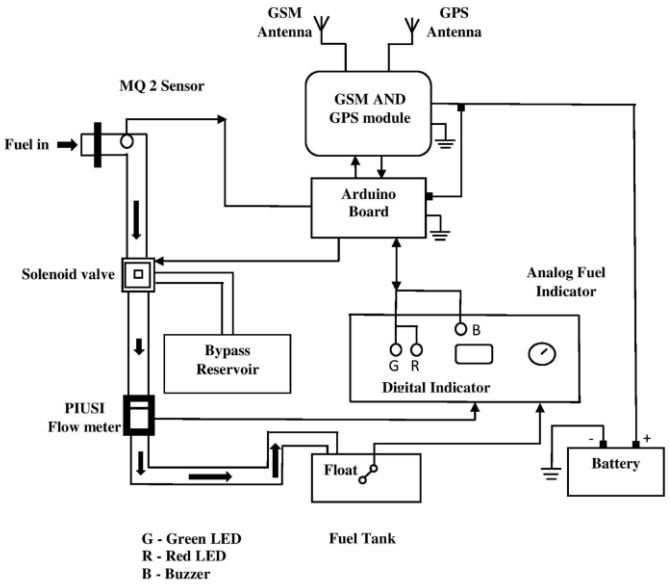

Fig. 1: Block diagram of automated re-fuelling system for automobiles with real – time GPS alerts

One of the major components of the automated refuelling system for an automobile with real time GPS alerts is a micro controller. This is connected to a *GSM-GPS* module a leakage water sensor, MQ2 smell sensor and a relay switching.

When the miss fuelling condition occurs the MQ2 smell sensor finds it with difference in resistance of different fumes. This voltage signals are passed to a relay switching unit. This voltage signal activates the relay switch to work and another signal passes to Arduino uno micro controller, an LED indicator and buzzer alarm provided in main panel of automobile to warn the driver against pouring of wrong fuel. At this same time, a signal is passed to solenoid valve and it closes the fuel line to the fuel tank and bypasses the wrong fuel to a bypass reservoir. Also Arduino uno micro controller gives instructions to GPS and GSM module. This module contains a SIM card and with the help of C program it is connected to owner's SIM. Only the owner can access this GSM module. GSM and GPS module sends a message and warns us when a wrong fuel is filled. By a text message as TRACK from owners mobile to module we can find the present location of vehicle.

The fuel goes directly to the fuel tank and the flow is measured by a flow meter. Flow meter works on turbine rotor, impulsive reed switch which gives the accurate reading of quantity that passes to the fuel tank. GPS and GSM module would be useful for us for a situation where the solenoid valve stops working.

Main components used for the fabrication of automated refueling system for automobiles are:

a. Smell sensor
b. Arduino microcontroller
c. Solenoid valve
d. Bypass reservoir
e. Flow meter
f. Fuel tank
g. SIM 808 Module
h. LED Lights green and red
i. Buzzer/alarm
j. Digital flow indicator
k. Fuel indicator operated by float
l. Power supply.

4.2 Theoretical aspects of components used

a. Smell sensor: The MQ-2 smoke sensor is sensitive to smoke and to the following flammable gases like LPG, Butane, propane, methane, Hydrogen. The output can be an analog signal (A0) that can be read with an analog input of the Arduino or a digital output (D0) that can be read with a digital input of the Arduino.

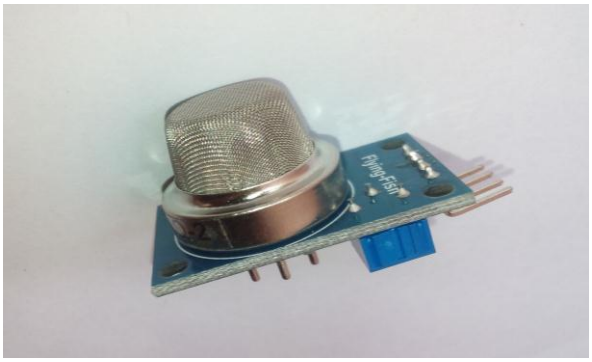

Fig. 2: MQ2 smell sensor

b. Arduino microcontroller: The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

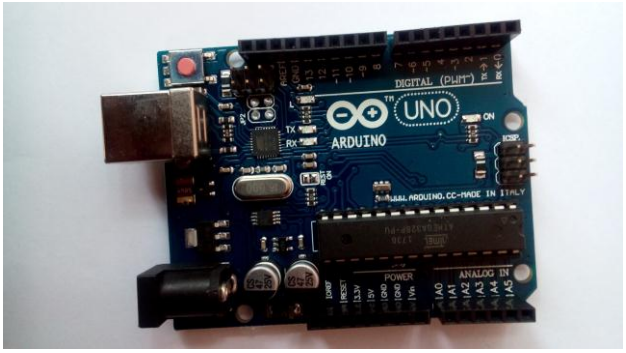

Fig. 3: Arduino Uno Micro controller

c. **Solenoid valve:** A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports.

Fig. 4: Solenoid valve

d. **Bypass reservoir**: It is 5-liter tank which collects wrong fuel when the solenoid valve closes main fuel line and is operated by the microcontroller.

Fig. 5: Bypass Reservoir

e. **Flow meter:** PIUSI K24 flow meter is used to measure the amount of fuel passing to fuel tank which works on two 1.5 V batteries.

Fig. 6: Flow Meter

f. **Fuel tank:** A fuel tank (or petrol tank) is a safe container for flammable fluids. Though any storage tank for fuel may be so called, the term is typically applied to part of an engine system in which the fuel is stored and propelled (fuel pump) or released (pressurized gas) into an engine. Construction of fuel tanks follows a series of specific steps. The craftsman generally creates a mockup to determine the accurate size and shape of the tank, usually out of foam board. The capacity of fuel tank used for our design is seven liters.

Fig. 7: Fuel tank

g. **SIM 808 module:** SIM808 module is a GSM/GPS/BT three-in-one function module. It is based on the latest GSM/GPS/BT module SIM808 from SIMCOM, supports GSM/GPRS Quad-Band network and combines GPS technology for satellite navigation. It has high GPS receive sensitivity with 22 tracking and 66 acquisition receiver channels. Besides, it supports A-GPS that is available for indoor localization.

The module is controlled by command via micro controller and supports 3.3V and 5V signal transfer control data using SMS or GPRS between two machines located at two different factories. It is used in remote control of appliances. Main application is in Vehicle tracking System.

Fig. 8: SIM 808 module

h. **LED**: Red and green LEDs are used for indication of normal case and misfuelling case.

i. **Buzzer**: It is used to alert the driver that wrong fuel is entering to fuel line and is fixed at the instrument panel of the vehicle.

Fig. 9: Buzzer alarm

j. **Digital flow indicator:** PIUSI K24 flow meter transfer amount of fuel in liters to digital flow indicator.

k. **Fuel indicator operated by float**: A normal float mechanism which shows fuel level in tank.

l. **Power supply:** Power Supply: As the input to the microcontroller is 5V, we have used LM 7805 as a voltage regulator which has a fixed voltage of 5V.

4.3 Programming and hardware interface

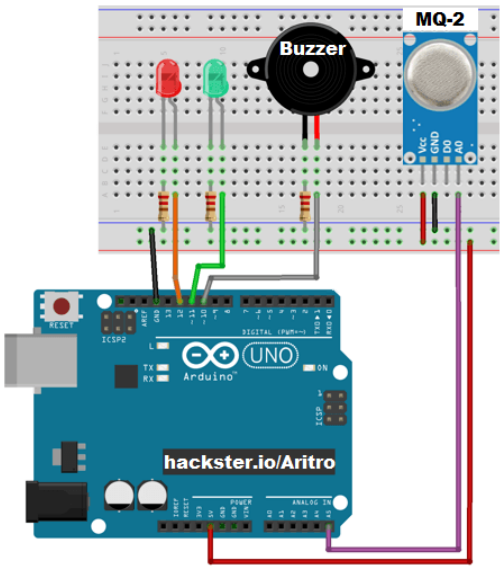

Fig. 10: Connection circuit of MQ2 smell sensor

After setting up the hardware components properly, we have to flash a C program in Arduino Microcontroller and adjust the variable "Sensor Threes" with a different threshold value and the programme is as follows:

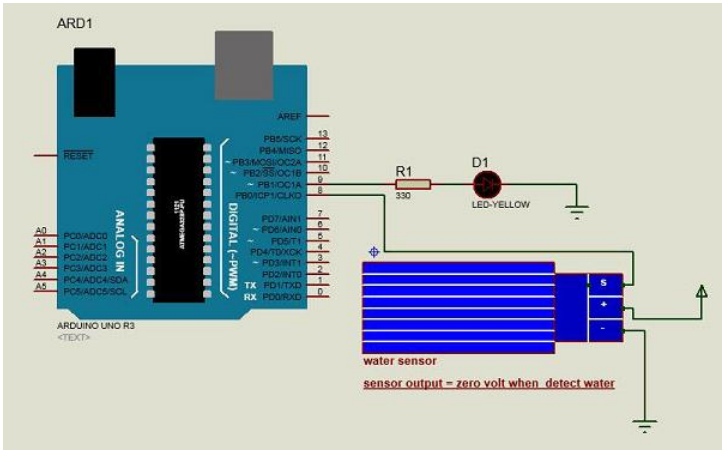

Fig. 11: Connection circuit of water sensor

5. FABRICATION OF AUTOMATED RE-FUELING SYSTEM FOR AUTOMOBILES

In accordance with all the needs we have fabricated an automated refuelling system which includes some major parts namely Smell sensor (MQ2) for the identification of the fuel being injected to the tank, an Arduino uno Microcontroller in which all the sensors are programmed, a Flow meter to detect the amount of fuel entering to the tank and its display unit, a solenoid valve which helps in bypassing the wrong fuel being fueled to the tank and a Fuel indicator operated by float to determine the remaining fuel in the tank, a *GSM-GPS* module for sending warning message to the owner and for locating the position of fuel station. In addition to this LEDs, fuel tank, buzzer, power supply,

bypass reservoir, etc. was also installed to meet the needs of fabricating the system.

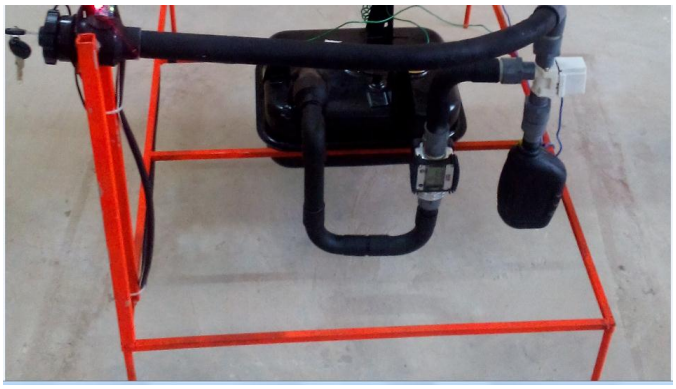

Fig. 12: fabricated model of automated re-fuelling system for automobiles with real – time GPS alerts

6. CONCLUSIONS

The project intelligent refueling management system is a very advanced type indicating system. The implementation of the system was very smooth, easy and effective at a very low cost compared to all other techniques. It could give an accurate value of the remaining fuel in the tank and also the amount of fuel while refilling or fuelling the system. The operation time taken is very less i.e, micro seconds. The calculated value is then displayed on the display unit which is kept on the dash board. The proposed idea also consists of a system which identifies the type of fuel which is filled in the fuel tank. Thus the filling of wrong type of fuel could be avoided by warning the driver thus avoiding further complications in the vehicle engine. It also includes a sensor system with a buzzer and LEDs to warn the driver about the fuel if it is a wrong one.

The test for the work has been conducted by fuelling the system with diesel and found that the system is 90% - 95% efficient and also the wrong fuel could be determined accurately. We have achieved a least possible error and maximum accuracy in the measurement of the fuel. Thus, it is an efficient device made by keeping in mind about the petroleum thefts at the various petrol pumps at the time of filling of tanks and also the large loss happening to the owners if wrong fuel is being refilled.

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