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Flow rate based Fuel Quantity Measurement and Advance SMS system for vehicle

Hardik J. Gohil[1], Chintan T. Patel[2], Aman S. Rupareliya[3], Nisarg H. Ranpura[4],

MohitSingh G. Rajpurohit[5], Dhavalkumar K. Patel[6]

[1-4]UG student, Department of Automobile Engineering, L. D. College of Engineering, Ahmedabad, Gujarat, India
[5]Mechinical Engineer, Executive at Johnson Controls Hitachi Air Conditioning, Gujarat, India
[6]Asst. Professor, Department of Mechanical Engineering, L. D. College of Engineering, Ahmedabad, Gujarat, India

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Abstract - *The present invention relates to improving the accuracy of fuel quantity measurement in Passenger and Commercial vehicles. Conventional fuel quantity measuring analog meters are not providing an accurate or numerical value of the quantity of fuel inside the fuel tank. Thus, occasional fuel theft cases may be observed by the customer. The transportation industry is significantly affected by fuel costs. Any fuel theft cases or fake fuel bills can reduce their profit margins. With our Flow rate-based fuel measurement system, users can get the exact amount of fuel added into the fuel tank. Our invention is based on the principle of measurement of the Flow rate of fuel with help of a turbine flow meter. The processor derives the output from the sensor's signal. The previous fuel level, fuel lastly added, and current fuel level are displayed digitally on the output panel in the form of digits. The GSM module also sends the notifications of the last fuel transaction to a registered mobile number. For industries like transportation, fuel consumption data is saved and can be used to analyze and manage fuel consumption.*

***Key Words*: Fuel quantity measurement, Advance SMS system, Passenger and commercial vehicles, Flow rate based fuel quantity measurement, fuel level measurement.**

1. INTRODUCTION

This innovation is an integrated system of sensors, GSM module, and control unit for data processing and a display to print the output. The system uses input from three sensors that are namely turbine flow sensor, oval gear flow sensor, and infrared sensor. For calculation of required parameters such as volume inflow and outflow, the inputs from these sensors are taken into a microprocessor[1].

The infrared (IR) sensor performs the test function of monitoring if the fuel tank cap is open or closed[2]. At each transaction at the fuel station, the turbine flow sensor performs the function of measuring the fuel inflow into the tank. This sensor works with optical sensing to create an electrical pulse to measure the rate of flow. The oval gear-flow sensor measures the fuel tank outflow.

It is a positive displacement flow meter that measures the correct flow rate irrespective of fuel temperature or changes in viscosity[3]. An oval gear pair that is precisely adjusted and well-formed acts as the sensing element in the sensor. The fuel flow causes rotation of the pair of gears. The rotating motion is sensed by non-contact sensors resulting in a pulse being produced. These pulses are refined and used to measure the rate of flow. The flow rate is used to calculate the fuel volume exiting the tank.

The GSM module is used to send the message wirelessly with the amount of fuel added in the last transaction to the tank, and other necessary details[4]. In harmony these all elements work together to efficiently produce the desired output.

2. Working of the Invention

2.1 Detailed Description of the Invention

The following description relates to a particular manifestation of the present invention. The present invention comprises four main parts namely data acquisition, processing microcontroller, wireless communicator, and a display panel.

Data acquisition relates to the fuel flow sensor present at the neck of the fuel tank to measure the flow rate of the fuel filled in a particular instance, an infrared sensor is used to detect if the fuel tank cap is open or not. The fuel flow sensor at the neck of the fuel pump is to measure the flow rate of fuel flowing to the engine and surplus fuel returning to the fuel tank.

The microcontroller receives an initial digital signal from the infrared sensor which tells that the cap of fuel tank is opened for refueling. After the fuel is filled, another digital signal is sent by the infrared sensor which points out that the cap is closed. Thus the microcontroller calculates the fuel volume filled in the fuel tank from the signals from the fuel flow sensors.

The microcontroller also calculates the fuel efficiency of the vehicle using the necessary data of net fuel outflow and the distance travelled during the same time. The microcontroller also processes the real-time level of fuel in the fuel tank from the level of fuel filled in the fuel tank and the amount of fuel being used.

The main objective of the present invention is to deliver real-time data to the owner of the automobile. Thus a GSM module is incorporated which is installed with a registered sim card. The digital output from the microcontroller is passed to the GSM module which then transmits the level of fuel in the tank, the volume of fuel refilled at a fuel station, and the volume of the fuel used for a particular journey to the registered mobile device.

The present invention is also used to protect the owner of the vehicle against trickery from the fuel station.

The same quantities are displayed in the LCD installed in the dashboard of the vehicle to aid the driver also.

The invention is also useful for those individuals who lend money to helpers for refueling of their vehicles, as they would know if the money is used for the same or not.

It is also useful to the driver as it will warn them for servicing of the vehicle if overconsumption of fuel is occurring.

The design can be divided into two subsystems, one with all the sensors and the other with the microcontroller.

The sensory subsystem includes a fuel flow sensor, Infrared sensor, which is housed in the fuel tank. Another fuel sensor is located between the fuel pump and engine and GSM Module linked to Arduino R3.

The fuel flow sensor is placed at the neck of the fuel tank, to measure the flow rate of fuel filled in by the fuel dispenser. An infrared sensor is fixed at the inner ceiling of the fuel tank to check the state of the fuel cap (open or closed).

The fuel flow sensor functions according to the principle of the Hall Effect. It is fitted with a water rotor and a Hall Effect sensor. When fuel flows through the valve the rotor will rotate. Through this, the change can be observed in the motor speed. The Hall Effect sensor calculates that change as output as a pulse signal. Thus, the fuel flow rate can be measured.

Infrared sensor, which consists of a receiver and an emitter. The emitter guides an infrared beam which is traced back to the receiver after being reflected from the fuel cap which determines if the fuel cap is closed or not.

Fuel flow sensor, which is an oval geared type, consists of oval geared rotors rotating inside a specific geometric housing. This is located at the fuel pump neck, to measure the fuel flow rate when fuel exits the fuel tank.

The sensor readings from the fuel flow sensor, IR sensor, and oval gear fuel flow, sensors are transmitted to Arduino R3.

Arduino R3 is an open-source microcontroller board based on the microchip ATmega328P. It has 20 digital input/output pins. Program to use the inputs from the sensors and provide an accurate output is uploaded into it. It also contains a 16 MHz resonator, a USB connection, a power jack, an in-circuit system programming header, and a reset button.

Using a 12 V DC rechargeable battery, Arduino R3 and fuel pump are supplied with electricity. All the sensors are relayed power by power cables via Arduino R3.

GSM module, features an interface that delivers 900/1800 MHz performance for voice, SMS, data, and fax in a small form factor. A registered sim card will be inserted into the GSM module.

GSM module will be used to deliver an SMS regarding the quantity of fuel filled inside the tank to the registered mobile device.

In the invention red cable is used to supply power, black cable is used to ground the component. Arduino R3 is connected to the positive terminal of the 12V DC rechargeable battery through a red cable and the negative terminal is grounded to the vehicle frame by the black cable. Arduino R3 is also grounded by a black cable. The red cable from the 12 V DC battery is branched to connect the GSM module. GSM module is grounded by the black cable.

Red cable from 5V port of Arduino R3 is branched out to supply power to fuel flow sensor, Infrared sensor, and oval gear fuel flow sensor. The ground ports of all the sensors are connected to the GND port of Arduino R3, by a black cable.

Analog signal from fuel flow sensor is transmitted to input port A0 of Arduino R3 by a blue cable. Analog signal from Infrared sensor is transmitted to input port A1 of Arduino R3 by a green cable. Analog signal from fuel flow sensor is transmitted to input port A2 of Arduino R3 by a purple cable.

GSM module consists of 4 ports namely VCC, TXD, RXD, and GND. GND port of the GSM module is connected with the GND port of Arduino R3 by a black cable. TXD port of GSM module is connected to digital output port RX-0 of Arduino R3 by a yellow cable. RXD port of GSM module is connected to digital output port TX-1 of Arduino R3 by a dark orange cable. TX and RX are serial ports used for communication between the microcontroller Arduino R3 and GSM module.

The red cable from the 5V port of Arduino R3 is connected to the VCC port and LED+ port of the fuel level indicator display, to supply power to the display. The digital output GND port of Arduino R3 is connected to VSS, VEE, RW and LED- ports of fuel level indicator display by a black cable. VSS port is used for grounding the circuit, VEE port is used for contrast control, and RW port selects reading mode or writing mode.

A dark blue cable is used for connecting the Arduino R3 digital output port 12 with the fuel level indicator RS port display. RS port controls where you write data to the LCD's memory. You can either select the data register, which holds what is going on the screen, or a register of instructions, which is where the controller of the LCD is looking for instructions on what to do next.

A light orange cable is used to connect the digital output port 11 of Arduino R3 with the E port of the fuel level indicator display. E port enables writing to the registers.

Digital output port 5 of Arduino R3 is connected to data pin D7, of fuel level indicator display through a purple cable. Digital output port 4 of Arduino R3 is connected to data pin D6 of fuel level indicator display through a blue cable. Digital output port 3 of Arduino R3 is connected to data point D5 of fuel level indicator display through a green cable. Digital output port 2 of Arduino R3 is connected to data pin D4 of fuel level indicator display through a light blue cable.

2.2 Arduino R3 Code[5]

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <SoftwareSerial.h>
SoftwareSerial mySerial(10,11);
LiquidCrystal_I2C lcd(0x27, 16, 2);
#define IRQ_A 0
#define IRQ_B 1
#define FlowA 2
#define FlowB 3
int qty, finqty;
char msg,call;
int SendMessageCount = 0;
const int IRsensor = 6;
volatile unsigned long countIN = 0, countOUT = 0;
unsigned long oldTime  = 0;
float flowRate;
volatile float pulseCountIN, pulseCountOUT, pulseCount;
float liters;
void setup()
{mySerial.begin(9600);
 pinMode(IRsensor,INPUT);
 Serial.begin(9600);
 lcd.begin();
 pulseCountIN = 0.0;
 pulseCountOUT = 0.0;
 pulseCount = 0.0;
 flowRate = 0.0;
 pinMode(FlowA, INPUT);
 pinMode(FlowB, INPUT);
 digitalWrite(FlowA, HIGH);
 digitalWrite(FlowB, HIGH);
 liters = 0.0;
 attachInterrupt(IRQ_A, CounterIN, RISING);
 attachInterrupt(IRQ_B, CounterOUT, RISING); }
void loop()
{  unsigned long now = millis();
 if(now - oldTime >= 1000)
 { unsigned long duration = now - oldTime;
   oldTime = now;
   pulseCount = (pulseCountIN - pulseCountOUT) / 
10000.0 * 3600;
   flowRate = ((1000.0 / (millis() - oldTime)) * 
pulseCount);
   unsigned int frac;
   Serial.print("pulseCountIN: ");
   Serial.println(pulseCountIN*1000/450);
   Serial.print("pulseCountOUT: ");
   Serial.println(pulseCountOUT*1000/2725);
   Serial.print("TOTAL: ");
   Serial.println((pulseCountIN*1000/450)-
(pulseCountOUT*1000/2725)); }
 if(digitalRead(IRsensor)== HIGH && SendMessageCount 
== 0)    //Check the sensor output
  {  Serial.println("FUEL CAP WAS CLOSED AFTER 
REFUELING");
   Serial.println((pulseCountIN*1000/450)-
(pulseCountOUT*1000/2725));
   Serial.println((pulseCountIN*1000/450)-(qty));
   lcd.setCursor(0,0);
   lcd.print("new in");
   lcd.print((pulseCountIN*1000/450)-(qty));
  SendMessage(); }
```

```
  if(digitalRead(IRsensor)== LOW && SendMessageCount
== 1)
  {Serial.println("FUEL CAP WAS OPENED");
   SendMessageCount = 0;
   qty = countIN*1000/450;  }
  if (mySerial.available()>0)
{ Serial.write(mySerial.read()); }
lcd.setCursor(0,1);
lcd.print("total");
lcd.print((pulseCountIN*1000/450)-
(pulseCountOUT*1000/2725)) }
 void SendMessage()
  {mySerial.println("AT+CMGF=1");        //Sets the GSM
Module in Text Mode
  Delay (1000);
   mySerial.println("AT+CMGS=\"+xxxxxxxxxxxx\"\r");  //
Replace x with mobile number
 Delay (1000);
   mySerial.println((pulseCountIN*1000/450)-(qty));//
Replace x with The SMS text you want to send
 Delay (1000);
   mySerial.println((char)26);// ASCII code of CTRL+Z
   SendMessageCount++; }
void CounterIN()
{ countIN++;
 pulseCountIN++; }
void CounterOUT()
{ countOUT++;
 pulseCountOUT++; }
```

3. Description of Drawings:

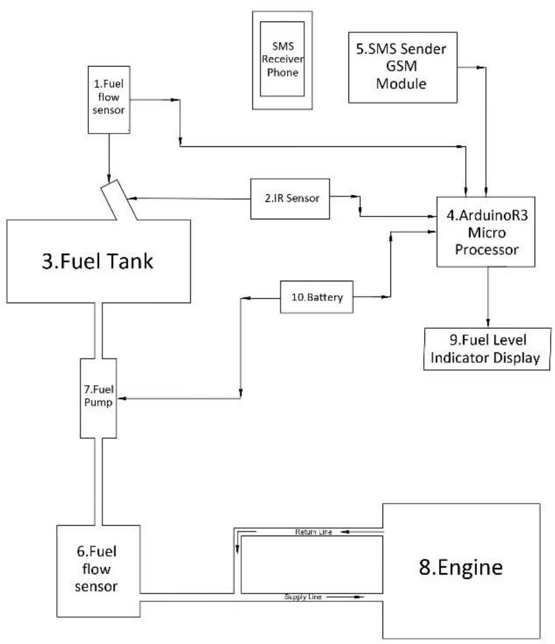

Figure 1

Figure 1 shows the block diagram of the present invention.

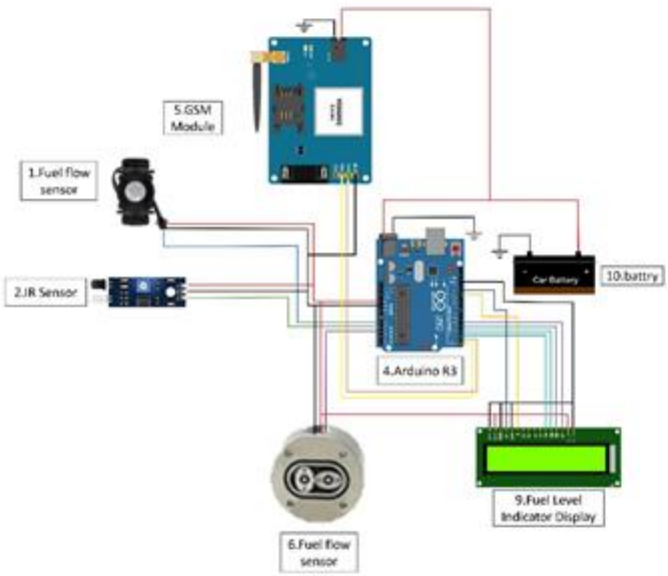

Figure 2

Figure 2 shows the circuit connections of the present invention.

4. CONCLUSION

This invention will save a lot of money for the transportation industry and fuel suppliers. These industries relying heavily on fuel consumption and transportation will benefit a lot monetarily as any fuel thefts or adulteration will be caught. This invention will give the exact amount of fuel added or removed from the fuel tank so any theft be it small or big will get caught. It will improve the accuracy of fuel quantity measurement in Commercial vehicles as well as Passenger vehicles, so any person can benefit from this invention and protect themselves from possible fuel thefts and see their vehicle mileage accurately.

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BIOGRAPHIES

Mr.Hardik J. Gohil, is a final year student of Department of Automobile Engineering, L.D. College of Engineering, Gujarat Technological University.

Mr.Chintan T. Patel, is a final year student of Department of Automobile Engineering, L.D. College of Engineering, Gujarat Technological University.

Mr.Aman S. Rupareliya, is a final year student of Department of Automobile Engineering, L.D. College of Engineering, Gujarat Technological University.

Mr. Nisarg H. Ranpura, is a Mechanical Engineer, currently working with Johnson Controls Hitachi Air Conditioning as Executive in Global Development Center.

Mr. MohitSingh G. Rajpurohit, is a Second year student of Department of Automobile Engineering, L.D. College of Engineering, Gujarat Technological University.

Prof. Dhavalkumar K. Patel, is presently associated with the L. D. College of Engineering, Ahmedabad as an assistant professor in the Mechanical engineering Department.