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Internet of Things for Fuel Leakage Detection

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Abstract : The issue of fuel leakage or theft are common problems in Vehicle these days. Due to dire requirement of own transportation, in developing countries we notice lot of demand for own vehicles commonly two wheelers. or four wheelers. Fuel theft is one of the common issues in parking areas. The soaring fuel prices are generating humongous revenue for all the ill-minded people involved in these thefts. The simple connectivity from engine to fuel tank is making the system vulnerable to such threats. Apart from threats, there are many instances of the leakage of fuel, resulting in the loss of fuel. To mitigate such risks, we have come up with an idea to build a Microcontroller based system for detecting leakages and thefts using "IOT" (Internet of Things). The aim of this work is to develop a model using Internet of Things (IOT) which can be used to detect fuel theft and leakage from the vehicle. If a theft or leakage is detected, the owner of the vehicle will be alerted automatically through a mobile message indicating the flow or leakage of the fuel. We used various components like the Arduino Uno, Humidity Sensor, Temperature Sensors and a GSM Module to build the model. This work demonstrated efficient results.

Keywords: Fuel Leakage, Humidity Sensor, GSM Alert System

I. INTRODUCTION

1.1 Introduction : Fuel is one of the most valuable resources in the world today. Many non-renewable resources like petrol, fuel, diesel, and natural gas play a vital role in today's fast paced world. According to the sources, there are nearly 1.4 billion cars on the road by the end of 2020, enhancing the vehicle saturation to 18 per cent. Most of the vehicles need Petrol or Diesel as the primary source of fuel to operate smoothly. This figure substantiates the fact that the demand for Petrol and Diesel is soaring high. All these resources occur naturally and take thousands of years to form., which are either extracted straight from the earth or produced by refining substances such as petroleum. Because of its demand, fuel has become a valuable resource. According to a survey, 133 billion dollars of fuel is stolen or adulterated every year. Fuel is one of the most stolen commodities in the world. Many measures and stringent laws to get their way, traffickers are using different methods to steal, alter and then sell fuel. This work has been developed to mitigate such thefts and leakage.

3. LITERATURE SURVEY

In this section we list the works that motivated our work to detect and alert "Fuel thefts or leakages" to its owner. There is very little research done in this area. It is a very recent research area. In a system developed by Mr. P. Senthil Raja and Dr. B.G.Geetha, Vehicle Area Network (VAN) and embedded design have been used[1]. In the proposed system, the owner of the vehicle immediately receives a message when the fuel tank is opened by the operator or by a fuel trader, he receives the height of the fuel tank when opening and closing of the tank lid. The system uses wireless-based communication for monitoring the vehicle's position. The process involves measuring the fuel level followed by eliciting the information and sending it to the server for further detection. The major drawback observed in this project is that the numeric lock opens after several trials, is very time consuming, also the proposed system is extremely expensive. There is a scope of improvement for sensors.

Similar work is done by Mr. M. Saravanan, Mr. T. Krishnapriya, Mr. S.R. Lavanya, and Mr. P. Karthikeyan contributed their efforts in making this system[2]. There are various methods to monitor the quantity of fuel namely Dipsticks, level sensors, float switch, load cell, analog, and digital meters, Dipsticks are widely used and it is a manual job. To overcome this issue, this system is proposed to know the number of liters present inside the tank with the help of the Ultrasonic sensor and GSM to indicate the level in case of full/empty and theft. The disadvantages observed here are that it requires continuous electric energy for the production and

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display of signals. It also requires an amplification circuit for the generation of display because the signals produced by the gauge itself are of very much low voltage, almost in millivolts. It cannot be used for highly reactive or corrosive materials because they can damage the gauge. It cannot be used for the measurement of very high pressure if the diaphragm used is made of plastic.

Mr. Heda Venkata Sai Ajith1 and Mr.Pinjala Sai Kiran have developed an Antitheft security system that utilizes an embedded system designed with GSM to monitor and safeguard a car[3]. In an attempt of theft, the system sends a text message to the car owner and at the same time starts up an alarm from the buzzer installed within the system. The sensors are not effective in most cases, also, it is complicated to do the setup within the fuel tank.

Ms. Nandini Hiremath, Ms. Mrunali Kumbhar1, and Ms. Aakriti Singh Pathania developed one more system. The system includes a GPS module, Microcontroller, GSM module, LCD, and a keypad[4,5]. The GPS module transmits coordinates to the microcontroller that converts the data which is sent to the user in text format. This text message contains the longitude and latitude of the location. This smart system gives 24x7 access to fuel consumption, alerts when fuel drains, and storage tank leaks immediately identified. The only drawback observed here is the size of the model. It is not ideal to fit in small tanks.

The manual locks from third party manufacturers are being used popularly, but the vehicle manufacturers never advise to install such in the fuel system since it interferes with the flow of the fuel and results in poor engine performance and ultimately deteriorating the functioning of the vehicle and can easily be hacked with simple tools like a screwdriver.

Our approach is to develop a model using Internet of Things (IOT) that can autonomously detect fuel theft or leakage. We used various components like the Arduino Uno, Humidity Sensor, Temperature Sensor and a GSM Module to build the model. Humidity sensor is used to check the humidity in the fuel pipe, Temperature sensor was used to check the temperature of the engine and GSM module is used to autonomously send a message to the owner of the vehicle.

3. Technology

3.1 ARDIUNO UNO : The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The word "uno" means "one" in Italian and was chosen to mark the initial release of Arduino Software. The Uno board is the first in a series of USB-based Arduino boards. The ATmega328 on the board comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer. While the Uno communicates using the original STK500 protocol, it differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Arduino code is written in C++ with an addition of special methods and functions, which we'll mention later on. C++ is a human-readable programming language. When you create a 'sketch' (the name given to Arduino code files), it is processed and compiled to machine language.

3.2 LM35 – Temperature Sensor : LM35 is a precession Integrated circuit Temperature sensor, whose output voltage varies, based on the temperature around it. It is a small and cheap IC which can be used to measure temperature anywhere between -55°C to 150°C. It can easily be interfaced with any Microcontroller that has ADC function or any development platform like Arduino. Power the IC by applying a regulated voltage like +5V (V_S) to the input pin and connected the ground pin to the ground of the circuit. Now, you can measure the temperate in form of voltage as shown below.

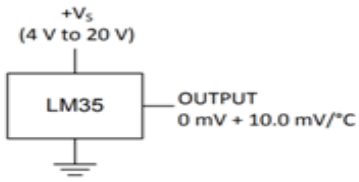

Figure 1: Measure of Voltage

If the temperature is 0°C, then the output voltage will also be 0V. There will be rise of 0.01V (10mV) for every degree Celsius rise in temperature. The voltage can be converted into temperature using the below formulae.

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V_{OUT} = 10 mv/°C × T

where

- V_{OUT} is the LM35 output voltage
- T is the temperature in °C

3.3 REES52 – The Humidity Sensor : The Humidity Sensor uses capacitance to measure dielectric permittivity of the surrounding medium. The dielectric permittivity is a function of the water content. The sensor creates a voltage proportional to the dielectric permittivity, and therefore the water content of the pipe. The sensor averages the water content over the entire length of the sensor. There is a 2 cm zone of influence with respect to the flat surface of the sensor, but it has little or no sensitivity at the extreme edges. The figure below shows the electromagnetic field lines along a cross-section of the sensor, illustrating the 2 cm zone of influence.

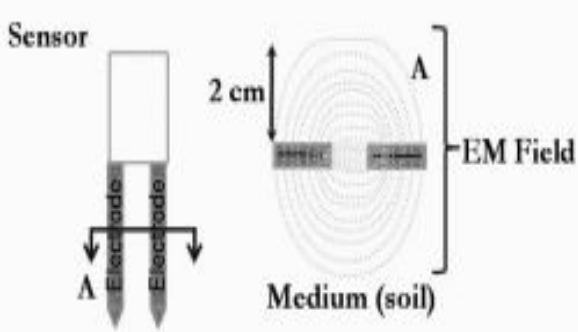

Figure 2:Electromagnetic Field in REEES52 Sensor

4 Methodology

Our system uses a microcontroller-based Arduino Uno board for processing all user commands. Arduino Uno is used since it has an inbuilt module which is used to connect to the user device and receive user commands. Device will monitor the environment using different sensors and with the help of the GSM Module SIM900A, an alert is sent to the user's mobile. Our system is cost effective and easy to deploy. Also, the temperature and humidity sensors used work with great efficiency with almost zero percent chances of error.

4.1 Architecture : The below diagram depicts block diagram of the overall functioning of the system with the IoT devices. In this work LM-35 Sensor monitors and reports vehicle temperature REE$52 sensor returns the humidity information. When the bike is started, Temperature raises, and monitored with LM-35 Sensor, and the leakage of the fuel is monitored using REE$52 sensor to check the humidity. If bike starts and humidity is more it will not send an alert message, whereas the bike is off and the humidity is more then the system raises an alarm to the user via GSM module.

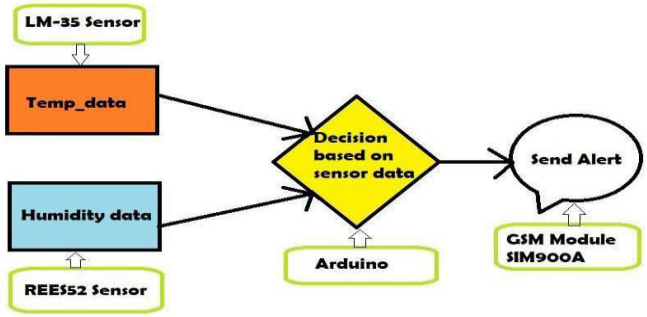

Figure 3 : System Architecture

4.2 Implementation

4.2.1. Instantiation

```
#include <SoftwareSerial.h>
SoftwareSerial SIM900(7, 8); // gsm module connected here
```

The Arduino hardware has built-in support for serial communication on pins 0 and 1 (which also goes to the computer via the USB connection). The native serial support happens via a piece of hardware (built into the chip) called a uart. This hardware allows the Atmega chip to receive serial communication even while working on other tasks, as long as their room in the 64-byte serial buffer. The SoftwareSerial library has been developed to allow serial communication on other digital pins of the Arduino, using software to replicate the functionality (hence the name "SoftwareSerial"). It is possible to have multiple software serial ports with speeds up to 115200 bps. A parameter enables inverted signaling for devices which require that protocol.

4.2.2 Global Variables

```
String textForSMS;
const int T_pin=A5; //Analog pin to receive Temperature data.
const int H_pin=A0; //Analog pin to receive Humidity data.
```

- These are the user defined global variables for our system where the string "textForSMS" takes the message to be delivered as an alert.

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- T_pin reserves the A5(Analog pin) to receive the temperature data from LM35 temperature sensor.
- H_pin reserves the A0(Analog pin) to receive the Humidity data from REES52-The Humidity Sensor.

4.2.3 Receiver's Mobile Number

```
String mob_no = "+919398668718"; // Mobile number to which you want to send the security alert message
```

The string mob_no holds the mobile number of the vehicle owner to whom the message is sent autonomously.

4.2.4 Decision Statement

The decision statement plays a pivotal role in our system, where it analyses the Temperature and Humidity data. The temperature and humidity data are constantly received from sensors. There is a possibility of two cases:

i. Temperature is high(>40^0c) and the humidity is present (level>60):

This depicts that the vehicle is in the running condition and it is switched on legally by the owner, as the temperature of the engine is high and the fuel is flowing through the pipe.

ii. Temperature is high (temp <40^0c) and the humidity is present (level>60):

This depicts that the vehicle is in the idle state and the fuel is flowing through the fuel pipe. It forms the case of unconventional activities like fuel theft or leak, as temperature of the engine is low and the humidity is sensed in the fuel pipe. After the sense of an unauthorized activity an alert message is sent autonomously to the vehicle owner's mobile through a GSM module.

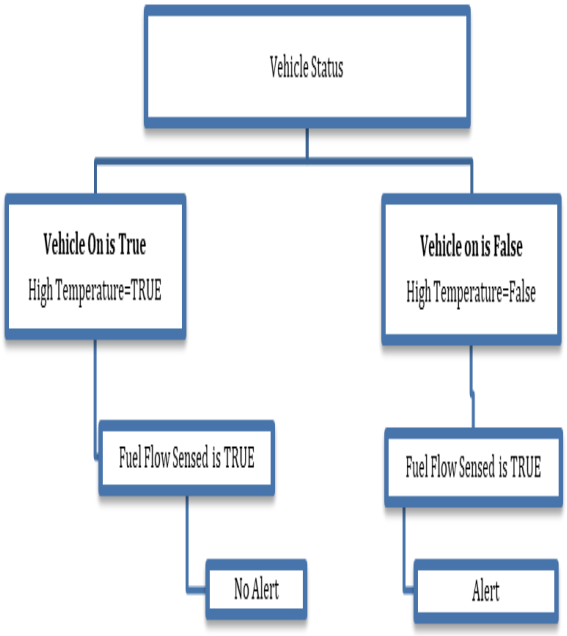

Figure 4: Decision Process for Proposed Model

4.2.5 User defined function to send Alerts

```
void sendsms(String message, String number)
{
  String mnumber = "AT + CMGS = \""+number+"\"";
    SIM900.print("AT+CMGF=1\r");
    delay(1000);
  SIM900.println(mnumber);  // recipient's mobile number, in international format

   delay(1000);
   SIM900.println(message);                    // message to send
   delay(1000);
   SIM900.println((char)26);                   // End AT command with a ^Z, ASCII code 26
   delay(1000);
   SIM900.println();
   delay(100);                                 // give module time to send SMS

}
```

In the above function we make use of the predefined methods from the SoftwareSerial.h header file to transform the mobile number and assign it to the GSM module. Then, the alert string is converted in to ASCII code. The converted data is transferred to the mobile as an alert message. A small amount of delay is made so that the GSM module is not overwhelmed with the data. The entire process consumes less than 10 seconds to sense and send alert.

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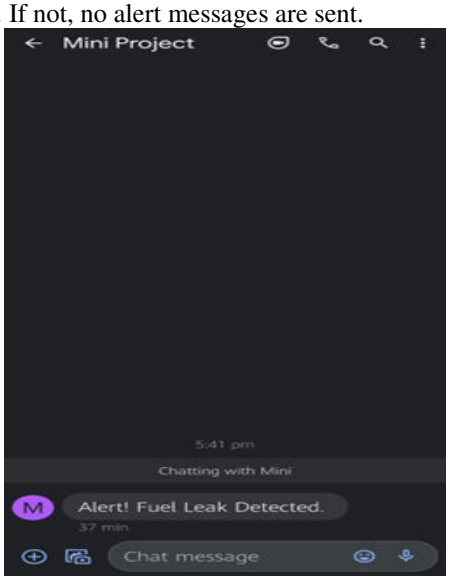
- The **LM35**, the temperature sensor can determine temperatures ranging from -50^{0}c to 200^{0}c.
- The **REES52**, the humidity sensor can determine even the little flow of fuel through the pipe instantly.
- **Arduino Uno** collects the data from both the sensors and assess the data for every 2 microseconds, which makes the system very vigilant.
- With decent network availability the **GSM module** can send the alert message to the owner's mobile in less than 5 seconds.

LM35(temp sensor) & REES52(Humidity sensor) sensors in the system helps to detect the leak or theft. If it detects any mischievous behavior in the fuel flow with respect to engine temperature the Arduino sends alerts. If not, no alert messages are sent.



Above is the alert message received by owner's mobile in one of our test cases.

5. CONCLUSION AND FUTURE ENHANCEMENTS

In this work, we prepared an Autonomous Anti-theft/Leakage detection system using Internet of Things (IOT). This system is capable of autonomously detecting a fuel leakage or theft. We have created a working model to show the process of execution. The system was developed with the help of various components like Arduino Uno, Humidity sensor, Temperature sensor and a GSM module. The system is efficient when the owner's mobile is in the signals range. If the mobile doesn't receive the signal the owner may not be aware of the leak. In such cases, an alarm can be fixed to the vehicle, which alerts the owner regarding the theft. Since Arduino ports support only one alerting component at a time, we have connected a GSM module for representation. However, while developing a bigger system that can be fixed in the cars, we can also provide the facility of alarm along with the GSM module. The aim of this project is to inform the owner about the fuel theft or leakage happening in his vehicle on the go. This system can prove very effective to mitigate awful fuel thefts. In the case of bad network signals, the GSM may not be able to send a message to the owner's mobile. In such cases, fixing an alarm to the vehicle will help the user to know regarding the theft or leakage. As of now, only GSM functionality is installed in the system, in future it can be improved by integrating both the alarm system and GSM features[6].

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