

## RESEARCH ARTICLE

# Smart IoT Based System for Monitoring and Detecting Fuel Theft and Fuel Indication for Refilling Process

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Received: 25 April 2023 / Revised: 27 May 2023 / Accepted: 09 June 2023

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DOI: 10.5281/zenodo.8068149

**Abstract** – Theft of fuel in vehicles is a prevalent issue in many regions, leading to financial losses for vehicle owners and fuel stations. To address this problem, a smart fueling system is proposed that utilizes sensors to detect fuel theft and alert the vehicle owner. The system incorporates an analog-based fuel status check before and after refueling to ensure accurate fuel measurement. Additionally, GPS technology is employed to determine when a vehicle enters reserve mode and the system displays the nearest fuel station. The implementation of such a smart fueling system has the potential to significantly reduce fuel fraud incidents and improve the overall security and efficiency of the fueling process in vehicles.

**Index Terms** – Fuel level sensor, GPS Tracking, Fuel theft detection, Ultrasonic sensor.

## I. INTRODUCTION

Fuel level indication and theft detection are important features in modern vehicles that provide drivers with important information about their vehicle's fuel level and help prevent fuel theft. Fuel level indication systems are typically made up of a fuel level sensor, which is located inside the fuel tank, and a fuel gauge, which is located on the dashboard of the vehicle. The fuel level sensor measures the amount of fuel in the tank and sends this information to the fuel gauge, which displays the fuel level to the driver. This allows drivers to keep track of their fuel levels and plan their refueling accordingly.

Theft detection systems, on the other hand, are designed to prevent fuel theft by alerting the driver or vehicle owner if someone attempts to steal fuel from the vehicle. These systems may include



anti-siphoning devices, which prevent thieves from accessing the fuel tank, or fuel level sensors that can detect sudden drops in fuel level that may indicate theft. Some systems may also include alarms or notifications that are sent to the driver's smartphone or other device if a theft attempt is detected.

## II. LITERATURE SURVEY

"Development of a Fuel Monitoring System for a Mobile Generator Based on Internet of Things" by Cheng-Hong Yang et al. (2021) - This study proposes a fuel monitoring system for a mobile generator based on the Internet of Things (IoT) technology. The system includes a fuel level sensor, GPS tracker, and wireless communication module to provide real-time fuel monitoring and theft detection capabilities.[5]. "A Novel Fuel Theft Detection and Prevention System for Mobile Generators using Machine Learning Techniques" by Mohammad Abul Bashar et al. (2020) - This article proposes a fuel theft detection and prevention system for mobile generators using machine learning techniques. The system uses a fuel level sensor and machine learning algorithms to detect fuel theft and prevent further losses. [3]

"Smart Fuel Management and Theft Prevention System using IoT" by Deepika G. et al. (2020) - This article proposes a smart fuel management and theft prevention system using IoT. The system includes a fuel level sensor, GPS tracker, and IoT gateway to provide real-time fuel monitoring and theft prevention capabilities.[1] "Wireless Sensor Networks for Fuel Monitoring and Theft Detection in Automotive Systems" by Paulo Vinicius Koerich Borges et al. (2018) - This study proposes a wireless sensor network for fuel monitoring and theft detection in automotive systems. The system includes a fuel level sensor and wireless communication modules to provide real-time fuel monitoring and theft detection capabilities.[2] "Fuel Monitoring System for Vehicle Tracking and Management" by Hafiz Muhammad Umar Siddique et al. (2017) - This article proposes a fuel monitoring system for vehicle tracking and management. The system includes a fuel level sensor, GPS tracker, and wireless communication module to provide real-time fuel monitoring and theft prevention capabilities.[4]

Kaivalya Kulkarniet.al executed this fuel system using Raspberry Pi to compare the fuel level in the tank. The Raspberry pi was connected to the GSM/GPRS module. The voltage obtained from the fuel sensor was given as input to single channel ADC 0804. This converted an equivalent analog input voltage to the corresponding 8-bit digital output. These pins are connected to 8 Raspberry pins. The buzzer was directly connected to Raspberry Pi. When the system was ON, the Raspberry Pi stored the first value of the fuel level as the reference value. Whenever a false decline in fuel level occurs, the resistance of the fuel level sensor gets changed by the corresponding analog voltage obtained from the sensor. Raspberry pi converted this 8-bit binary output into an equivalent decimal format and compared it with reference value. If the difference exceeded the threshold value the buzzer was switched on. Then, Raspberry pi transmitted commands to the GSM module. It sends SMS/Call to the specified mobile number. After the SMS request, the current value of fuel became the reference value of Raspberry pi and again the process was started. This idea of implementation opens new avenues for safeguarding fuel from theft and has a wide range of applications. Thus, this project assured the owner of complete protection of fuel and the automobile considering the future aspects.[7]

### III. FUEL GAUGE

Fuel gauge as a crucial component to accurately measure the amount of fuel in the tank of a vehicle. The fuel gauge is connected to a sensor, which uses a float to measure the level of fuel in the tank. The sensor sends this data to an electronic circuit, which converts it into a digital signal using an analog-to-digital converter. This digital signal is then displayed on a user interface, such as a digital display, that shows the fuel level in numerical digits in real-time. To ensure the accuracy of the fuel gauge, calibration is performed to ensure that the fuel gauge accurately reflects the actual amount of fuel in the tank. This calibration process is typically done during vehicle assembly or can be done manually using specialized tools. The fuel gauge is an essential part of the Smart Fuel Level Indication System, as it provides accurate and realtime data about fuel consumption, which helps the vehicle owner to avoid situations where they run out of fuel or face fuel theft.

#### Techniques used in fuel detection

There are several techniques used for sensing and indicating fuel level in a smart fuel level indication system. Some of the commonly used techniques are: **Ultrasonic Level Sensing** In this technique, an ultrasonic sensor is used to measure the distance between the fuel surface and the sensor. Based on the distance, the fuel level is determined. **Capacitive Level Sensing** In this technique, a capacitive sensor is used to measure the capacitance between the fuel and the sensor. Based on the capacitance, the fuel level determined.



**Fig.1: Ultrasonic Level Sensing**



**Fig.2: Capacitive Level Sensing**

**Resistive Level Sensing** In this technique, a resistive sensor is used to measure the resistance between the fuel and the sensor. Based on the resistance, the fuel level is determined. **Magnetic Level Sensing** In this technique, a magnetic sensor is used to measure the magnetic field of the fuel. Based on the

magnetic field, the fuel level is determined. **Optical Level Sensing** In this technique, an optical sensor is used to measure the light reflection or refraction of the fuel. Based on the light characteristics, the fuel level is determined. Once the fuel level is determined using any of these techniques, it is indicated using a fuel gauge or a digital display in a smart fuel level indication system.

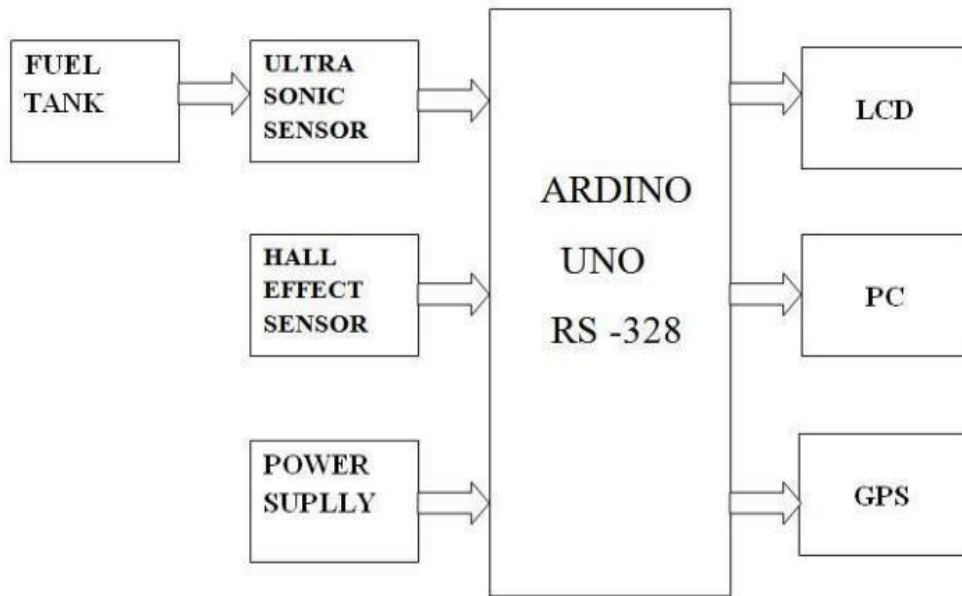
## Working

The Fuel Theft Monitoring project employs an Arduino (328P Microcontroller), an ultrasonic sensor for measuring fuel level, a flow sensor for detecting fuel theft, an LCD display for showing real-time fuel level, and a GSM module for sending SMS alerts to the user about fuel theft and fuel level. The circuit is powered by a 9V, 2A SMPS, which converts the 230V input from the main supply to 9V. The MCU measures the fuel level and displays it on the LCD display, along with the ignition ON/OFF condition. The flow sensor is used to detect the flow of fuel, and the GSM module sends an alert SMS to the user about the fuel level. In case of fuel theft during the ignition OFF condition, the owner receives an alert SMS, and a buzzer is used to alert the surrounding area about the fuel theft.

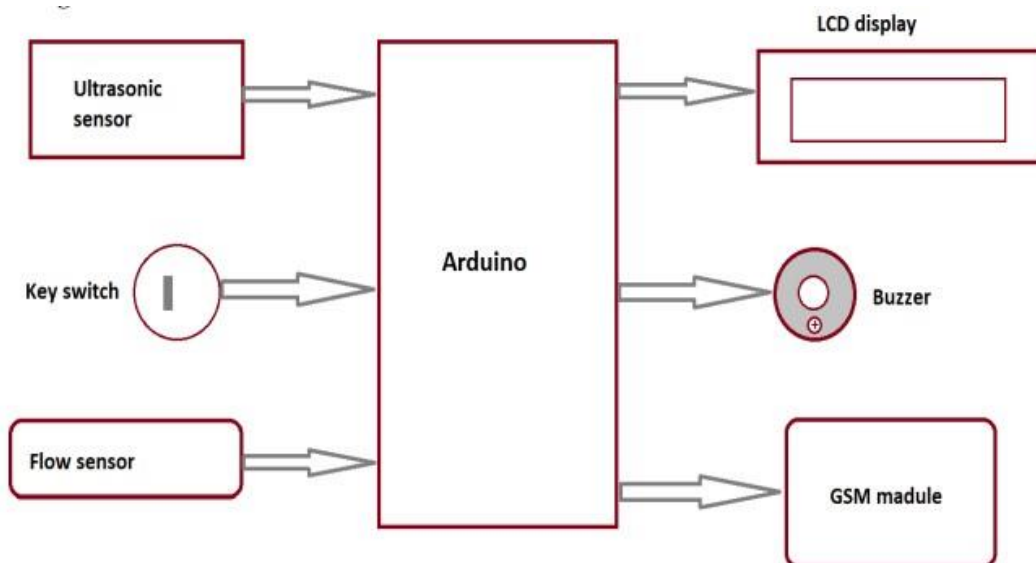
## V. IMPLEMENTATION PROCESS

The proposed system utilizes an ultrasonic sensor to accurately measure the fuel level in the vehicle tank by calculating the time required for ultrasonic waves to travel and reflect back to the sensor. An Arduino controller is used to interface with the ultrasonic sensor, which offers greater reliability compared to the 8051 controller. The system also incorporates a Hall Effect sensor to determine the vehicle's mileage by counting the rotations of the wheel. Additionally, when the fuel tank reaches reserve mode, the system's GPS feature will indicate the nearest petrol pump within a specified area. The ultrasonic sensor is directly connected to the fuel tank, and the Hall Effect sensor is mounted on the vehicle's wheel, allowing for easy calculation of distance travelled based on the number of rotations.

Install the ultrasonic sensor and the flow sensor in the fuel tank of the vehicle. Connect the sensors to the Arduino microcontroller board. Write and upload the code to the Arduino board to measure the fuel level and detect any fuel theft attempts. Connect an LCD display to the Arduino board to show the real-time fuel level and any other necessary information. Add a GSM module to the system to send an alert message to the vehicle owner's phone in case of fuel theft attempts or low fuel level. Add a buzzer to the system to provide an audible alert to the surroundings in case of fuel theft attempts. Power the entire system with a 9V, 2A SMPS connected to the main supply. Test the system by checking the real-time fuel level on the LCD display and ensuring that the GSM module sends alert messages when necessary. Install the system in the vehicle, ensuring that all components are properly secured and connected. Regularly check and maintain the system to ensure proper functioning and accurate fuel level measurements.



**Fig.3: Block diagram of fuel level indication system**



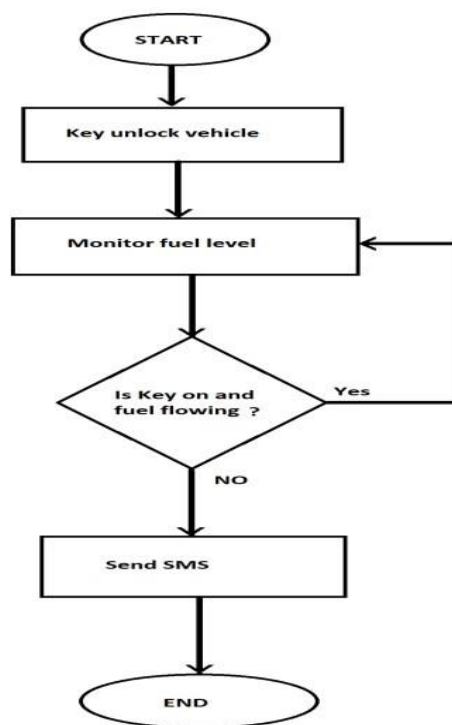
**Fig. 4: Block diagram of fuel theft detection and monitoring system.**

**Process Diagram**

It is basically a low level programming language to program a microcontroller. The action to be taken by the microcontroller depends on the type of signal received which in turn depends on the programming language.

The algorithm for the flow sheet is explained here.

- Step 1: Start the process
- Step 2: Enter unlock Keypad code
- Step 3: Check fuel level
- Step 4: Is fuel below the range? If “YES” then goto  
4.1: If “NO” the message will not be sent to owner. Step 5:  
Send text message to owner
- Step 6: Buzzer is “ON”
- Step 7: Check the buzzer is stopped within 2 minutes.
- Step 8: Send message to police station & owner.
- Step 9: Stop



**Fig.4: Flowchart**

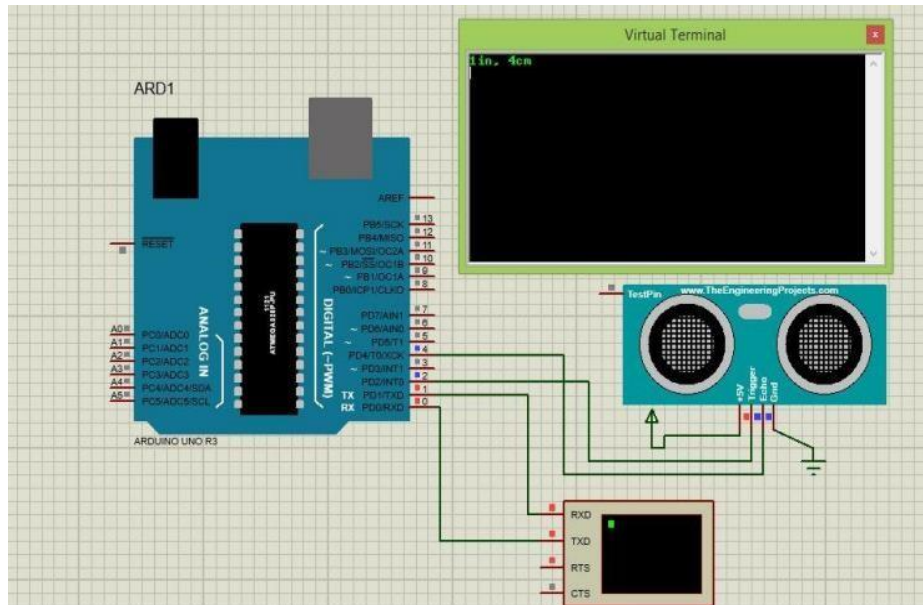
## VI. SIMULATION RESULTS

The simulation of the system was carried out separately on each module in proteus simulation environment.

### Ultrasonic Sensor Simulation

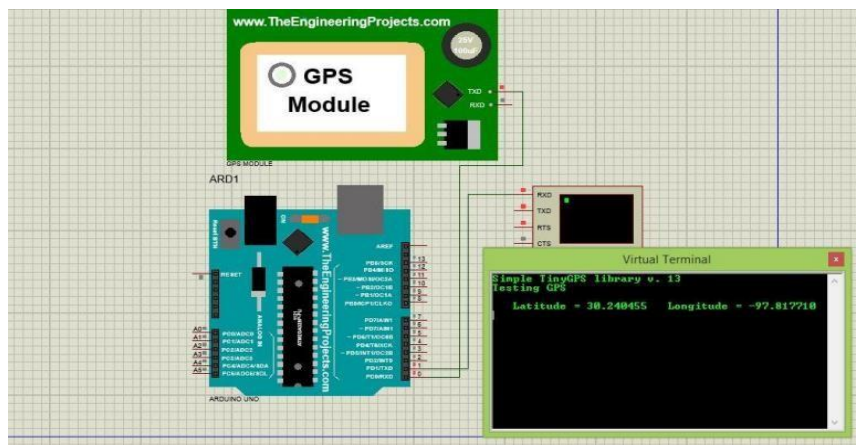
Ultrasonic refers to sound waves that are too high for humans to hear. These sound waves are used in various applications, such as medical imaging, distance measurement, and object detection.

Ultrasonic waves can bounce off surfaces and be detected by special sensors, which can then be used to determine the distance to an object, measure its size or shape, or detect any changes in the environment. Ultrasonic technology is often used in situations where other types of sensors, such as optical sensors, might not work effectively, for example, in low light or dusty environments.



**Fig.5 : Ultrasonic sensor.**

**GPS Module Simulation**



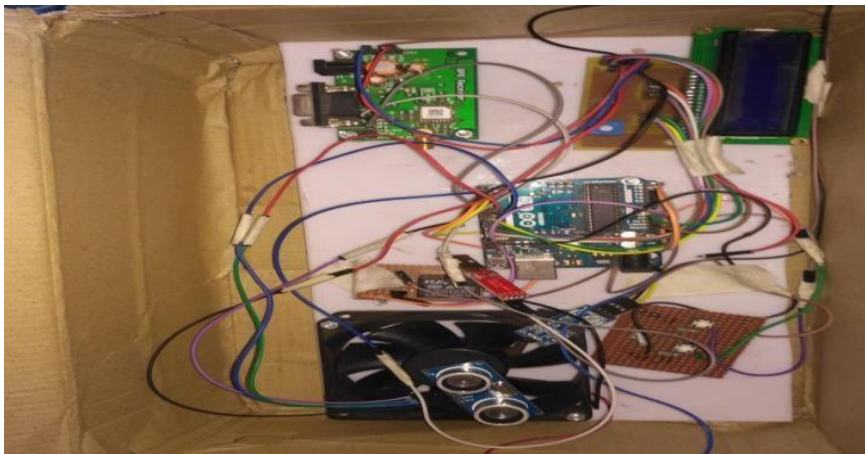
**Fig.6: GPS Module.**

GPS stands for Global Positioning System, which is a network of satellites in orbit around the Earth that provides location and timing information to GPS receivers. GPS was developed and is operated by the United States government, and it is freely accessible to anyone with a GPS receiver. GPS works by using trilateration, a process that measures the distance between a GPS receiver and several GPS satellites to determine the receiver's precise location on Earth. GPS receivers receive signals from at least four GPS satellites, which they use to calculate their latitude, longitude, altitude,

and speed. GPS is widely used in various applications, such as navigation, mapping, surveying, and tracking. GPS technology has revolutionized the way people navigate and explore the world, and it has enabled new applications such as locationbased services, autonomous vehicles, and precision agriculture.

### Flow sensor Simulation

A flow sensor is a device that measures the rate or quantity of fluid flow through a system. Flow sensors are commonly used in various industrial, commercial, and scientific applications to monitor and control the flow of fluids, such as water, gases, and liquids. Flow sensors are devices that measure the rate of fuel flow in vehicles or equipment. They can be used in a smart IoT based system to monitor and detect fuel theft by detecting any unusual patterns or drops in fuel flow. They can also provide accurate fuel level indication to help with refilling processes. By using flow sensors in a smart IoT system, fleet managers and fuel station operators can prevent fuel theft, reduce losses, and improve operational efficiency.



**Fig.7: Hardware simulation of proposed system**

## VII. CONCLUSION

In the Smart Fuel Level Indication System using ultrasonic and Hall Effect sensors along with Arduino controller and GPS module can accurately measure the fuel level and mileage of a vehicle. It provides real-time updates to the vehicle owner when the fuel level goes below a certain threshold and also helps locate nearby petrol pumps. This system can help vehicle owners to efficiently manage their fuel consumption and reduce the risk of running out of fuel. It is a reliable and cost-effective solution that can be implemented easily in any vehicle.

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