Smart Fuel level Monitoring and Alerting System based on IoT

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***Abstract*—Presently, IoT is a popular collection of technologies that are commonly used in day-to-day lives, which automates processes. In this paper a smart fuel monitoring system is proposed. The proposed system monitors the fuel level, when it drops below a predetermined threshold, then the system notifies the user via e-mail as well as through IFTTT application that fuel level dropped below threshold and it also guide them to the nearest fuel station using Google Maps.**

Keywords*—*IoT, Smart fuel monitoring, Real time, Ultrasonic sound sensor, Node MCU, IFTTT, Google maps.

I. INTRODUCTION

Internet of Things (IoT) refers to interconnection of physical objects or things embedded in every day object through internet [1]. The scope of IoT is not limited to interconnection of things but its more about exchanging of meaningful information between things for a specific purpose. IoT is a collection of technologies that include technologies for acquiring the data, technologies for analyzing the data, technologies for control action and finally technologies that help for security enhancement [11]. In IoT the major role is played by sensors i.e. they acquire the data from the environment and provide data to cloud storage for further analysis. Based on result of data analysis, control action is performed through mobile application or web application.

Due to fuel management, the fuel is monitored and expenses are controlled. Fuel monitoring systems are a crucial component of logistics and transportation businesses all over the world. The lack of fuel in the tank is indicated and this assists in managing and monitoring the car's fuel efficiency. The improvement of fuel efficiency and cost savings are two of the main objectives of fuel monitoring systems. This motivates us to develop a smart fuel monitoring system that is beneficial for transportation companies and people who own private vehicles.

In this paper, fuel monitoring system continuously monitors and measures the level of fuel in the tank. This data is stored, analyzed in the cloud and based on the analyzed data, some control actions are performed. This automated process saves on time and probable wastage of extra fuel [2]. Through the notification, the user will be able to find out how much more fuel and cost is required to fill the tank [2]. This system is efficient, accurate and simple to implement and use.

The following are some of the main advantages of utilizing fuel level sensors:

- Fuel savings through the detection of illegal drains and the elimination of theft.
- Precise and trustworthy data on fuel usage.

II. LITERATURE REVIEW

The accuracy of the fuel level reading has not been a major concern up until now. To display the information on the dashboard with a fuel level meter, the aim of monitoring the fuel level has been to do so. The two most crucial factors, rather than accuracy, have been to prevent abrupt fluctuations in the gasoline level shown and to make the meter signal that the tank is empty when the fuel falls below a set level [5].

Gasoline level sensors are used to check the amount of fuel in fuel tanks of many types of vehicles, such as locomotives, ships, and boats. Additionally, it may be used to keep an eye on the fuel levels in stationary fuel tanks and large generators. Fleet owners and asset managers are being compelled by skyrocketing gasoline prices to use fuel monitoring systems that will assist save fuel-related expenses [4]. Fuel Level sensors are mounted onto the fuel tanks of vehicles/machines whose fuel consumption is to be monitored. They are positioned such that the sensitive element's axis is as close as feasible to the tank's geometric center. After that, the sensor is calibrated for the size of the tank. After everything is set up and connected to the monitoring system, data is transferred to the software or application platform where further analysis is done [4].

Based on the detecting methods used such as mechanical, magnetic, pressure, electrostatic, radar, and ultrasonic, different types of fuel level sensors are available [4]. We chose to employ an ultrasonic sensor for our application over the others due to the following advantages listed in Table 1.

Table 1: Comparison Chart

Sensors Characteristics	Resistive/ Float Sensors	Pressure Sensors	Capacitive Sensors	Ultrasonic Sensors	Flow
Cost	Low	Low	Medium	Medium	High
Installation	Medium	Easy	Medium	Easy	Difficult
Maintenance	Medium	Low	Low	Low	Medium
Accuracy	~ 80-85 %	~ 95 %	~ 99 %	>99 %	>99%

III. METHODOLOGY

This section explains, in detail, the various methods and techniques used to build this system.

A. System Architecture

In this model, we use an ultrasonic sensor to measure the level of fuel. The sensed data is processed by the Node MCU and published to the cloud service i.e adafruit. The data is analyzed in the IFTTT platform. If the fuel is below the predetermined threshold, a notification is sent to the user and google maps is launched as shown in Figure 1.

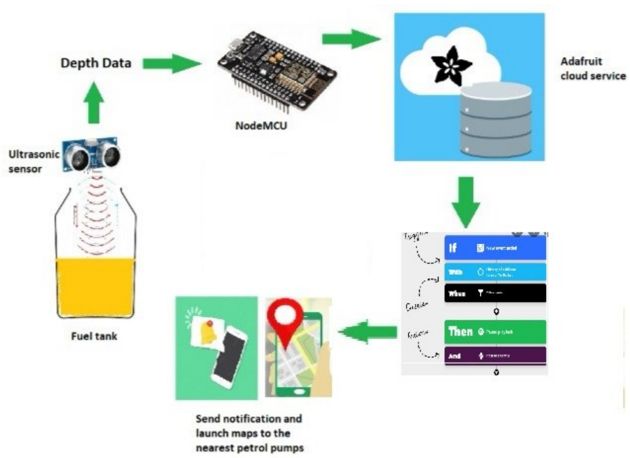

Figure 1. Components of proposed system

B. Circuit Diagram

The ultrasonic sensors typically have four pins: VCC, GND, Echo, and Trigger. The VCC supply for these sensors is generally 5 volts. The trigger and echo pins are attached to the NodeMCU's D6 and D5 pins, respectively, and VCC is connected to the Node MCU's pin 5v. The GND pin is also connected to the Node MCU's GND pin as shown in Figure 2. Setting the trig to a high state is required to generate the ultrasound waves, and the echo pin will pick up the sound that is produced [3].

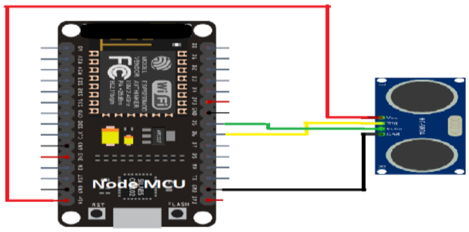

Figure 2: Schematic of NodeMCU with ultrasonic sensor

C. Working Flow Diagram

The workflow diagram is a diagrammatic step by step representation of the working of the system and its shown in Figure 3. The ultrasonic sensor is placed at the top of the fuel tank. The sensor will send waves and calculate the amount of time it takes to return to the sensor after hitting the fuel. Using time, the distance between the sensor and the liquid (fuel) can be calculated. This data is processed by the Node MCU and published to the cloud service adafruit. The equation 1, 2, and 3 are used to calculate the distance in centi-meter:

duration = calculated by the sensor (1)

Sound_velocity = 0.034 (2)

Distance = duration * Sound_velocity/2 (3)

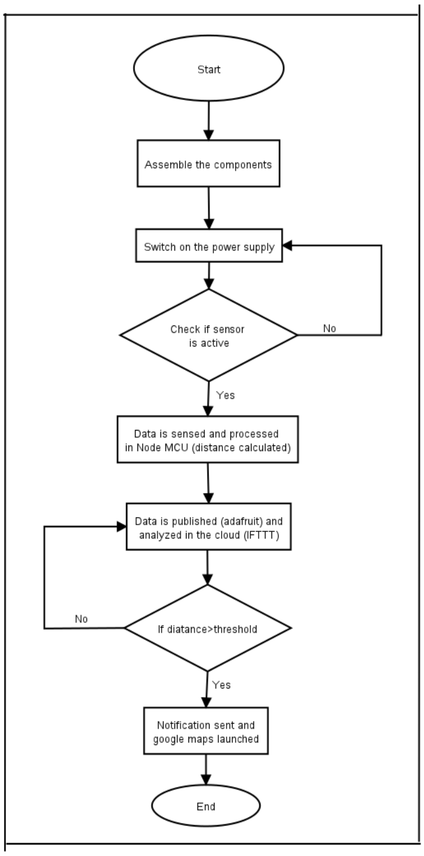

Figure 3. Work flow of smart fuel monitoring system

The data is analyzed in IFTTT platform - if the distance is more than the threshold distance (given as a condition), then the system sends a notification to the user and launches google maps which directs the user to the nearest petrol pump.

TECHNOLOGIES USED

Cloud:

The cloud service used in this project is adafruit. Adafruit is used to store the depth data that the ultrasonic sensor senses and Node MCU processes. This data can be retrieved or analyzed in the cloud, based on which some control actions can be performed. The collected data is displayed in real time using the dashboard, using which data can be visualized as a chart, graph, text, slider, image, stream, and many more [6].

Microcontroller:

An MCU is a sophisticated semiconductor integrated circuit (IC) made up of a processor, memory modules, interfaces for communication, and peripherals. A wide variety of devices, such as washing machines, robotics, drones, radios, and game controllers, utilize MCU technology. The microcontroller used in this project is Node MCU, which is easier to use due to the in-built wifi chip. [7]

MQTT Protocol:

The Message Queuing Telemetry Transport (MQTT) protocol is a lightweight messaging protocol used to send and receive data between devices.It is a simple communication mechanism, where data is published and subscribed with respect to the cloud. [8]

Web Service:

The web service used in the application is IFTTT. It is a free online digital automation tool which connects multiple apps and services. It works on a simple 'if this' - 'then that' condition. It automates tasks which would otherwise be repetitive. It improves productivity and efficiency. [9]

Sensor:

A sensor detects and records a physical property like temperature, resistance, capacitance, etc. In our application, an ultrasonic sound sensor is used. It is a device that uses ultrasonic sound waves to calculate the distance to an object. It transmits and receives ultrasonic signals using a transducer to determine the proximity of an item. [10]

PROJECT DESCRIPTION

In this phase, the ultrasonic sensor, Node MCU and the remaining hardware are assembled as shown in Figure 4. This hardware is integrated with the software tools used i.e. adafruit and IFTTT. The system prototype is then tested and the outcomes are documented and described.

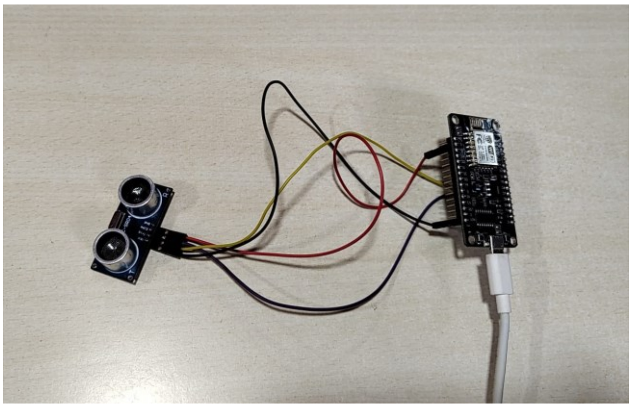

Figure 4: Connection of NodeMCU with ultrasonic sound sensor

System Prototype:

The hardware unit shown in Figure 5 consists of the Ultrasonic sensor, which is connected to the Node MCU via jumper cables as shown in the circuit diagram.

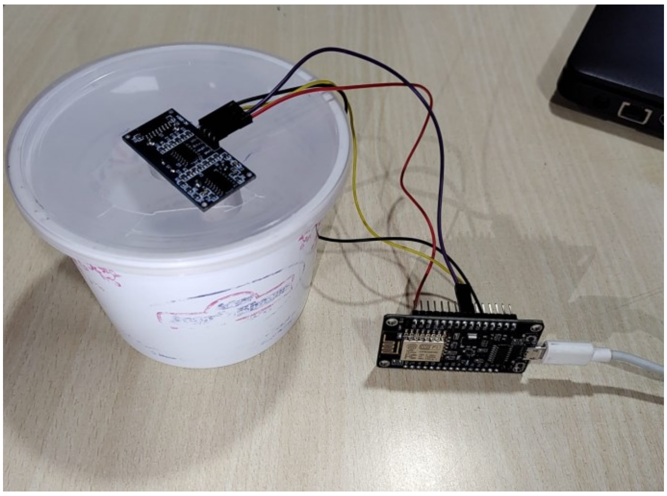

Figure 5: Fuel level monitoring system

○ IV. RESULTS AND DISCUSSIONS

The data that is published to the Adafruit cloud service when the code is run using the Arduino IDE corresponds to the output that appears on the serial monitor display. The results of serial monitor and adafruit cloud data are shown in Figure 6.

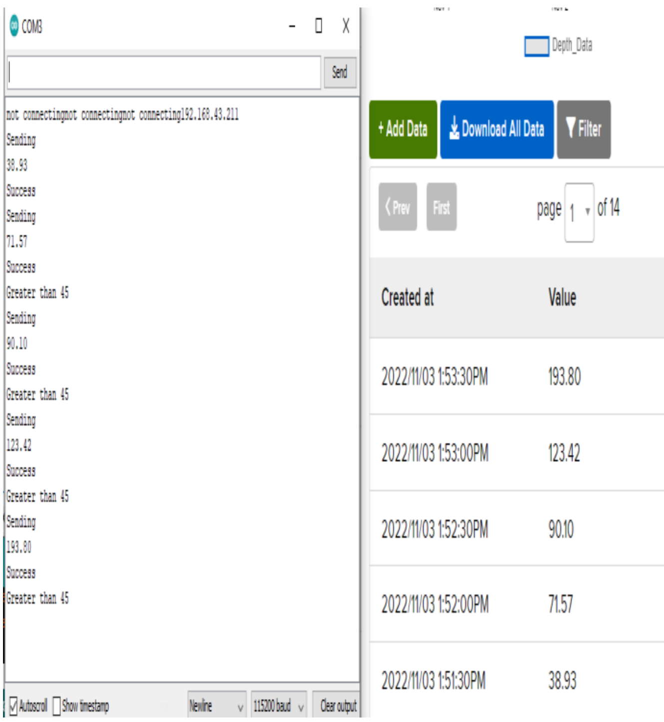

Figure 6. Fuel level in Serial monitor and adafruit cloud

The graph in Figure 7 shows the fuel level in adafruit dashboard.

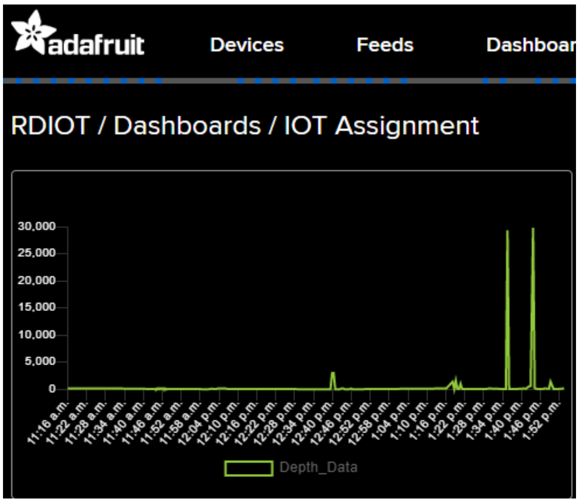

Figure 7. Dashboard showing fuel level

The data in the cloud is analyzed using IFTTT. If the condition is met, then a notification () is sent to the user and google maps is launched as shown in Figure 8.

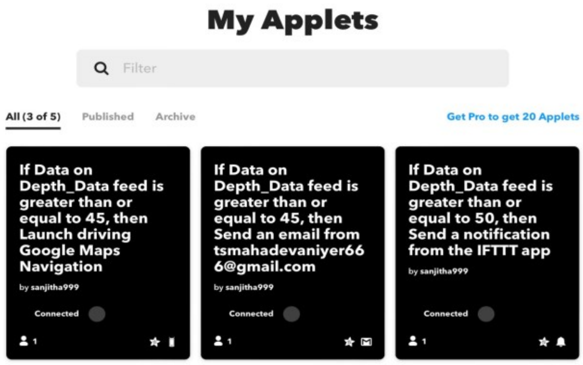

Figure 8: IFTTT Applets for notification

The notification (via email) is sent and is shown in Figure 9 and google maps is launched as shown in Figure 10.

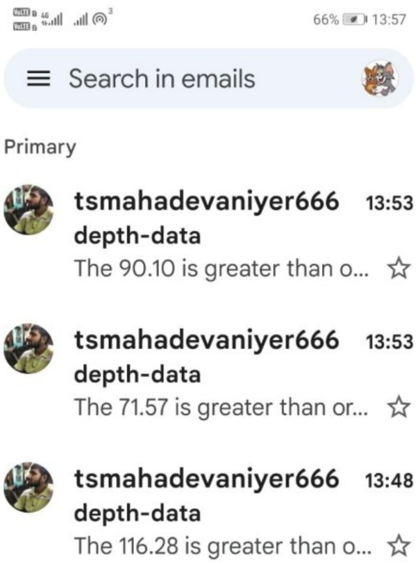

Figure 9: Notification through email

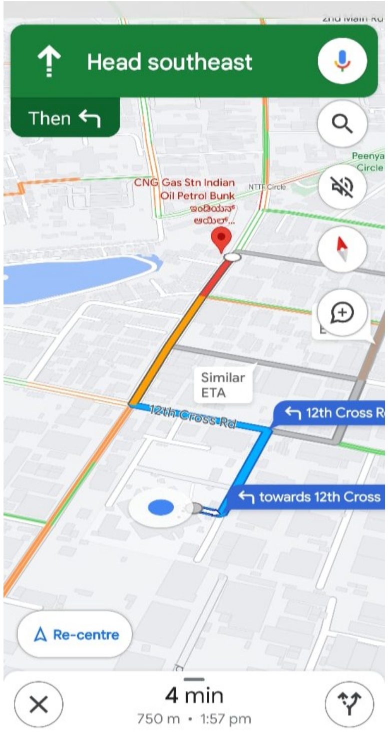

Figure 10. Launching of Google maps

BENEFITS OF OUR APPLICATION

- A Smart System: The IOT-based technology enables remote accessibility and intelligent reporting.
- The system is economical: Our system's control over fuel use and consumption results in cost savings.
- The system is adaptable: It is compatible with all gasoline tanks.
- Personalized timely alert: A notification on fuel status is sent to the user.
- The system is Upgradable: It is easy to improve with simple processes.
- The system is accurate: The distance data that is sensed is collected in real time and is accurate.

V. CONCLUSION

In applications like vehicles, stationary fuel tanks and large generators, our IoT based fuel system continuously and accurately monitors the level of fuel. If the level is below a certain predetermined threshold, then the system notifies the user and directs to the nearest petrol pump. This saves on fuel, cost and time. Hence, this system is economical, efficient and accurate.

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