Compactible Level Measurement and Forewarning in Petrol Station

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Abstract. It is known that India is the third-largest country in fossil fuel consumption, and the economy of India dramatically depends on the transportation of goods and services which require fuel. Petrol stations should ensure the correct fuel stock and restore the fuel on time once it gets exhausted. Thus, the customer's needs get satisfied. Generally, the level measurement in fuel storage tanks is carried out by physical methods which involve dipsticks or using some level sensors, float switch, and load cell. Dipsticks are more often used in level measurement. The usage of dipsticks involves a human operator removing and read the dipstick scale. The measured data is communicated to the refill manager through phone calls, and the petrol station gets refilled. The refilling of petrol station may get late due to improper communication and late transportation of fuel vehicles when stuck in traffic. This work aims to overcome the material problem and improve efficiency and accuracy in the level measurement of fuel by introducing automation in measurement and communication. The depth of the fuel tank is estimated by a level sensor accompanied by a Wi-fi module to bring out automation. The measured data can be accessed directly by the user through a telegram app. The level of the fuel tank is automatically indicated. The dynamically changing data of the fuel tank can also be acquired by using the telegram app. The refill manager will be aware of the fuel level, and fuel can be restored on time. This product will be very useful in remote areas. This product has vast potential and will play a significant role in fuel measurement for key oil companies.

1. Introduction
Here, the point which seeks our attention is, In India, there is a significant rise in vehicle count between 1981 and 2005. During this period of 25 years, the vehicle population in India has incremented by about 15 times, from 5.36 to 81.5 million vehicles, while the population has increased only 1.7 times [2]. The retail petrol companies and their outlets are facing competition in terms of product and brand. The petrol station companies/outlets do not have price invariance. Thus, this is of no significance to the consumer. Therefore, consumers are the determinant of petrol retailers. So, providing good service will earn consumers. Fuel outlets should ensure reserve stock of fuel and refill it once it exhausts. This product is an excellent option to overcome the physical methods of dipsticks and introduce automation in retail outlets. As the product is much compact, it requires a small space. The product's performance will assure the fuel stock to the retailer, and the fuel gets refilled. Thus it
will help to improve the service to the consumer, and consumer satisfaction is highly valuable. Therefore, this product is highly suggested for petrol stations to improve their service.

The level measurement in fuel storage tanks is usually carried out by dipstick [1] (see Figure 1). The dipstick is the means through which the measurement of liquid is known approximately. This dipstick consists of a scale etched in it and is fixed in the container. The dipstick is taken out of the container to measure the fuel level, and the reading is taken by how far the liquid wets the scale. This method requires a human operator to take out and read the level in the dipstick. The availability of a person at a needed time is uncertain, and if the person missed the regular check of the level, it might inconvenience the consumers. This method has a communication drawback that the data has to be communicated to the refill manager through a phone call.

The main objective is to overcome the above limitations by a compact level measurement device to measure levels and introduce automation in the communication of measured data. The primary sensing unit is introduced to measure the distance between the sensor and fuel level, which emits the ultrasonic sounds to measure the distance. The measured data is processed in a data processing unit which is nodeMCU, a Wi-fi module. The activity to be carried out by the nodeMCU board is written in the form of code. The code is preloaded in the nodeMCU board, and the board functions as per the instructions in the code.

The telegram bot plays the data visualization unit role. The medium of communication is established by creating a bot in telegram. Telegram consists of an API that permits third-party developers to create bots [4]. Bots are applications that appear like unique telegram users. The bot is created by the instructions of the "Bot Father" and named as per need. The token ID is generated and fed in the code. Once a voltage supply powers the device, the device starts to function.

The real-time measured data sensed by the primary sensing unit is communicated to the bot when the data processing unit gets connected to the network. The user in the receiver’s end receives the message in telegram once the fuel level lowers below the threshold level. The purpose of using telegram is to make commands/requests to the bot through chat to update the current level of the fuel anytime.

The physical method of the dipstick is replaced by using the ultrasonic level sensor and nodeMCU, and there will be no need to depend on the person. So, here the human operator is eliminated. The measured data can be accessed directly by the user anytime through telegram. Hence, automation is introduced. Once the fuel drops below the level, the user gets notified. A regular check of the fuel level will not be missed and can be done by making simple commands through telegram bot, and real-time data can be acquired anytime and refill of the petrol station can be ensured.

![Figure 1. Existing system [8]](image-url)
2. Components

2.1. Ultrasonic sensor
The ultrasonic sensor is a contactless distance measurement module with specifications of 5V supply voltage, 15 mA current consumption, 40kHz frequency, maximum range 400cm and minimal range 3cm and resolution 1cm and trigger pulse width of 10µs [7].

The ultrasonic sensor is used primarily as a proximity sensor. Ultrasonic sensors are level sensors that monitor, determine the current level and manage liquid levels in closed containers.

The main components of ultrasonic sensors are the transmitter and receiver. The sound waves are emitted by the transmitter using piezoelectric crystals: the sound waves hit the target and are reflected back to the receiver. The quantity measured by the ultrasonic sensor is time. The time is applied in the below formula to get the distance

The formula for this level measurement calculation [7] is

\[ D = k \times T_f \times V_s \]  

Where

\( k \) - Time of flight of an ultrasonic pulse, i.e., the pulse takes to cover the distance \( D \),

\( T_f \) - constant close to 0.5, which depends on the sensor geometry,

\( V_s \) - Velocity of sound in air.

2.2. NodeMCU
The Node Microcontroller Unit or nodeMCU is pair of firmware and hardware development board, with a Wi-fi enabled microchip called the ESP8266 [5]. It consists of CPU, RAM, networking (Wi-fi), and even a modern operating system and SDK.

NodeMCU can be operated at adjustable clock frequency in a range of 80MHz to 140MHz. NodeMCU stores and processes the program and data in 4MB of flash memory with 128KB RAM. It has features of inbuilt Wi-fi / Bluetooth and deep sleep operating features. Micro USB jack can be used power nodeMCU and \( V_{in} \) pin (External supply pin).

2.3. Telegram App
The Telegram Messenger is a mobile application that allows users to send, receive messages, photos, and any other files. The messages, photos, and documents are stored in the cloud servers of the app. The data stored are highly encrypted, and the encryption keys are stored in several other data centers and are highly secure. Unlike other messenger applications, the telegram has the unique feature of creating a bot. The telegram app plays an essential role in the communication of measured data.

2.4. Telegram bot
Telegram possesses an API that permits third-party developers to create bots[4]. Bots appear like unique telegram users operated by software. Users can talk to the bot from their chat list, can be added to groups, or use a special "inline" interface to access their features.

The telegram bot is the medium through which a connection is established between the sensing unit and the user. Users can start to chat with bots by sending commands, requests, or messages.

Two ways in which user communicate with the bot,

- Open the chat with telegram bot and make commands or messages and can also be used by adding them in groups.
- Send requests directly from the input field by typing the bot's @username and a query. This can be used to send content from inline bots directly into any chat, group, or channel.
One of the key features of a telegram bot is getting a customized notification. The commands, requests, or messages sent by the user is received in the app's server. The app's server processes the messages in Application Program Interface(API). We access the app's server through a simple HTTPS interface, a simplified version of the Telegram API [4]. This interface is our bot API. To set up a telegram bot, we follow the following steps:

- Find a telegram bot named "@botfather" it will help us create and manage the bot.
- Print "/help" and we can see all possible commands that the botfather can operate.
- To create a new bot, type "/newbot" or click on it. Follow the instructions it gives and proceed forward.
- After completing all steps, the message appears, the telegram bot is created successfully.
- A new API token will be generated and copy it for further use.

Other peripheral components include a battery, casing, and wires.

3. Methodology
The system consists of an ultrasonic sensor and nodeMCU, which is operated by a battery. When a required voltage is supplied, the device starts to work. As the components get adequate power, the primary sensing unit (see Figure 2) starts to function by emitting the ultrasonic waves.

**Figure 2.** Block diagram of the proposed system

The primary sensing unit consists of two piezoelectric transducers, transmitter and receiver, to send and receive ultrasonic sound waves. The emitted sound waves from the transmitter travel till it strikes the fuel in the storage tank (see Figure 2). Once the sound waves strike the fuel, it reflects the primary sensing unit and is captured in the receiver. The primary sensing unit consists of four pins Vcc, gnd, trigger, and echo. The Vcc pin of the primary sensing unit is connected to the power supply. The ground pin is connected to the ground of the data processing unit (see Figure 4).

**Figure 3.** Fuel level measurement
Generally ultrasonic sensor uses ultrasonic waves to detect the object or distance between the object and itself. Here the ultrasonic sensor is fitted in the top inner layer fuel tank. The sensor is triggered with the power supply. The transmitter emits an ultrasonic wave of frequency 40KHz. When the fuel surface blocks it, it is reflected and bounce back to the receiver (see Figure 3). The receiver absorbs the reflected wave. The sensor gives the time taken by the ultrasonic waves to travel from the transmitter to the fuel surface and the fuel surface to the receiver.

The level measurement process is initiated once the trigger pin goes high to low for a period of 10µs. The piezoelectric transducer generates ultrasonic sound waves of frequency 40KHz in eight cycles and starts to calculate the time it takes to echo back to its adjacent transducer. Meanwhile, the echo pin produces a pulse and is produced till it receives the emitted wave back. This length of the pulse is used to calculate the distance. The length of the pulse is directly proportional to time. The time taken by sound waves to travel is directly proportional to the distance. The time taken by the sound wave to hit the target and reach back is calculated by the primary sensing unit, which is an ultrasonic sensor.

The distance measured is the air gap of the fuel tank, not the actual level of the fuel. The measured value should be subtracted from the entire depth of the storage tank to get the fuel level. For that, this statement distance = 122-distance is included in the arduino sketch. Here, it is assumed that the entire depth of the tank is 122 cm. This value can be changed based on the requirement.

The measured data is further processed in a data processing unit (see Figure 2), nodeMCU. The data processing unit consists of a wi-fi module used for communication. The trigger pin of the primary sensing unit is connected to the D3 pin of nodeMCU, and the echo pin is connected to the D4 pin of nodeMCU (see Figure 4). Once the nodeMCU board comes into connectivity, it sends the data to the data visualizing unit that is the telegram bot.

**Figure 4. Pin connection**

In the code uploaded into nodeMCU, the connectivity SSID and the password are provided. To establish communication with the telegram bot, the token ID generated by the bot father is also provided. Once the data processing unit connects with the network, the measured data is communicated to the telegram, a data visualization unit (see Figure 2).

The data visualization unit consists of a telegram bot, a telegram account operated by software. Once the level drops below the threshold level, a certain statement is executed to automatically alert the user through the telegram bot. When the level drops below the threshold level the nodeMCU reports the telegram bot about the current fuel data. The telegram bot communicates the received data with the refill manager and gives the alert message to refill the petrol station (See Figure 5). For instance the statement if (distance<=8) will be executed here. The threshold level is assumed to be 8 cm, and it can be changed as required.
The unique feature of the telegram bot is that the real-time value of fuel level in any number of storage tank can be accessed at any time by making commands or request messages in the telegram bot.

Whenever the refill manager wants to know the current fuel level of any distinct petrol station, he makes requests with certain commands in the telegram bot. The telegram bot makes data request with that particular petrol station's nodeMCU (See Figure 6). The nodeMCU responds with the current fuel level data to the telegram bot, and the bot returns the received data to the refill manager (See Figure 6).

The way of communication between user and module is full-duplex. Users can get updates of any petrol station at any instant. Whenever the user wishes to get the fuel update of any petrol station, the user can chat with a telegram bot with the unique identifier for the petrol station and command. The input is given in telegram bot chat with syntax <unique identifier> <command>. For instance, to get the update of the petrol station named station 1, give the input as "station 1 update me" (here station 1 – a unique identifier, update me – command) in telegram bot chat. The nodeMCU receives this message, and a certain statement of code is executed. Then, the sensor will detect the petrol's current level and send back the reply in the telegram bot (See Figure 6). The unique identifier identifies the number of petrol station units, and the command is passed through the bot with that unique identifier. For instance, a petrol station is named station 2. In the same manner, if we give input as "station 2 update me", then station 2 will provide the fuel level. In addition, whenever the level of petrol drops below a certain value, the nodeMCU will send an automatic alert message to the bot along with the name of the petrol station (See Figure 5).

In addition to this, the product can be further improved. The cloud storage of messages received in the telegram bot has scope for future analysis of data. The fuel level is measured periodically and updated to the user through a telegram bot. The dynamically changing data of the fuel accessed by the end-user at any instant is simultaneously stored in the telegram message cloud. If this data is retrieved, time to time, and stored in the external cloud will help in further analysis. If this stored data is intended for computing, it will help predict the peak fuel exhaust and ensure stock restoration. Cloud computing could play a vital role here. Cloud computing, in which utilities like storage and CPU offered as lease over the internet in an on-demand approach [6]. Resources in cloud environments can be easily accessed at any time over any device through internet connections. The stored data is highly useful in performing analysis and interpret the data.

4. Results
The working module in the test run gave effective results. The user requested the current fuel level data with the unique identifier of a particular petrol station. The telegram bot communicates with the nodeMCU of that particular station and displays the current fuel level received from that nodeMCU.
Therefore, the main objective of this module, the user getting real-time fuel level data through telegram, is attained (See Figure 7). When the fuel level drops below the threshold level, the nodeMCU communicates with the telegram bot, and the user is intimated with alert message by the telegram bot (See Figure 7).

This module has a vast potential that to be utilized in petrol stations. The key oil companies should take this into account and make use of this. Moreover, 60,000 petrol stations across India in which this module can be employed. This module will prevent the late refill of petrol station due to late or improper communication and ensure refill stock.

5. Conclusion
The material problem of using dipsticks is overcome by introducing the level sensor. This module will replace the current measuring methods involved in fuel level measurement. The primary sensing unit measures the parameter to be considered, and data collected is sent to the telegram bot through the data processing unit. Whenever the user wants to know the current fuel level, he makes simple commands to the telegram bot. The telegram bot communicates with the respective nodeMCU and updates the user with the current fuel level. Here, the automation is introduced by a telegram bot. Whenever the fuel level drops below the threshold, the end-user receives the fuel level and gets an intimation to refill the petrol station through a telegram bot. The real-time dynamic change in fuel can also be accessed by making commands/requests in the telegram bot. The data stored in the cloud can be used for further analysis to ensure fuel requirements by calculating peak exhaust time. This module is compact and enhances the accuracy and efficiency in level measurement. The cost of this product is budget-friendly and has a great utility in petrol stations. Here, the significant role of automation is achieved with a telegram which guarantees the data transmission and storage for further use.

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