IOT Based Fuel Quantity Measurement

Abhiraj Sutar, Anshu De*, Jaskaran Singh, Dr. Manisha Mhetre

Department of Instrumentation and Control Engiineering, Vishwakarma Institute of Technology,University of Pune,Pune, India

A B S T R A C T

A Digital fuel gauge implemented in automobiles are bar graphs or gauge displays. They indicate a rough value of the fuel present in the tanks using float sensors. They lack both linearity and precision. A load cell however gives an edge over this problem as it overcomes the problem, giving the exact volume as an effect and combining with IOT to get a good monitoring and tracking system. Used in both indication, Alerts, and Data Acquisition using a Microcontroller and IOT Devices.

Keywords: Float Sensor, Load Cell, Microcontroller and IOT.

1. Introduction

Petrol Stations fool customers over less petrol for equivalent money due to non-precise measurement. A load Cell gives exact measurement but is susceptible to vibration. Combining both get precise yet stable measurement. A microcontroller will get these values from both sensors but will only indicate the exact values by considering the values. These values will be recorded and uploaded to a cloud server. The microcontroller will also detect faults and send instant alerts to customer.

2. Literature Survey

According to Raveena A. and Deepa the problem of petrol station problems and the problems of ease to customer can be solved by interfacing the sensor to a microcontroller. They used a GPS and GSM module to alert the driver for problems like insufficient fuel left.
According to Aravind R, Arun Kumar E suggests that increasing corruption in fuel filling process, as well as the increasing vehicle theft, has become a big deal to the society. This problem can be addressed using a GPS and GSM connected to the Fuel sensor. This also enables the customer to avoid frauds due to online system monitoring the fuel quantity. This also enables the manufacturer to continuously monitor the vehicles for the problems and updates.
According to Raj Patel, Hitesh Pungalia and Saurabh Mahajan they have solved the problem of in-consistent fuel measurement by designing a system to measure the fluid level in the reservoir. We have used basically using two circuits. During still condition we have measured fuel volume using weight measuring sensors. During dynamic conditions we have used fuel usage signals from one or more fuel meters to determine the a mount of fuel consumed and subtracting that amount from the previous reading.
According to Vinay Divakar, he has made a more efficient and reliable sensing technology is the capacitive level sensing system that makes use of inclinometer as well as a microprocessor which has corrective action code inbuilt that is applied to the fuel sensor signal based on the inclinometer measurements to provide highly accurate measurement of the level of fuel in the tank.
Rahul Gogawale, Sumit Sonawane, Om Swami and Prof. S.S. Nikam have proposed an idea to solve petrol theft and continuous measurement using a ultrasonic technique for fuel measurement that acquires the measured fuel level and sends to the display unit which is present on the dash board. If the petrol level suddenly decreases when the bike is in off condition, security alarm rings, thus avoiding petrol theft.

Kunal D. Dhande, Sarang R. Gogilwar and Sagar Yele have solved the problem for petrol theft and non-linear fuel quantity measurement using an ultrasonic sensor. The measurement was more accurate, but, the consumers also will not be cheated for their hard earned money.

According to J. Vinoth Kumar he has solved the problem of petrol frauds using fuel level finder. He has implemented fuel level finder. There is no knowledge of how much of petrol was filled and its value was accurate or no knowledge of balance amount of petrol in to our vehicle and was useful for vehicle fuel saving and reduce petrol bunk theft.

3. Process Description

3.1 Process

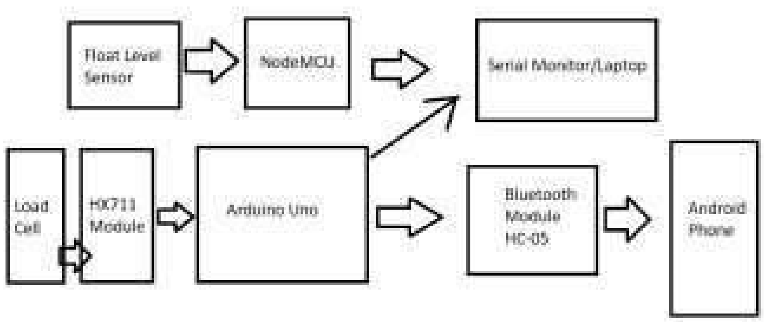

Fig. 1 Block schematic

A load Cell is mounted under an aluminium Fuel Tank. A load cell mounted on a wooden plank. The load cell on the wooden plank using a M8 Bolt with 4 mm spacers to suspend the load cell in a cantilever formation. The Load cell calibrated using 100 gram weight. Tank is placed and the tank weight is measured. It was used as zero setting for the volume measurement. Further the tank was sealed for leaks

with sealant. Initially water was filled till top. Weights were measured for 0 to 100% volume. Then emptied in steps. The required values were recorded. The Tank was filled with Petrol 0 to 100%. Values of weights at every instant were recorded. An arduino code was made and checked for problems with refill and emptying petrol. A bluetooth module HC-05 was interfaced and an android application was used. The communication was achieved and alerts were added in the code. A fuel float level sensor was procured and connected in a voltage divider configuration. The input was given to the arduino. It was calibrated for 0 to 100% Level output. Further a NodeMCU was connected. The volume and Level values were uploaded on a cloud server. An arduino code for NodeMCU was written. The Cloud Server Channel Id, API Key were included in the code. A Wi-Fi was setup and the Network SSID and Password was entered in the code. Further a cloud field, dashboard, Gauge, Notification and Digital Display was setup. The Values were uploaded in live time. The logged data was stored for further use.

3.2 Experimentation

Plastic Fuel tank was tested but was too flexible and fuel used to spill from the tank slowly. So switched to closed tank of metal. 2.5 mm Sheet Aluminium was an available material and also got a ready tank of our requirement.

ESP Module was tried for the Communication Part. Multiple problems were faced, the module was not able to connect to the Things Speak server. Further Bluetooth was tried. Initially it was not responding but after some adjustments the module was communicating. Further a Float level sensor was connected with a Voltage divider circuit to a NodeMCU Microcontroller for the cloud interface.

3.3 Equations, calibration and Mathematical work

The values for the readings were taken using tap water. For the Fuel (Petrol/diesel) measurements have to considered the Densities as

Petrol: 800 kg/m3 (0.8 water), Diesel: 830 Kg/m3 (0.83 water). The Volume was 4500 Millilitres.

Arduino command for the load cell calibration: count=count+1;

val = 0.5*val + 0.5*hx711.read();// This gives stable and averaged values.

val1 = -1*((val- 8398436)/687.63f); //This gives values in grams.

Table-1 Calibration table for the load cell

Reading No.	Volume in %	Load Cell Value(grams)
1.	0	900
2.	10	1770
3.	23	2358
4.	50	3516
5.	55	3725
6.	60	3900
7.	75	4090
8.	100	5200
9.	75	4100
10.	60	3853
11.	50	3519
12.	50	3512
13.	30	2583
14.	0	1196

Table 1 is the calibration table for the load cell. The values were again separately measured and averaging the values were calculated and tested. The thresholds were setup with the following values

Tank Weight: 900 gms 10% Weight: 1700 gms

20% Weight: 2100 gms Tank Full Weight: 5000 gms

Table-2 Calibration table

Reading No.	Level in %	ADC Value
1.	0	592
2.	10	620
3.	20	650
4.	50	692
5.	55	710
6.	60	780
7.	75	850
8.	100	1023

Table 2 is the calibration table for the load cell. The values were again separately measured and averaging the values were calculated and tested.
Arduino command for the float interface:

val1= ((val - 592)/4.32); Resistor Value: 14 Ohms

ADC Values for Float sensor: 592 to 1024. Converted to 0to 100% level

Petrol to be filled: (Full Tank – Present Quantity) Eg: 4.5 – 1.2 = 3.3 Litres

Money to be paid: (Full Tank – Present Quantity) * Petrol Cost/litre

Eg: (4.5 – 1.2) * 72 = 238 rupees

3.4 Hardware

- Fuel Tank: An Aluminum tank of 4.5 Litres was constructed using a 2.5mm sheet aluminum. The tank has a Fuel Pump Opening of Diameter 100mm and Fuel Hose opening of Diameter 1.5cm. It is a cuboidal tank with drain Plug at bottom.
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Fig 2. Fuel Tank

- NodeMCU: NodeMCU is an open source IoT platform including firmware which runs on the ESP8266 Wi- Fi Chip. NodeMCU Development board is featured with wifi capability, analog pin, digital pins and serial communication protocols. It was used as the wireless device to communicate and upload data values on the cloud Server. It was setup with baud rate of 115200, High Speed Wi-Fi connection. The Channel Number/Id, API Keys and Host were added.
- Arduino Uno: The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment). We use this Microcontroller to receive the data, calculate the values and as a Central block for the system.
- HX711: HX711 is a precision 24-bit analog to-digital converter (ADC) designed for weigh scales and industrial control applications to interface directly with a bridge sensor. The module features high precision easy interface and inbuilt ADC. It sends digital values at the set baud rate.
- Load Cell: A load cell is a transducer that is used to create an electrical signal whose magnitude is directly proportional to the force being measured. The various load cell types include hydraulic, pneumatic, and strain gauge. Using a 6KG for the system as the filled tank weighs around 5 KG. It is mounted on a wooden plank in a cantilever arrangement. Among the two Mountings. One is used for the load cell mounting and other is kept in cantilever to as act a weight measurement.

Fig. 3 Load Cell mounting

- Bluetooth Module: HC-05 module which is designed for wireless communication. This module can be used in a master or slave configuration. A fast-glowing red led defines that the Bluetooth device is powered. A Baud rate of 9600 was setup up for the communication. The Android Phone was paired with the HC- 05 with a key of 1234. We use the Terminal function of the application to receive the alerts. We receive timed responses as Separate messages. They are received in a train of messages on the terminal.

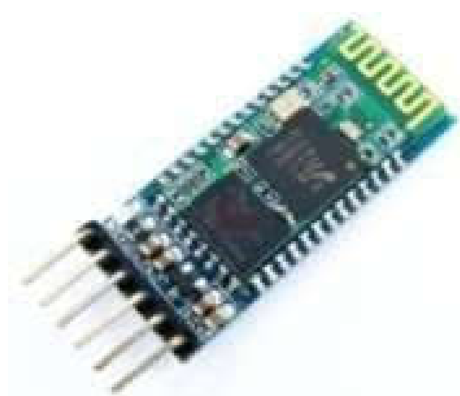

Fig. 4 Bluetooth Module

- Cloud : A cloud server is a hosted, and typically virtual, compute server that is accessed by users over a network. Cloud servers are intended to provide the same functions, support the same operating systems (OSes) and applications, and offer performance characteristics similar to traditional physical servers that run in a local data center. Thingspeak server was used for this purpose. A Private server was created for this application. A Field for the input of values, a dashboard gauge display, a Notification alert and Digital display were created on the channel.

Fig.5 Cloud Display

- System: A 6 Kg Load cell (Model: CZL-601, Precision: 0.02) with an Atmega 328p Development Board (Arduino Uno) with a HX711 Load Cell Amplifier Module. The Load Cell was bolted to a wooden plank. The wooden Plank supports the load cell. The digital values from the Hx711 were monitored on the serial monitor of the Arduino. The calibrated values are again fed back. Customer alerts and messages were created. A Bluetooth module was interfaced. A Bluetooth module hc-05 was used. The Tx, Rx, Vcc, Gnd pins were connected to the Arduino. A Float Sensor was interfaced. A NodeMCU for cloud interface. Float sensor and load cell values are sent to wireless devices. A cloud server for data monitoring.

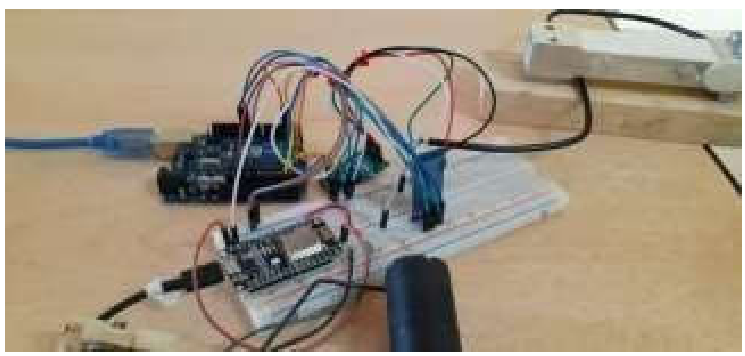

Fig.6 System

3.5 Circuit Schematic

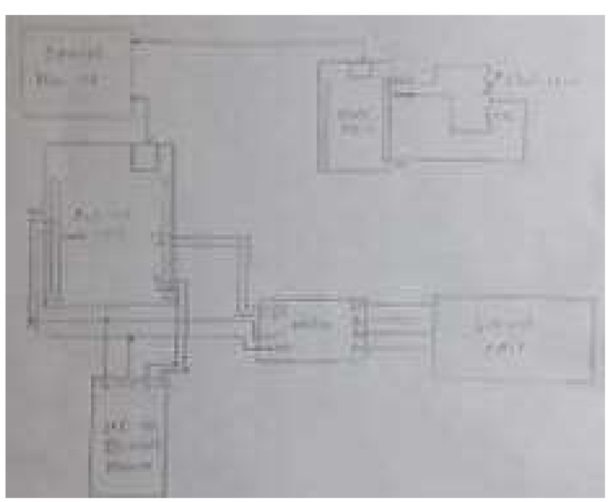

Fig. 7 (Circuit Schematic)

The Fig. 7 is a circuit schematic for the system. The Vcc for the Bluetooth and HX711 modules was provided from the +5V pin of the Arduino Uno. The gnd pin acts as the ground for the circuit. It was kept common for the modules. The HC-05 TX(Transmitter) and RX(Receiver) pins are connected to 2 and 3 pins of the arduino. The 2, 3 digital pins are defined as the RX and TX pins. The Arduino was a microcontroller and the TX RX pins exchange data. The HC-05 transmits the data send from the Arduinno. The HX- 711 sends digital data through two pins DT and SCK (Serial Clock). The DT and SCK from the HX711 are connected to 10 and 11 pins of the arduino. The NodeMCU acts the wireless device. It uses a In-built ESP8266 Chip to transmit the data to the cloud Server.

4. Results

An IOT based Fuel Quantity measurement system was made. Two Sensors were used, a load cell and a Float Sensor. Both were interfaced with Arduino Uno and NodeMCU. Wireless Device HC-05 was connected. The System gives Fuel quantity as a function of Percentage left. It also displays the amount of petrol to be filled in litres, the required money according to current fuel prices.
The Setup was tested multiple times and the Bluetooth and Cloud Dashboard output is displayed below.

Fig. 8

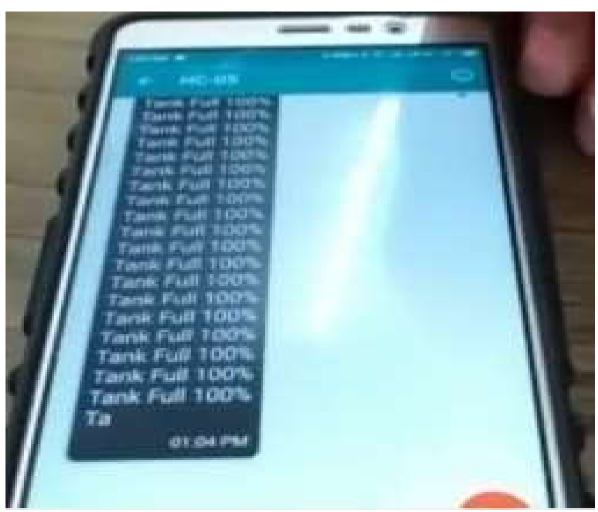

Fig. 9

Fig. 10

Fig. 11

Fig. 12

Figures Fig. 10, Fig. 11 and Fig. 12 display the Cloud Dashboard for various Fuel Quantities.

5. Conclusion

The fuel quantity measurement system is a very advance type indicating system. The main advantage of this system was that it can gives accurate value of remaining fuel as well as the vehicle running capacity in percentage and Km. The operation time taken was very less. All the equipment's have long life, durable & quality material. This project was able to show that simple available hardware and technology can be used to construct a robust fuel level monitoring system. The system was designed and tested in this project presented at the low construction cost of the system. Involving mechatronics in such design applications can eventually solve many practical problems with ease, reliability and at low cost. It is easy to install, Easy to connect and less connections.

Even though the quality of material used and components used are of good quality, the cost of the project was not so costly and it can be used and implemented in all vehicles without much increment of cost of the vehicle. This system was best in its field and will be most widely used in advance systems.

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