Design and Implementation of Load Cell Based Fuel Level Measurement

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Abstract — **With the increase of vehicle usage over the world, fuel necessary has become a tremendous problem. Design and implementation of load cell based fuel measurement measures the accurate level of fuel adding while fuel filling process. There is a large variety of methods for measuring fuel level, ranging from those using mechanical floats and capacitive and optical sensors to ultrasound methods. Nowadays all fuel bunks having types of digital displays unit in order to display the value of fuel adding to the vehicle. But we don't know whether they adding accurate value or not. By fixing the load cell below the fuel tank, at any point of time it will continuously measures the level of fuel with the help of processor and displays the value in the display unit fixed on the dash board. Speedometer which is configured with the processor, this will continuously monitor the current speed of vehicle and the calculation of mileage which signify the residual kilometer of vehicle will pass through, depending upon my current speed. This helps the user can easily identifies the remaining kilometer to run and be aware of fuel usage by engine. At the same time this helps the owner or user came to know about what amount of fuel will adding suppose if drivers are able to cheat. Hence, the measured values are send to the owner mobile through GSM in order to avoid the unprincipled method and be aware of the fuel consumption through SMS services.**

Keywords- Single Walled Carbon Nanotube (SWCNT), Load Cell, Fuel Density, Global System for Mobile Communication (GSM).

I. INTRODUCTION

In India vanav digital fuel indicator were introduced first and this one was first digital fuel indicating system. By using three digits it displayed the remaining fuel which is present in the fuel tank .The fuel level can be displayed in liters. This indication system implemented in the four wheeler also. The amount of fuel is indicating by using digital circuit so user or owner can know the right amount of the added fuel from the petrol bunk. This calculation must be used to calculate the mileage of the vehicles. But in the case of analog display user cannot find out the accurate and precious value of the remaining fuel. Nowadays lot of information regarding the petrol bunk frauds which leads to corruption. There is difference between the amount of fuel which is displayed in the fuel tank and most of the times that is less than the quantity of filled fuel in the customer tanks. Because the pump owner make the arrangements which leads to the benefit to the owner of the bunk. This case customer only cheated by them without knowing that. Most of the vehicles consist of analog meter so it cannot show the current amount of fuel. So now the time is going to change to digital and user want to understand everything.

Basically two types of measurement technique is available that are intrusive and nonintrusive methods. Liquid level is a accurately measured by nonintrusive optical sensing method. Liquid level is measured by using conventional based measurement which is mostly included resistive capacitive, transducers. But this conventional method not suited for fuel measurement. Because they having poor sensitivity, and susceptibility. External noises also affect them. To the next of that and overcome the disadvantage of that measurements, fibre -optic liquid level sensors were introduced. Fibre-optic liquid level sensors having better sensitivity, and also reliable to measure the liquid level. Basic principle of sensor is that light is transmitted to the media and reflected back. In the intrusive method light is transmitted and reflected back to same media .intrusive probe is used to transmit the light to the media. Contact and Contactless are the two methods of Liquid-level. These methods are used to measure liquid level directly by placing a sensor that comes into contact with the liquid.

On the other hand, Contactless methods, such as those for optical and ultrasound sensing, measure liquid level without having to contact the liquid. Although Contactless methods are more complicated than contact methods. There is lot and lot of sensors available for the fuel measurement. Most of the companies are very interested to manufacture the sensors to indicate fuel from level and save your money. Digital fuel gauge in used to measure the accurate amount of fuel in the fuel tank compared to the previous method .that is previous method consist of dash board in that needles are moved to indicate the amount of fuel but that is not accurate it just show the approximate value. In the previous system consist of sender unit and also the indication unit .the sender unit is connected with the resistor .if the fuel is full means then the

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resistance value is low. The second case is that if the tank is empty it will send the high resistance. Nowadays all the fuel bunks having types of digital displays are using in order to display the value of fuel level. But user doesn't know the exact value of the added fuel level. It will lead to the corruption and user get cheated by the bunk owners. So to avoid this corruption many manufactures design is fully focused on the sensors which is very useful to indicate fuel level exactly and save your money. Fuel level indication and alarm system were used to indicate fuel level .It gives an audiovisual indication that is alarm system is used. here whenever fuel level drops below to the reserve level the alarm is activated, helping you to avoid running out of petrol .And also avoid the user to search to the bunk for filling fuel it can be used to alert the person in advance about the fuel level. Nowadays dash-mounted fuel gauge meter used to indicates the fuel levels on an analogue display. The 'reserve' level is indicated by a red marking in some vehicles, but the needle movement cannot accurate one most of the times analogue values will not be accurate .This red marking will confusing the user and not precise. Through LED indicators and audible beeps reserve level and warns when the reserve level is approaching. The fuel monitoring unit works by sensing the voltage variation across the meter and activates the alarm when the fuel tank is almost empty.

II. EXISTING SYSTEM

Liquid level measurement is necessary for different application such as Industrial automation, Industries and variety of filling process. There are various type of methods for measuring liquid level from those using capacitive sensors, optical sensors methods[1], mechanical float to ultrasound methods. Most of these types are not measuring the liquid in accurate manner. General capacitive liquid-level sensors method measures the electrical capacitance between two electrodes immersed in a liquid and calculate the liquid level from the capacitance value[2]. Optical sensors, such as CCD cameras, can measure liquid level without having to contact the liquid by image processing. By using ultrasound sensors, liquid level can be calculated from the range between the sensor and liquid surface. However, these sensors cannot be used for sealed containers and accurate measurement values are not possible, similarly consider same as in the fuel level measurements.

The above-described millimeter-wave Doppler sensor makes it possible to distinguish the millimeter wave modulated by the piezoelectric vibrator from the other portion of the millimeter wave beam. We developed a millimeter-wave Doppler sensor, composed of a millimeter-wave sensor chip with an on-chip antenna and two external directional lenses[3]. The sensor chip is in a miniature resin molded package with a dielectric lens to provide a large potential at reduced manufacturing cost with ease of handling without any millimeter-wave connections to the outside of the package. Figure 1 shows a block diagram of the millimeter-wave Doppler sensor. The millimeter wave sensor chip contains all the functional blocks necessary for a Doppler sensor, such as

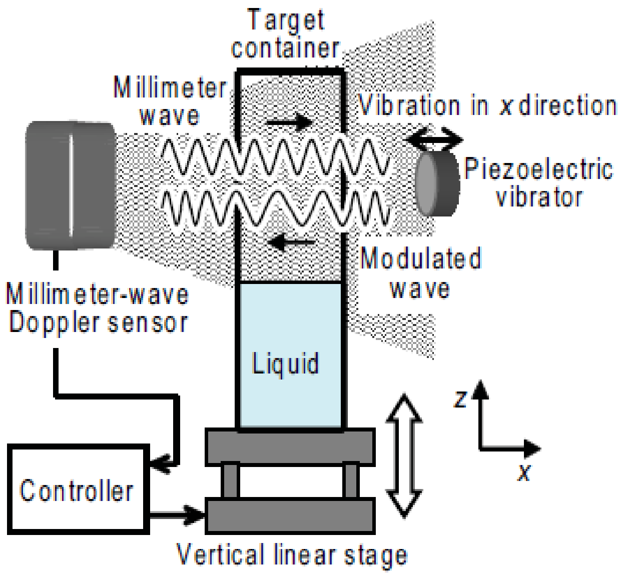

Figure 1. Architecture of Millimeter-Wave Doppler Sensor

an oscillator, amplifiers, a mixer, and an antenna as shown in figure 2. A signal generated by the voltage-controlled oscillator is divided into two signals, which are respectively used as a transmission signal and a local signal of the mixer. The transmission signal is amplified by a power amplifier (PA) before feeding the antenna and lens to produce millimeter-wave radiation. The reflected signal received by the same antenna and lens is amplified by a low-noise amplifier (LNA) to feed the mixer. The mixer mixes the resulting radio-frequency (RF) signal and the local signal to obtain an intermediate-frequency (IF) signal. An external analog-to-digital converter (ADC) converts the IF signal to a

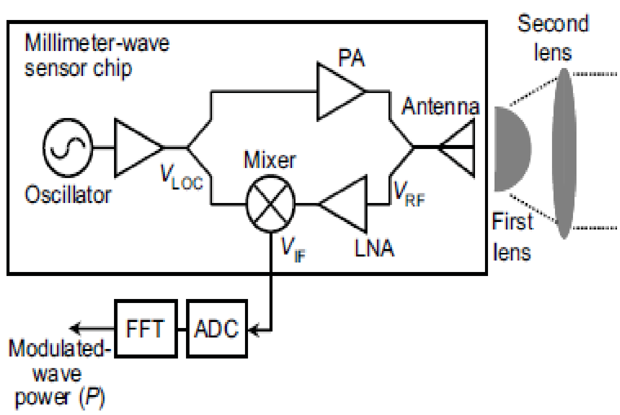

Figure 2. Schematic of Millimeter wave Doppler sensor

Digital signal. Modulated wave power *(P)* is calculated using FFT analysis of the digitized signal.

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III. PROPOSED SYSTEM

The basic concept of the proposed system is to develop a measurement techniques and it has to be implement in all type of vehicle with minimum requirements. Fig.3 illustrates the general overview of system architecture which is configured with each other.

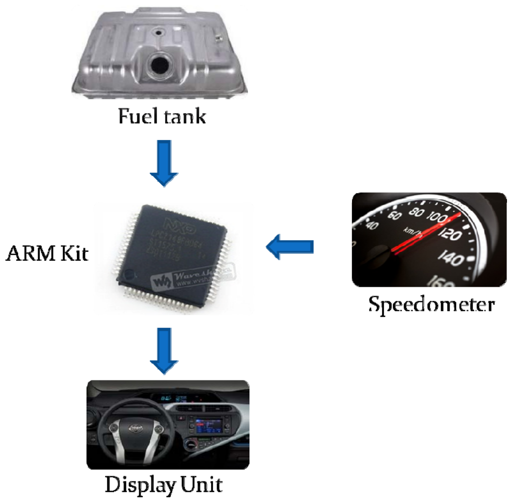

Figure 3. Overview of System Architecture

The block diagram of the proposed system is shown in the Figure 4. The Proposed system overcomes the drawbacks of existing systems and it will measure the accurate level using load cell and displays with help of digital display. It is capable of transmitting information to vehicle owner via GSM.

It is an efficient and accurate method of measuring the amount of fuel adding into the vehicle tank. Initially the load cell is fixed under the fuel tank with the help of vehicle base. The display unit which is fixed in the Dash Board. While we enter into the fuel bunk, click the reset button which is present in the display unit. Then the load cell measures the weight of tank with initial fuel and sends the value to the Controller LPC2148.This converts the weight value into liters and displayed in display unit. After that the adding fuel will automatically measured and displayed in unit as added level. This will help us to find the exact amount of fuel added in our vehicle tank at the time of fuel filling in bunk[5]. At the same time Speedometer will interface for measuring the remaining Kilometers to run with remaining fuel. The system reduces fraud in the petrol bunk.

Here conversion of weight into liter process is carried out by the ARM processor. This having some formula to calculate the exact value of fuel level. Each fuel having some density value, on depending upon these density value the conversion process is taken place. This density value which may vary depending upon the current temperature level. Fuel such as petrol, diesel, gasoline are using for the vehicles in our daily use. So here we concentrated on these three parameters and calculations are made.

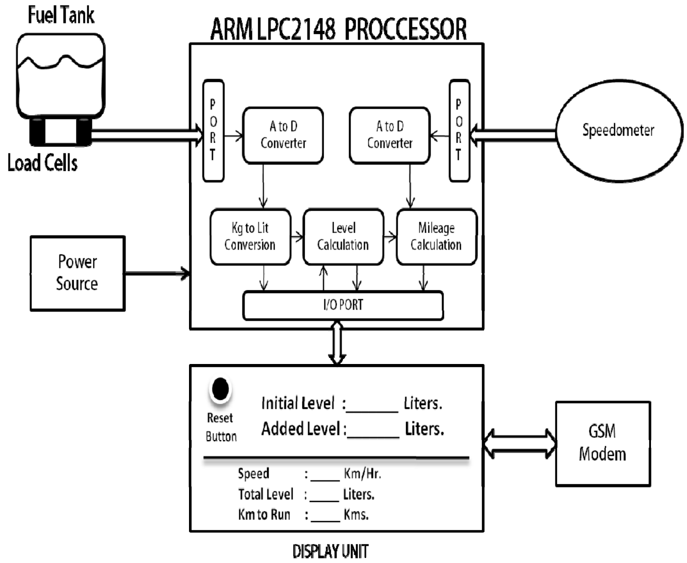

Figure 4. Proposed Block Diagram

Some energy density of meter joule per kilogram and meter joule per liter are measured and tabulated below as shown in table 1. Different types of fuel having different density values depending upon the fuel type.

Table 1. Fuel Density Values

Fuel	Energy density ($MJkg^{-1}$)	Energy density ($MJlitre^{-1}$)
Nuclear fusion of hydrogen	300,000,000	425,000,000
Nuclear fission of uranium 235	77,000,000	1,500,000,000
Liquid hydrogen	143	10
Natural gas (compressed to 200×10^5 Pa)	54	10
Petrol	46	34
Diesel fuel	45	38
Aviation fuel	43	33
Residential heating oil	43	33
Vegetable oil	42	31
Crude oil	42	37
Liquified natural gas	37	24
Coal (anthracite)	33	72
Charcoal	29	
Coal (bituminous)	24	20
Wood	6–18	2–3
Liquid hydrogen and liquid oxygen	13	6
Household waste	8-10	
TNT	4.2	7

Density is nothing but the thickness of fuel, initially crude oil having higher density from that different fuels are separated by the process and distributed in various applications[6]. Hence the petrol and diesel having some set of density value and calculations are made by the formula which we are defined. At the same time the process which is done by ARM processor within a few seconds and displays the values on display unit.

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IV. LEVEL CALCULATIONS

Calculation of fuel level depends on the fuel density. The density of the fuel is commonly expressed in kilograms per cubic meter. Hence greater the fuel density, the greater the mass of fuel and the greater the mass of fuel than can be pumped for a given pump. Fuel density commonly increases with increasing molecular weight of the fuel and energy density values are tabulated as shown in the table 1. Fuel density also generally increases with increasing molecular weight of the component atoms of the fuel molecules. Fuel density is used to calculate fuel volume ratio, which is in turn used to calculate the tank mass. Therefore the by considering the fuel density, the calculation was made by the following formula.

Fuel volume ratio = Fuel Mass Ratio / Fuel Density

Tank mass = Tank pressure * 3.0 / effective tensile * X

Where,

X = Fuel Ratio + Oxidizer Ratio + Propellant Ratio

(Consider all Ratio in Volume)

FOR PETROL:

$$L = \frac{(W-T)}{0.7372199} \text{ Liters}$$

Where,

W indicates Weight measured by Load Cell,

T indicates Tank Weight,

L indicates Liters which are calculated.

Here Petrol having the density of **737.22 kg/m^3.** Hence the proportional values are,

1 Kilogram of vehicle petrol = 1.3564472 Liters

0.7372199 Kilogram = 1 Liter

FOR DIESEL:

$$L = \frac{(W-T)}{0.885} \text{ Liters}$$

Where,

W indicates Weight measured by Load Cell,

T indicates Tank Weight,

L indicates Liters which are calculated.

Here Diesel having the density of **885.0 kg/m^3.** Hence the proportional values are,

1 Kilogram of Diesel = 1.1299435 Liters

0.885 Kilogram = 1 Liter

Similarly for gasoline there is some density values are given and calculations are made. These are the calculations which we made for the conversion of weight into liters. These converted values are now turned on into display unit which is in the dash board.

V. SPEED CALCULATIONS

The second part of our module is speed calculation which depends upon the current speed of the vehicle. The speedometer is configured with the ARM processor. This will continuously updating the current speed of vehicle and there is certain criteria for speed level and the remaining kilometers to run.

One of the important parameter is mileage of that particular vehicle. Because of depending upon the mileage only we can derive how much kilometer to run with remaining fuel for current speed. Consider the vehicle which gives the mileage of 20 km/liter, then that vehicle running with the average speed of 70 km/hr, this gives the correct kilometers with the remaining fuel. Suppose if it goes more than 100 km/hr, then the mileage gets dropped. Hence it displays very less kilometers to run.

VI. SOFTWARE IMPLMENTATION

Software implementation is using by keil IDE software, by using this ARM controller coding was designed and the HEX files are generated. The ARM coding consists of level calculation and speed calculation process. The input parameters are Weighted Load Cell value and Speed value from Speedometer.

These values are get as input values on some port numbers of ARM LPC2148 and process was carried out by the coding, the output parameters such as Real Time Clock, Initial level and Added level, GSM interfaced values. Flow chart which gives a complete idea of design flow using both software and hardware.

Step1:

The fuel level indicating process is begin .

Step 2:

with the start function and the click button is pressed by user after get into the petrol bunk.

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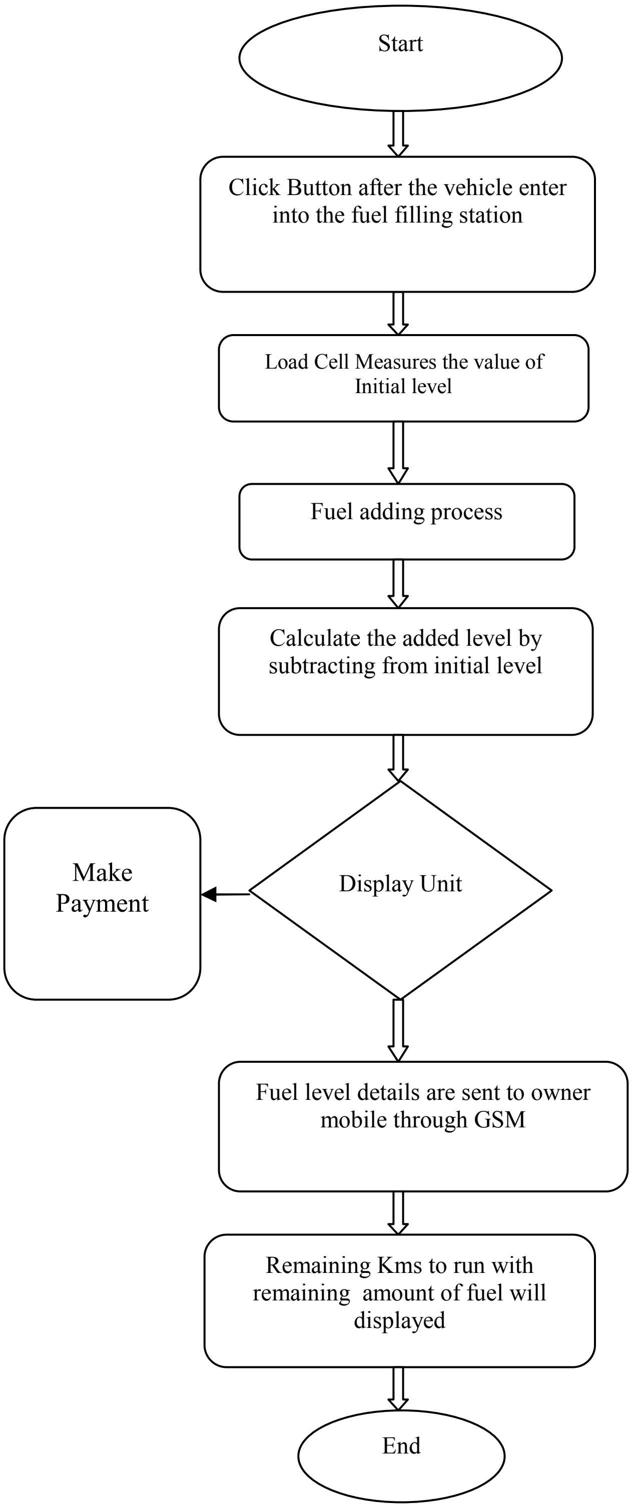

Step 3:
After the reset button load cell measure the initial fuel level.
Step 4:
In the petrol bunk fuel adding process is performing.
Step 5:
Calculation was made by the ARM processor by subtracting from original value.

Step 6:
The amount of fuel will be displayed in the display unit which is present inside the car.
Step 7:
Fuel level details are send to the user mobile by using GSM technology.
Step 8:
At the same time remaining Kilometers to run with remaining amount of fuel will displayed on the dashboard.

VII. RESULTS

Measurement and conversion of fuel level from fuel tank has been coded using Keil software with required input and output parameters. Design of circuit using Proteus has been completed.

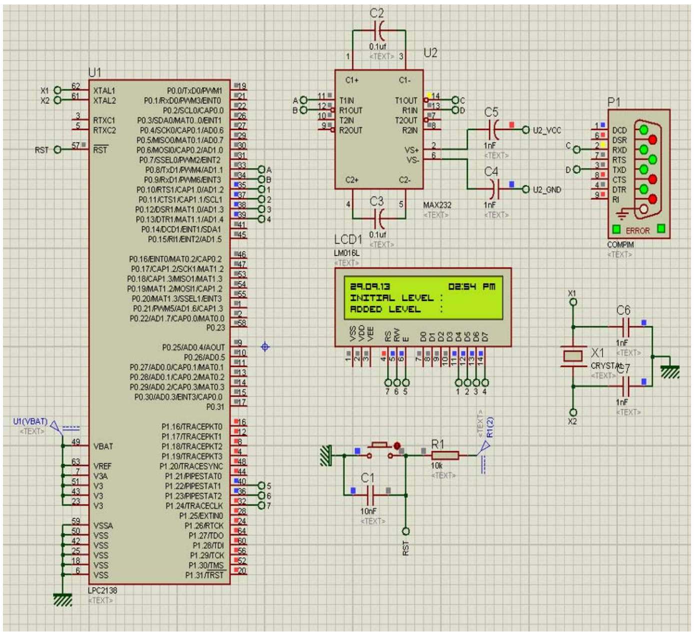

Figure 5. Simulated Output using Proteus

VIII. CONCLUSION

The proposed idea which consists of load cell based fuel measurement system that acquire the measured fuel level and send to the display unit which is present on the dash board. The data acquired from the load cell is given to the ARM processor. The processor processed the data by calculating the liter value that send to the display unit and at the same time it will generate the SMS alert which is sent to the vehicle owner using GSM. The simulation requires Embedded C program which was created and debugged using KEIL IDE software. After that simulation is done with ISIS 7 professional which is in the package of Proteus software for displaying the values. From these process the following advantage which we get by designing this system. By this

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design, unprincipled method in fuel bunks can be avoided, Driver dishonesty is identified and overcome and the owner will be aware of the fuel consumption through SMS services.

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