

Smart Sensing Fluid Flow Device for Mid Stream Process in Oil and Gas Industry

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Abstract

In petroleum industries the storage tanks have a real problem of handling and management of fuel quantity. Various devices are used to monitor fuel quantity in storage tanks or boozers, such as flow sensors, level sensors, float switches, analog meters, most commonly probes and manuals. In this regard, we propose digital system to find out the amount of fuel in liters or milliliters in the storage tank. Main objective of this project is to develop a digital display which portrays the precise quantity of fuel being poured into a storage tank or fuel container. This display will help to verify the amount of fuel filled at petrol stations. Currently, the manual process of recording fuel readings is time-consuming and tedious. By implementing this proposed system, customers will save time by receiving an exact reading without the need for double-checking the tank or container. Lately, there have been frequent reports of fuel station fraud, where stations have pumps that display an inflated amount of fuel filled, while the actual quantity poured into the customer's vehicle is much less. In Pakistan, most cars are equipped with analog fuel meters, which do not provide an accurate measure of the fuel level or allow customers to verify the amount of fuel filled at a station.

Keywords: Arduino microcontroller; digital display; fuel monitoring; flow sensor; liquid crystal display; microprocessor

1. Introduction

A fuel flow sensor is a technology utilized for monitoring the total quantity of fuel in various types of tanks, including storage tanks, fuel containers, and vehicle tanks. It can also be employed for tanks used for storing other fluids such as oil. The fuel monitoring system comprises two crucial circuits that calculate and display the fuel flow. Considering the aforementioned information, our project aims to provide an accurate digital indication of the fuel quantity in storage tanks. Through a computer-generated meter, the total amount of fuel in liters and milliliters is precisely displayed (e.g., 5,823 L). The primary focus of the project is the fuel gauge on vehicles, with additional features such as calculating the total distance that can be covered with the available fuel, fuel efficiency averages, and tracking the overall fuel input and output. These features enable us to assess the vehicle's performance based on accurate fuel readings [1].

During the project analysis, it was discovered that the fuel tanks had irregular shapes and exposed wires, posing significant challenges and safety hazards when setting up the electronics and flow sensor for calibrating fuel flow in the vehicle's tank. Therefore, we designed a project that

considered these limitations and hazards to solve the aforementioned problems and find a suitable solution applicable to such situations. The fuel flow sensor can be employed with any type of fluid and automatically monitors the fuel flow, displaying the output in liters or milliliters on a screen.

Oil plays a crucial role in transportation, serves as a component in numerous chemicals and medications, and is utilized in the production of essential items like heart valves, contact lenses, and bandages. The presence of oil reserves holds significant value in terms of attracting foreign investments and contributing to the overall improvement of a country's economy. In the current age of modern and digital technology, the fuel gauge in your car's tank is digitized to give you the exact number of liters of fuel available in your car's fuel tank [2].

Using float-style sensors with very high-viscosity oil have a tendency to form sludge and varnish, or heavily contaminated oil. Other sensors are better suited for these applications. Use pneumatic level sensors where hazardous conditions exist, where the electric power use is restricted in applications involving heavy sludge or slurry. Since the compression of a column of air against a diaphragm is used to actuate a switch, no process liquid contacts the sensor's moving parts. These sensors are suitable for highly viscous liquids such as grease.

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Basically two types of measurement technique is available that are intrusive and nonintrusive methods. Liquid level is accurately measured by nonintrusive optical sensing method. Liquid level is measured which is mostly included resistive, capacitive, transducers. But these methods are not suited for fuel measurement. Because they have poor sensitivity, susceptibility and external noises. To overcome the disadvantage, fiber-optic liquid level sensors were introduced. Fiber-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. The methods are used to measure liquid level directly by placing a sensor that comes into contact with the liquid [3], [4].

2. Existing System

The biggest cause for increasing in the amount of fuel is due to having a fuel meter on the dashboard and making drivers think they are running out of fuel when they have enough fuel. So the existing systems used are notoriously imprecise. However, some embedded systems integrate with existing systems to increase accuracy. 1) Presently, the prevailing and conventional method of measuring fuel levels in tanks involves the utilization of a float-type resistive sensor [5]. This fuel gauge system is composed of two key components. 2) In addition to the conventional fuel gauge system, there exists an alternative technology known as the Intelligent Fuel Gauge System. This innovative approach incorporates embedded systems like microcontrollers and microprocessors, enhancing accuracy levels while retaining similarity to the existing technology [6]. Its primary purpose is to provide drivers with more precise measurements of the fuel level, improving overall fuel management. The operating principles of the existing fuel gauge technique is shown Fig. 1.

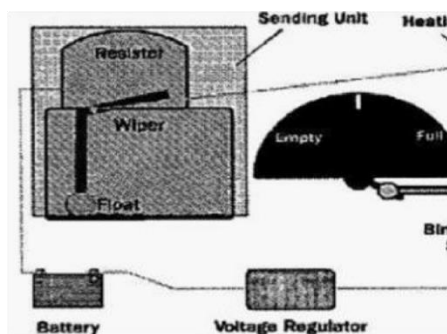


Figure 1. Existing system

In traditional fuel measurement system, a fuel flow sensor is a technology utilized for monitoring the total quantity of fuel in various types of tanks, including storage tanks, fuel containers, and vehicle tanks. It can also be employed for tanks used for storing other fluids such as oil. The fuel monitoring system 3 comprises two crucial circuits that calculate and display the fuel flow. Typically,

a flow sensor is employed in the sensor package to observe the fuel flow, and the fuel flow sensor system displays this flow by measuring the current passing through the sensor package. Considering the aforementioned information, our project aims to provide an accurate digital indication of the fuel quantity in storage tanks [7]. Through a computer-generated meter, the total amount of fuel in liters and milliliters is precisely displayed (e.g., 5,823 L).

The primary focus of the project is the fuel gauge on vehicles, with additional features such as calculating the total distance that can be covered with the available fuel, fuel efficiency averages, and tracking the overall fuel input and output. These features enable us to assess the vehicle's performance based on accurate fuel readings.

This project offers several benefits, including prevention of fuel theft and petrol station scams. It also avoids situations where a vehicle is stranded due to incorrect assumptions about the fuel level caused by analog gauges. Currently, vehicle fuel gauge systems are analog and do not indicate the precise fuel quantity in the tank. They typically display the fuel level using bars, dots, or points, rather than numerical values in liters. This limitation is addressed by developing a digital "numerical" fuel gauge system that accurately displays fuel amounts in liters or milliliters [1].

To begin the project, we examined existing fuel gauge systems and fuel tanks in various vehicles and automobiles. During the project analysis, we discovered that the fuel tanks had irregular shapes and exposed wires, posing significant challenges and safety hazards when setting up the electronics and flow sensor for calibrating fuel flow in the vehicle's tank. Therefore, we designed a project that considered these limitations and hazards to solve the aforementioned problems and find a suitable solution applicable to such situations. The fuel flow sensor can be employed with any type of fluid and automatically monitors the fuel flow, displaying the output in liters or milliliters on a screen [8].

3. Proposed System

The proposed system comprises both hardware and programming components. The hardware component is responsible for sensing the quantity of liters and facilitating communication, while the programming component handles data representation. The suggested framework primarily consists of three key elements: the installed framework components, the communication module of the Arduino microcontroller, and the components of the Arduino microprocessor. The installed framework components gather data from the fuel being dispensed into vehicles or tanks through a petrol pump nozzle. By ensuring a consistent flow of fluid, this system delivers precise data and accurately determines the volume of fluid passing through the flow sensor within microseconds. Furthermore, the system keeps track of and displays the cumulative amount of fluid flowing through the sensor on an LCD screen for observers or operators.

The Arduino microcontroller's communication module facilitates this process. Additionally, the communication module enables real-time tracking of fuel tankers. The block diagram of proposed system is shown in Fig. 2.

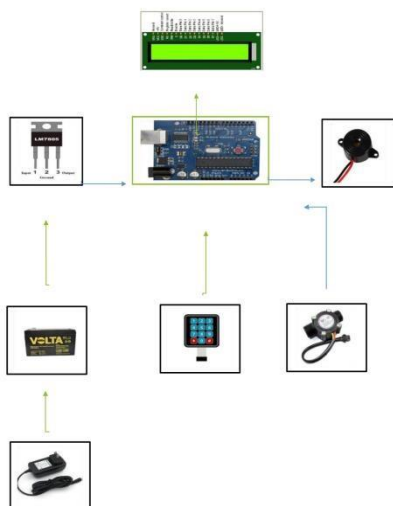


Figure 2. Proposed system

This system need:

1. Step down transformer to convert from 220w to 12w
2. 4 diodes are used to convert AC from DC
3. To filter DC current 1000 farads(F) capacitor is used
4. The we have a printed circuit board(PCB)
5. In PCB board we have our microcontroller
6. Which is microcontroller of Arduino (ATmega328p) which is a 28 pin microcontroller
7. On the microcontroller the pin#1 is used as a push button to reset or restart the program
8. On pin# 9,10 a 16000 oscillator is used which give clock pulse to microcontroller by the which the program in microcontroller is run ned
9. In order the microcontroller to work it needs 5w so we have 2 bridge rectifier, either we give it AC or DC in both cases it will give DC 12w
10. The 12w goes into the regulator which converts 12w into 5w by which our microcontroller and LCD is operated
11. Then we have 3 wires which are (ground wire)(5w wire)(pulse wire) these 3 wires are connected to the fluid flow sensor or flow meter
12. The function of flow meter is as any fluid such as petrol passes through it, So it will give pulses on 3rd wire 40 pins and there are 33 pins for input and output. It consist of two 8 bit and one 16 bit timer. Capture and compare modules, serial ports, parallel ports and five input/output ports are present.



Figure 3. Pin diagram of pic 16f877a



Figure 4. Simulation output for empty

4. Software and Coding Implementation

The provided code showcases the utilization of a liquid flow sensor on an Arduino microcontroller. Here is an interpretation of the code: The code commences by including the necessary header file for the LCD display, which enables smooth communication between the Arduino and the LCD. When an interrupt signal is received, the code increments the counter stored in the variable "flow frequency" by 1. This counter helps track the frequency of flow sensor interrupts, which can be valuable for calculating liquid flow rates or other related measurements. The code snippet provided declares a volatile integer variable named "flow_frequency" that is used to measure the pulses from the flow sensor.

Additionally, it declares variables for storing the calculated flow rate in liters per hour, as well as the current flow rate in liters per minute. The code also defines the pin number for the flow sensor input as "flowsensor," which is set to 2. Furthermore, the code includes the "LiquidCrystal" library and initializes an object named "lcd" of type "LiquidCrystal" with the appropriate pin connections for the LCD display (12, 11, 5, 4, 3, 9). This allows for easy communication between the Arduino and the LCD display module.

4.1. Indication of petrol capacity - EMPTY

The code also defines the pin number for the flow sensor input as "flow sensor," which is set to 2. Furthermore, the code includes the "Liquid Crystal" library and initializes an object named "lcd" of type "Liquid Crystal" with the appropriate pin connections for the LCD display (12, 11, 5, 4, 3, 9). This allows for easy communication between the Arduino and the LCD display module that creates a signal based.

4.2. Indication of petrol capacity – 100L

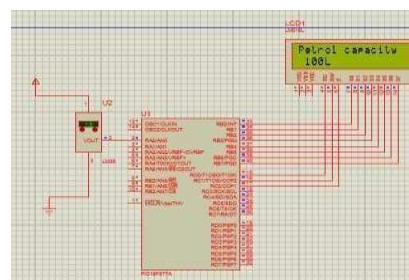


Figure 5. Output for 100 l

Fig. 5 shows the system output when the measured fuel volume reaches approximately 100 liters. In this condition, the flow sensor generates pulses corresponding to the amount of fluid passing through it, which are then processed by the Arduino microcontroller. The calculated value is displayed on the LCD, indicating that the system can accurately detect and represent low to moderate fuel levels in real time. This confirms that the conversion from sensor data to volume measurement is functioning properly at the early stage of filling.

Fig. 6 illustrates the system performance when the fuel volume increases significantly to around 900 liters. The LCD display reflects a higher reading, demonstrating the system's ability to maintain accuracy even at larger volumes. The consistency of the measurement indicates that the flow sensor and processing algorithm can handle continuous data without significant error accumulation, ensuring reliable monitoring throughout the filling process.

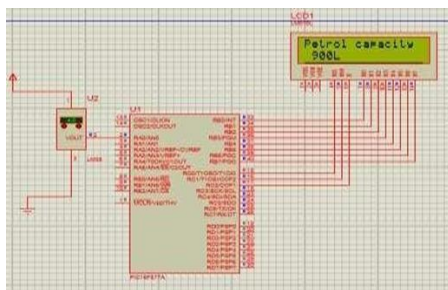


Figure 6. Output for 900 l

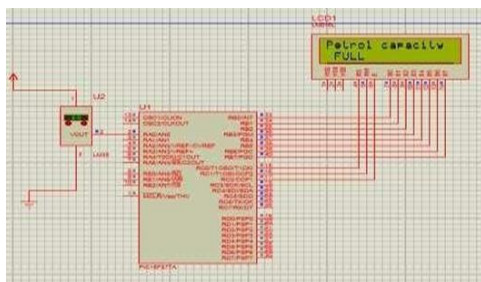


Figure 7. Output for full state

Fig. 7 presents the system output when the tank reaches its maximum capacity. In this state, the display indicates that the tank is full, providing a clear and immediate notification to the user. This feature is important to prevent overfilling and potential fuel loss. The system successfully identifies the upper limit of the tank capacity, showing that it can not only measure incremental volumes but also detect and signal the full condition effectively.

5. Conclusion

Rising fuel costs make the requirement for subsequent fuel theft significant. At the moment of an interruption or repeated replacement of fuel and fuel tanks, the control system is activated to provide the owner with accurate information about the vehicle and fuel contents. The main

reason for this operation is the safety provided by the operation of microcontroller and GSM modules. This exploratory work has proposed a development and practical methodology for fuel safety. There are some that can be introduced very well into a small space, and some that cannot be obtained efficiently.

The unmistakable feature of this framework is that it continuously delivers the worth to the owner or person till the proprietor or individual recognizes it. Despite the fact that these and other frameworks are employed, the majority of them are either expensive, problematic, complicated in configuration, and insufficient for long separation flag transmission. Further advancement should be achievable by utilizing advanced sensors, SIM, and microcontrollers to complete the verification.

This project shows a Fluid flow detector prototype model. The key component is the Fluid flow detector, which is a flow sensor on the pulses of liquid passing through the sensor in the tank and displays it digitally on the screen. Different car manufacturers will apply this type of digital fuel gauge technology in the future, which will also give security to vehicle owners. Not only will the measures be more exact, but customers will not be duped out of their money. Through the examination of various systems, subsystems, and technologies related to fuel management systems, it becomes apparent that significant progress has been made over time, resulting in improved efficiency.

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