A PROJECT REPORT ON

ENHANCED FUEL DISPENSING AND DETERMINING QUALITY OF FUEL

Submitted in partial fulfillment for the award of degree

BACHELOR OF ENGINEERING

IN

ELECTRONICS & COMMUNICATION ENGINEERING

Submitted By

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2020-2024

CERTIFICATE

This is to certify that the thesis titled "Enhanced Fuel Dispensing and Determining Quality of Fuel" submitted by Japathi Yashwanth Chandra (100520735018), Ritvik Aggarwal (100520735029), S Muhammed Farhan (100520735030) in the partial fulfillment of requirements for the award of the degree of Bachelor of Engineering in Electronics and Communication Engineering, University College of Engineering, Osmania University is an authentic work carried out by them is under my supervision.

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ACKNOWLEDGEMENT

The satisfaction that accompanies the successful completion of any task would be incomplete without the introduction of the people who made it possible and whose constant guidance and encouragement crowns all efforts with success

We would like to express our sincere gratitude to our guide **Mr. R. Narendra Reddy, Asst. Professor, Department of Electronics and Communication Engineering**, for his invaluable counsel and help. He was a huge inspiration for us to work on this project. His ability to encourage us was really beneficial to our endeavor.

We are also grateful to Prof. D. Ramakrishna, Head of the ECE department, and Prof.P. Chandra Sekhar, Principal, University College of Engineering, Osmania University for providing great facilities and a pleasant atmosphere to complete this project.

We sincerely acknowledge all the people mentioned above, without whose co-operation we couldn't have completed the project successfully.

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DECLARATION

We at this moment declare that the work presented in this project report entitled "Enhanced Fuel Dispensing and Determining Quality of Fuel" submitted in partial fulfillment of the requirement for the award of the degree of Bachelor of Engineering in Electronics and Communication Engineering, University College of Engineering, Osmania University Hyderabad, is an authentic record of our work carried out during the year 2023-2024 under the guidance and supervision of Mr. R. Narendra Reddy, Asst. Prof., Dept. of E.C.E and have not submitted for the award of any other degree.

This report's findings have not been submitted to any other university or institute for the purpose of conferring a degree or certificate.

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ABSTRACT

In recent times, various reports and complaints by customers have consistently raised concerns about the inconsistency in the quantity of fuel received from different fuel stations, sparking a pressing problem that demands immediate resolution, the issue of inaccurate fuel dispensing and quality of the dispensed fuel has become a grave concern, leading to customer dissatisfaction and industry integrity issues.

The growing need to address the problems in the fuel industry is what inspired this effort. Restoring trust in the fuel industry requires a strategy that combines both quantity and quality detection techniques.

This project aims to implement a comprehensive methodology that takes both the difficulties with fuel amount and quality dispensed into account. This approach includes a Quantity Measurement Device for accurate real-time fuel quantity measurement during refueling. This project uses the concept of density to assess fuel quality. By integrating data from these devices, a method is established for the consumer to know the fuel quantity and quality.

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CHAPTER - 1

INTRODUCTION

1.1 INTRODUCTION

India is ranked 11th in the world for the number of automobiles in use, as most of the automobiles in India run on petrol and diesel.India has turned out to be a great market for the fuel industry. Adulteration of fuel as well as reducing the fuel outflow in petrol bunks has become a major issue in India. Adding adulterants to fuel not only increases engine deposits and emissions but also reduces the customer's trust in the fuel industry. There are also issues with fuel amount being delivered to customer as few petrol bunks use longer pipes to deliver fuel where the fuel stagnates in the pipe letting lesser fuel to be delivered.

1.2 PROBLEM STATEMENT

The escalating number of reports and complaints from customers highlights a growing problem within the fuel industry—namely, the pervasive issue of inconsistent fuel quantity dispensed by different fuel stations. This problem is further exacerbated by concerns surrounding the accuracy and quality of the dispensed fuel. The persistent grievances from consumers regarding inaccurate fuel dispensing have reached a critical juncture, posing a serious threat to customer satisfaction and integrity within the fuel industry. Urgent attention is required to address these issues comprehensively and restore trust between fuel providers and consumers.

1.3 LITERATURE SURVEY

There is a lot of emphasis on the rising need of proper measurement for fuel quantity and its quality. This is because of the uncertainty in people in relation to obtaining the assured quantity and quality of fuel they have paid for. Traditional methods for detecting fuel adulteration such as laboratory analysis and manual inspections are time consuming, expensive and not applicable for real time monitoring. Several studies have discussed about the various methods of solving these issues and to find a way to enhance customer satisfaction.

The emergence of IoT technologies has revolutionized the field of fuel quality monitoring by enabling real time data collection and analysis. The study [1] implements a system that determines the adulteration and quantity of gasoline fuel using Arduino Uno microcontrollers, load cells and TCS3200 colour sensors. This system also integrates this data with a SIM00C GSM module for wireless communication and data storage and uses an open source IoT platform called ThingSpeak for data storage and visualization.

Similarly [2] discusses an IoT based system that incorporates load cells for monitoring and tracking fuel levels effectively. It also implements the use of GPS and GSM modules to alert the driver about insufficient fuel to prevent fraud and theft.
Despite the potential benefits of IoT based fuel quality monitoring systems, several challenges faced in both study [1] and [2] include sensor accuracy, reliability and most importantly high initial cost acts as a barrier that prevents widespread adoption.

Various sensor-based techniques have been explored for detecting fuel adulteration. [3] provides a comprehensive review of different sensor-based techniques such as the use of infrared sensors with camera-based imaging, optical sensors based on porous silicon microcavity, sensors based on fibre grating technology, quartz transducers, electrical meta material sensors along with the use of micro controllers for the same. Sensor calibration and external environmental factors interference are challenges associated with the use of this sensor-based techniques.

The proposed system in [4] utilizes a pH meter and microcontroller to detect adulteration in petrol. Key components of this system include a pH electrode, Petro cards, a PIC microcontroller, a pumping system and a display unit. The pH electrode measures the pH value of petrol, allowing for adulterant detection. Petro cards to automate the fuel dispensing process and the pumping system to regulate the amount of petrol being dispensed ensuring accurate fuel measurement. pH based systems offer advantages like simplicity and real time measurements but some limitations of these include integration with other sensors, higher initial investment for the setup of these.

Some of the innovative fuel monitoring systems offer advantages like real time monitoring like the system proposed in [5] which introduces a comprehensive fuel monitoring system which comprises of various modules including fuel level detection that incorporates the use of ultrasonic sensor, adulteration testing, oil quality check that uses IR rays to determine the quality of the engine oil, notification module that sends alerts to the user through a mobile application and a logs storage for all fuel related data in cloud. However, several challenges associated include sensor accuracy, data integrity and security and higher initial investment.

The device described in [6] includes a cylindrical cone tipped tank, PVC pipe, turbine flow meter, an Arduino uno microcontroller, digitizer, temperature sensor and a 9v battery. Fuel flows through this device and the quantity of fuel and its viscosity are measured using the flow meter via pulse signal processing. The data is sent to the digitizer for display. The advantages of using this system include portability, low maintenance. However, bulky nature, higher sensitivity and high initial cost are the constraints associated with this system.

The method proposed in [7] offers a real time approach to detecting fuel adulteration using optical fibre sensors. The system utilizes a fibre optic evanescent wave sensor interfaced with a PIC (peripheral interface controller) to detect to measure the percentage adulteration in fuel by noting down the variations in its refractive index. This system poses several advantages such as real time data acquisition, integration with other displays and safe handling but interferences from the external environment easily distort the data obtained from the sensors due to its higher sensitivity and difficulty in sensor calibration are its major drawbacks.

The system described in [8] offers a sensor based approach whose key components include a load cell sensor for computing the density of the sample and a TCS 320 colour sensor for detecting its colour. These sensors are interfaced with an Arduino microcontroller which processes the sensor data and displays it on an 16x2 LCD screen. The system developed was able to achieve an accuracy of 89% demonstrating its effectiveness in adulteration detection. However, sensor calibration and external environmental influences affect the accuracy and reliability of these types of systems.

1.4 EXISTING SYSTEM

Most fuel systems even in modern vehicles use a simple float assembly which rises or dips according to the level of fuel in the tank. This is very similar to the mechanism used in flush tanks. The float is connected to a resistor which in turn is connected to the battery and the gauge .According the level of float the resistor value increases/decreases which changes the amount of current being sent to the gauge .This shows the fuel level in the gauge.

To minimize the effect of fuel sloshing around the tank, fuel tanks usually have a feature to temporarily trap fuel around the float, so that it doesn't change whenever we accelerate, decelerate or change the vehicle's orientation.

Filling stations incorporate a system which is composed of an electronics component and a mechanical component. The electronics component is composed of a display and keyboard arrangement, flow sensors and a control system whereas the mechanical component comprises of the hose and nozzle arrangement which is used to pour the fuel into vehicles. The user interface of a fuel dispenser includes a digital display and a keypad. Customers use the keypad to select the desired quantity of fuel. Flow sensors measures the flow rate of fuel as it is dispensed. These sensors monitor the amount of fuel passing through the dispenser's nozzles, providing real-time data to the control system. The control system, processes information from the keypad and flow sensors. It calculates the amount of fuel dispensed and controls the flow rate accordingly. As fuel passes through the nozzle, the flow sensors monitor the flow rate, while the metering system calculates the volume of fuel dispensed.

Fuel quality checking in petrol bunks can be demanded by the customer, first they take a white filter paper and pour a drop of fuel from the nozzle on it. They let it dry for 2 minutes , if one doesn't observe any kind of stain after the filter paper dries up , then the petrol is pure Similarly for density checking at petrol bunks they fill 500 ml fuel in a clean measuring jar, immerse a hydrometer in the jar and measure the temperature using thermometer. They then use the ASTM table to check from where 15 degree density is achieved, compare with the density they get in the hydrometer, if the difference doesn't exceed plus or minus 3kg/m^3 the density is right. For quantity checking they have fuel measuring jars ready at the petrol bunks if they customer wishes to check the fuel quantity.

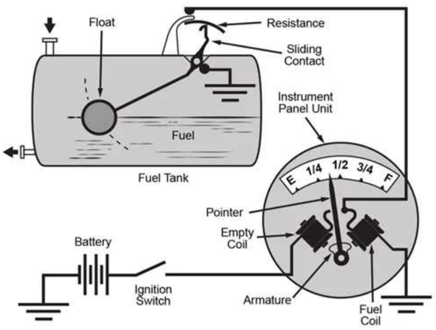

Fig 1.1:Typical fuel sensing in a tank

Fig 1.2:Fuel quality checking in petrol bunks

Fig 1.3 :Fuel density checking at petrol bunks using hydrometer

Fig 1.4 :Fuel meter at fuel station

Table 1.1 Existing systems for fuel checking

1.5 OBJECTIVES OF PROJECT

The goal of this project is to create a two-part system which is innovative, affordable, effective and simple to use in our day to day to life. The project is especially made for the awareness of the customers who feel the quantity and quality of fuel being dispensed in the fuel stations is declining every day. This system will help customers be assured about the quantity and quality of fuel being dispensed. The key objectives are:

1. To create a unit which can calculate the amount of fuel being poured into it for accurate checking of the fuel being dispensed.

2. To create a unit which can calculate the density of fuel in the fuel tank and show the changes in density when an adulterated fuel is added to the fuel tank.

By accomplishing these objectives, the designed system may prove to be a useful tool, potentially enhancing the general life quality of life. With the cost of fuel increasing every day, this system can help the customer not get cheated on. This initiative would also make a major contribution to the development of the automobile and fuel industry.

1.6 DISSERTATION ORGANIZATION

The Chapter-1 gives a brief introduction to the project including its need and aim of the project. It also includes the requirement for a fuel quantity and quality check system followed by a literature survey. The Chapter-2 explains about the design requirements in terms of hardware and software components required for carrying out the project. This chapter also contains a detailed explanation about each and every hardware component used as a part of the project. Chapter-3 discusses about design methodology, architecture of the developed system and details about both hardware and software implementation. The proposed ideas as well as reasons to alter the system are presented in this chapter. The results of the prototype, along with the observations are presented in Chapter-4. The conclusion and the future scope are mentioned in the final chapter i.e., Chapter-5.

1.7 SUMMARY

This chapter gives a brief discussion about the rising need for a quantity and quality measurement device that can calculate the fuel quantity and quality in real time. It describes the motivation of the project, its objectives and the literature survey. The literature survey highlights the importance of a system which can accurately calculate the fuel quality and quantity in real-time and gives an overview of the existing methodologies which have similar concepts involved and hence provides an opportunity to find the limitation in the existing methods and overcome those in the proposed system. The Dissertation organization helps to establish the research context and outlines the research objectives.

CHAPTER - 2

DESIGN REQUIREMENTS

2.1 INTRODUCTION

This project aims to design a prototype of a two-part system which can accurately calculate the amount of fuel being poured into it, and also compute the density of fuel in the tank which by extension is checking the quality of fuel in the tank. The proposed system requires both hardware and software equipment which are discussed in this section.

2.2 HARDWARE REQUIREMENTS

2.2.1 Arduino Uno

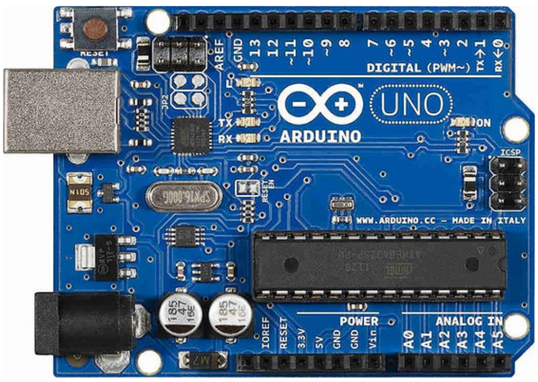

Fig 2.1 Arduino UNO

Introduction

The choice of micro controller for an IoT based solution plays a crucial role in deciding the performance and efficiency of the end product. In this proposed system we use 2 Arduino boards; Arduino UNO and Arduino Nano. The Arduino UNO is an open - source micro controller based on the Microchip ATmega328P micro controller. The micro controller board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits. The board has 14 digital I/O pins, 6 analog I/O pins and is programmable with the Arduino IDE via a type B USB cable. It can be powered by a USB cable or a barrel connector that accepts voltages between 7 to 20 volts.

Features

Features	Specifications
Processor	ATMega328P Processor
Memory	l AVR CPU at upto 16MHz
	l 32KB Flash
	l 2KB SRAM
	l 1KB EEPROM
Security	l Power on Reset (POR)
Peripherals	l 2x 8-bit Timer/Counter with a dedicated period register and compare channels
	l 1x 16-bit Timer/Counter with a dedicated period register, input capture and compare channels
	l 1x USART with fractional baud rate generator and start-of-frame detection
	l 1x controller/peripheral Serial Peripheral Interface (SPI)
	l 1x Dual mode controller/peripheral I2C
	l Six PWM channels
	l Interrupt and wake-up on pin change
Power	2.7-5.5 volts

Table 2.1: Specifications of Arduino Uno

The Arduino Uno board is perfect for students and beginners to get familiar with electronics and coding. This board gives new beginners the required first experience within the world of Arduino and IoT Applications.

Pin Description

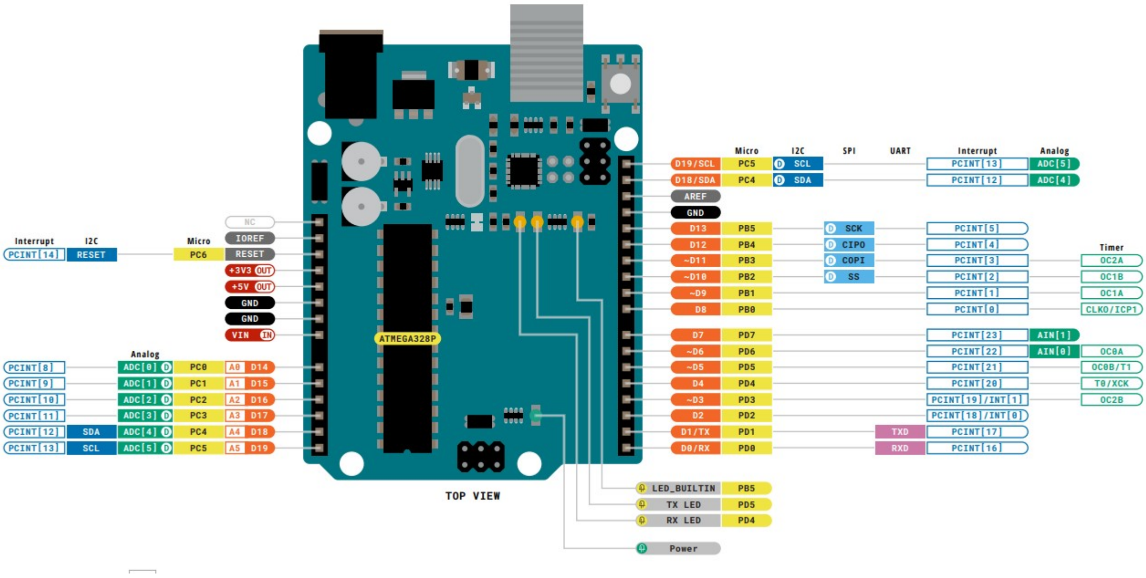

Fig 2.2 Arduino Uno Pin Diagram

Analog Pins

PIN	Function	Type	Description
1	NC	NC	Not connected
2	IOREF	IOREF	Reference to digital logic V - connected to 5V
3	Reset	Reset	Reset
4	+3V3	Power	+3V3 Power rail
5	+5V	Power	+5V Power rail
6	GND	Power	Ground
7	GND	Power	Ground
8	VIN	Power	Voltage Input
9	A0	Analog/GPIO	Analog input 0/GPIO
10	A1	Analog/GPIO	Analog input 1/GPIO
11	A2	Analog/GPIO	Analog input 2/GPIO

12	A3	Analog/GPIO	Analog input 3/GPIO
13	A4/SDA	Analog Input/I2C	Analog input 4/I2C Data line
14	A5/SCL	Analog Input/I2C	Analog input 5/I2C Clock line

Table 2.2: Analog pins and their description in Arduino Uno

Digital Pins

PIN	Function	Type	Description
1	D0	Digital/GPIO	Digital pin 0/GPIO
2	D1	Digital/GPIO	Digital pin 1/GPIO
3	D2	Digital/GPIO	Digital pin 2/GPIO
4	D3	Digital/GPIO	Digital pin 3/GPIO
5	D4	Digital/GPIO	Digital pin 4/GPIO
6	D5	Digital/GPIO	Digital pin 5/GPIO
7	D6	Digital/GPIO	Digital pin 6/GPIO
8	D7	Digital/GPIO	Digital pin 7/GPIO
9	D8	Digital/GPIO	Digital pin 8/GPIO
10	D9	Digital/GPIO	Digital pin 9/GPIO
11	SS	Digital	SPI Chip Select
12	MOSI	Digital	SPI1 Main out secondary In
13	MISO	Digital	SPI Main in secondary out
14	SCK	Digital	SPI serial clock output
15	GND	Power	Ground
16	AREF	Digital	Analog reference voltage
17	A4/SD4	Digital	Analog input 4/I2C Data line (duplicated)

18	A5/SD5	Digital	Analog input 5/I2C Clock line(duplicated)

Table 2.3: Digital pins and their description in Arduino Uno

2.2.2 Arduino Nano

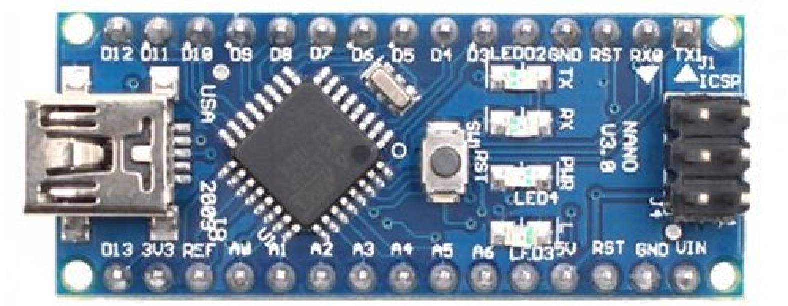

Fig 2.3 Arduino Nano

Introduction

The Arduino nano is a compact and a smaller version of Arduino Uno , It is also based on the ATmega328. It mainly lacks only a DC Power Jack, and works with a Mini-B USB cable instead of a standard one. It is used mainly mainly when space is a constraint. Despite it's small size the Arduino Nano retains most of the Arduino Uno R3's features making it suitable for multiple application in Electronics and Embedded Systems. The Arduino Nano board is designed for mini projects at its core. The hardware is compatible with Arduino IDE, Arduino CLI and Web Editor.

Features

Features	Specifications
ATmega328 Microcontroller	High-performance low-power 8-bit processor
	Achieve up to 16 MIPS for 16 MHz clock frequency
	32 kB of which 2 KB used by bootloader
	2 kB internal SRAM

	1 kB EEPROM
	32 x 8 General Purpose Working Registers
	Real Time Counter with Separate Oscillator
	Six PWM Channels
	Programmable Serial USART
	Master/Slave SPI Serial Interface
Power	Mini-B USB connection
	7-15V unregulated external power supply (pin 30)
	5V regulated external power supply (pin 27)
Sleep Modes	Idle
	ADC Noise Reduction
	Power-save
	Power-down
	Standby
	Extended Standby
I/O	20 Digital
	8 Analog
	1 6 PWM Output

Table 2.4: Specifications of Arduino Nano

The primary processor in the Arduino Nano board is the high performance and low power 8-bit ATmega328 microcontroller that runs at a clock frequency of 16MHz. Its able to interface external devices through serial communication supported by chip with UART TTL, I2C and SPI.

Pin Description

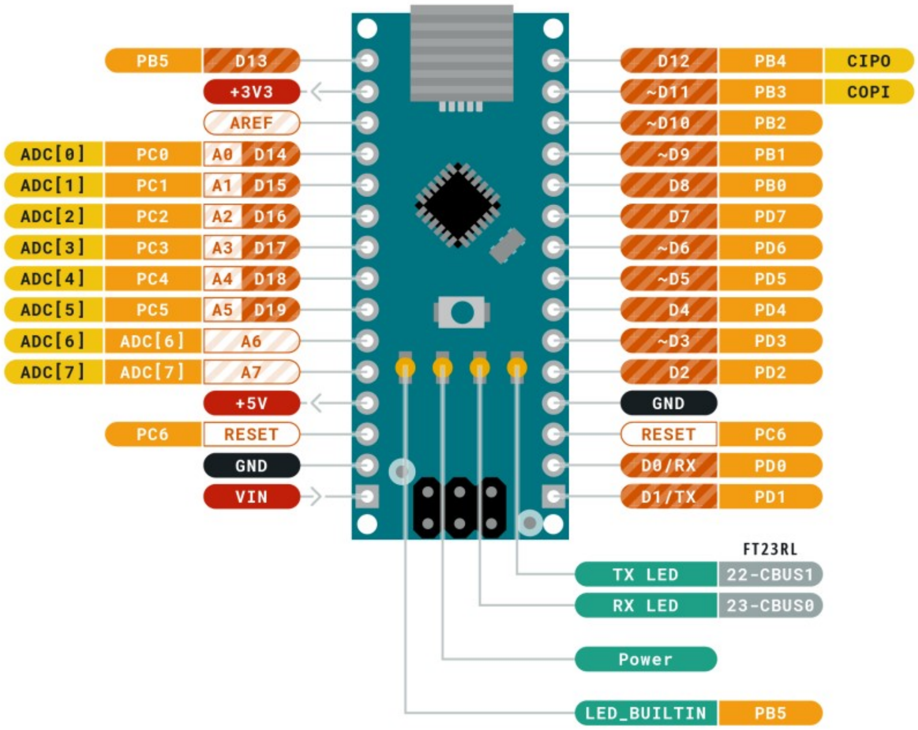

Fig 2.4 Arduino Nano Pin diagram

Analog Pins

PIN	Function	Type	Description
1	+3V3	Power	5V USB Power
2	A0	Analog	Analog Input 0 /GPIO
3	A1	Analog	Analog Input 1/GPIO
4	A2	Analog	Analog Input 2 /GPIO
5	A3	Analog	Analog Input 3 /GPIO
6	A4	Analog	Analog Input 4 /GPIO
7	A5	Analog	Analog Input 5 /GPIO
8	A6	Analog	Analog Input 6 /GPIO
9	A7	Analog	Analog Input 7 /GPIO

10	+5V	Power	+5V Power Rail
11	Reset	Reset	Reset
12	GND	Power	Ground
13	VIN	Power	Voltage Input

Table 2.5 : Analog pins and their description in Arduino Uno

Digital Pins

PIN	Function	Type	Description
1	D1/TX1	Digital	Digital Input 1/GPIO
2	D0/RX0	Digital	Digital Input 0/GPIO
3	D2	Digital	Digital Input 2/GPIO
4	D3	Digital	Digital Input 3/GPIO
5	D4	Digital	Digital Input 4/GPIO
6	D5	Digital	Digital Input 5/GPIO
7	D6	Digital	Digital Input 6/GPIO
8	D7	Digital	Digital Input 7/GPIO
9	D8	Digital	Digital Input 8/GPIO
10	D9	Digital	Digital Input 9/GPIO
11	D10	Digital	Digital Input 10/GPIO
12	D11	Digital	Digital Input 11/GPIO
13	D12	Digital	Digital Input 12/GPIO
14	D13	Digital	Digital Input 13/GPIO
15	Reset	Reset	Reset
16	GND	Power	Ground

Table 2.6 : Digital pins and their description in Arduino Uno

2.2.3 Turbo Water Flow Sensor (YF-S201)

Fig 2.5 Turbo Water flow Sensor

Introduction

Water flow sensor consists of a plastic valve body, a water rotor, and a hall-effect sensor. When water flows through the rotor, rotor rolls. Its speed changes with different rate of flow. The hall-effect sensor outputs the corresponding pulse signal.

Specifications

Parameter	Value
Working Voltage	DC 4.5V~24V
Normal Voltage	DC 5V~18V
Max. Working Current	15mA (DC 5V)
Load capacity	≤ 10 mA (DC 5V)
Flow Rate Range	1~30L/min
Load Capacity	≤10mA (DC 5V)
Operating Temperature	≤80°C
Liquid Temperature	≤120°C

Operating Humidity	35%～90%RH
Storage Temperature	-25～+ 80°C
External Threads	1/2"
Outer Diameter	20mm
Intake Diameter	9mm
Outlet Diameter	12mm

Table 2.7: Specifications of turbo water flow sensor

Connection And Part Information

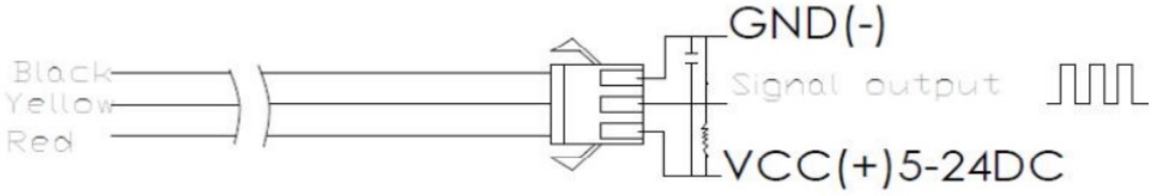

Fig 2.6 Flow Sensor Connections

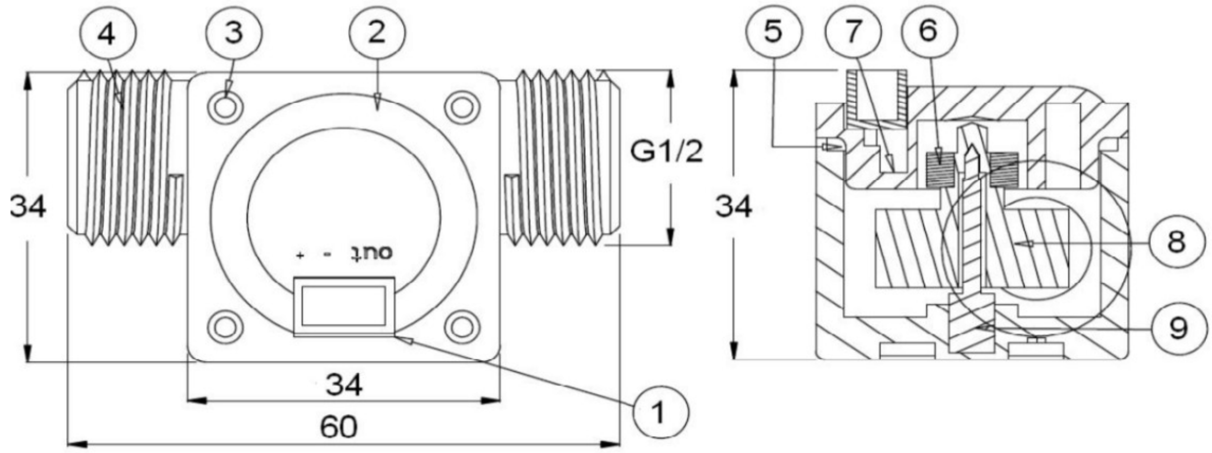

Fig 2.7 Flow Sensor Mechanical Diagram

2.2.4 Load Cell (Yzc-133 20kg)

Fig 2.8 Load cell sensor (20Kg)

Introduction

The load cell (sometimes called a strain gauge) can translate up to 20 kilograms of pressure (force) into an electrical signal. Each load cell is capable of measuring the electrical resistance that changes in response to a strain (e.g. pressure or force) applied to the tape

With this gauge one can see how heavy an object is, if the weight of the object changes over time, or simply measure the pressure or weight applied to the surface.

There are four lead connectors that can be connected to the HX711 A/D Pressure Sensor. It is easy to use with 5-10V driving voltage and the output voltage can be as varied with power.

Installing the sensor is also a simple task, one end has to be fixed through the screw hole and the other end hangs to the left, as the labels show the direction of gravity.

Specifications

Parameter	Value
Material	Aluminum
Dimensions	80 x 12.7 x 12.7 mm

Weighing Range	20 Kg
Rated Output	1.0 ± 0.1 mV/V
Non Linear Output	± 0.03% F.S
Cable Length	18 cm
Protection Standard	IP65
Impedance	1115±10% Ω
Output Impedance	1000±10% Ω
Operating Temperature	-20°C to 65°C
Weight	29 gm

Table 2.8: Specifications of load cell sensor (20kg)

2.2.5 Hx711 Load Cell Amplifier

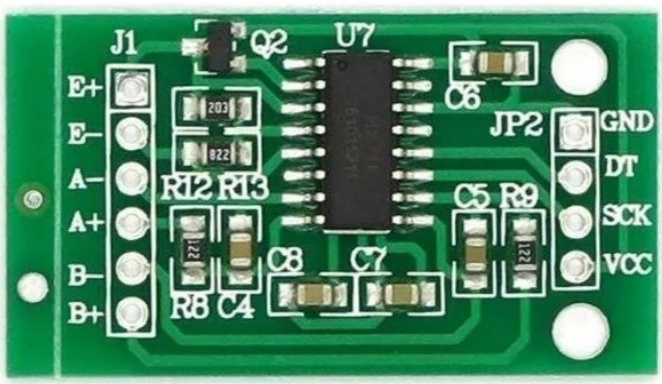

Fig 2.9 HX711 Amplifier

Introduction

The HX711 is a 24 bit analog to digital converter (ADC) designed to amplify and digitize signals from weight cells for weighing scales and industrial control applications Converters are designed to convert the energy applied to the weight cell into an electrical signal.

This amplifier communicates directly with microcontrollers such as the Arduino Uno utilized in this project. It incorporates the use of simple communication protocols making it easier to integrate into applications that require accurate load measurement.

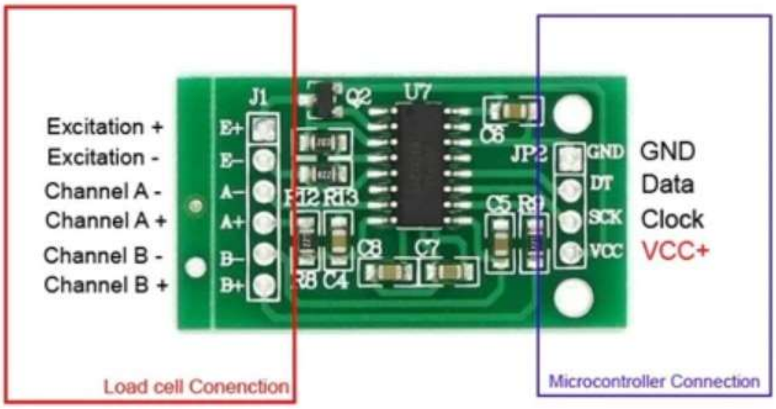

Fig 2.10 HX711 Pin Diagram

Features

1. Two selectable differential input channels.

2. On-Chip active low noise PGA with selectable gain of 32,64,128.

3. On-Chip power supply regulator for load-cell and ADC analog power supply.

4. On-Chip oscillator requiring no external component with optional external crystal.

5. On-Chip Power-on-reset.

6. Simple digital control and serial interface: pin-driven controls, no programming needed.

7. Simultaneous 60 and 50Hz supply rejection.

8. Current consumption including on-chip analog power supply regulator:

    a) Normal operation<1.5mA, power down<1uA

9. Operation supply voltage range: 2.6 - 5.5V

10.Operation temperature range: -40°C - +85°C

2.2.6 Piezoelectric Buzzer

Fig 2.11 Piezoelectric Buzzer

The Piezoelectric Buzzer is a small and efficient component that produces sound feedback as per requirements. Its two-pin compact structure allows it to be easily used with a breadboard and PCBs. This piezoelectric buzzer has 23mm diameter and 30mm spaced mount holes. It produces a 3.3kHz tone at an 85dB sound level when activated, drawing a current less than 15mA. It is supplied with a 100mm lead and is designed for a 3 - 20V power supply.

Specifications

Parameter	Value
Operation Voltage	5V DC
Frequency	3,300 Hz
Current	<15 mA
Color	Black
Operating Temperature	-20°C to +60°C
Polarity	Positive Pin marked
Number of Pins	2

Table 2.9 : Specifications of piezoelectric buzzer

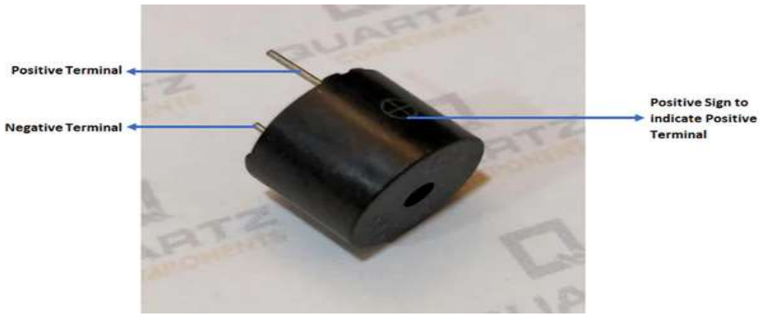

Fig 2.12 Piezoelectric Buzzer terminals

2.2.7 LCD With I2C

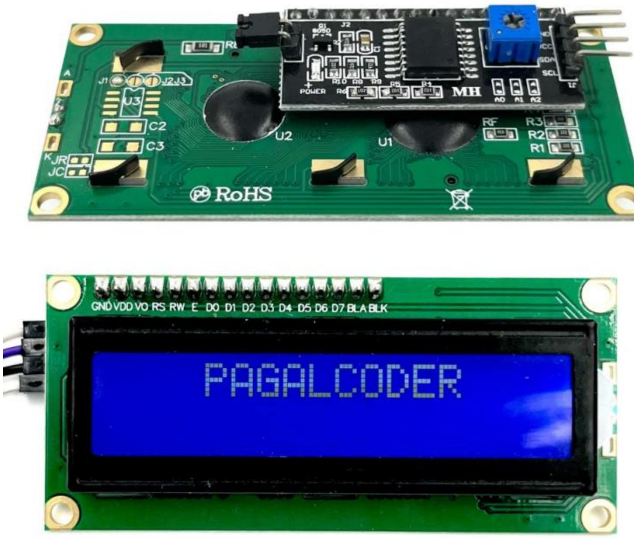

Fig 2.13 LCD with I2C

An LCD With I2C uses Inter-Integrated circuitry to communicate and transfer data for visual or textual displays. These LCDs use only 2 lines, SDA and SCL to transfer data.

Features

Parameter	Value
Characters	16x2 Lines
LCD Controller IC	AiP31068L or Equivalent
Viewing Angle	6 O'clock direction
Interface	I2C MPU Interface

Backlight	White LED
Operating Temperature Range	-20 to +70°C
Storage Temperature Range	-30 to +80°C
Module Size	87 x 32 x 13 mm
View Area	64.5 x 16.0 mm
Number of Characters	16 x 2 lines

Table 2.10: Specifications of LCD with I2C

Pin description

ITEM	SYMBOL	LEVEL	FUNCTION
1	SDA	H/L	I^2C Bus Serial Data
2	SCL	H/L	I^2C Bus Serial Clock
3	GND	0V	Power Ground
4	VCC	+3.3 - 5.0V	Power supply for logic

Table 2.11: Pin description of LCD with I2C

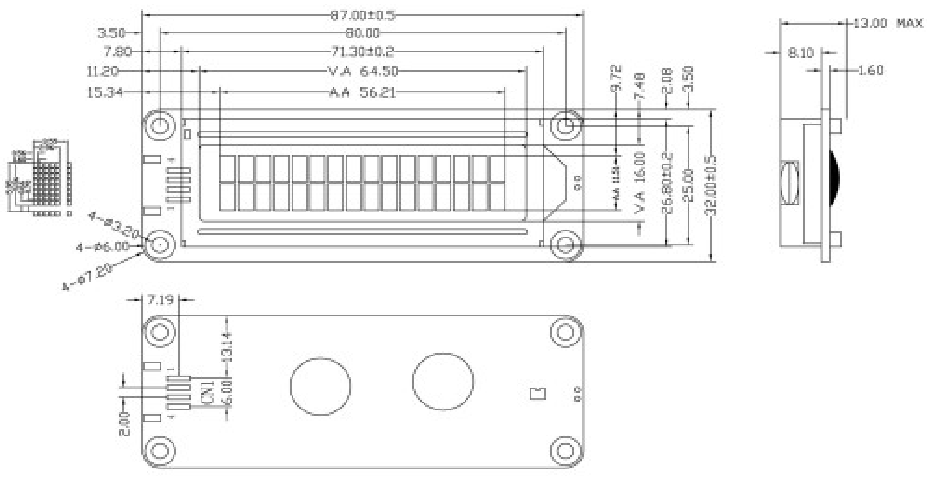

Fig 2.14 LCD with I2C Mechanical Drawing

2.2.8 SPST Push Button switch

Fig 2.15 SPST Push button switch

A Push Button is a mechanical device which is used to control the power flow in an electrical circuit. The button is used to manually switch the circuit on or off. They can also be used to provide an input by the user for a start / stop function. The switch we have used is a SPST switch (Single pole single throw), it has 2 terminals and can be used to control power flow only in one circuit.

Specifications

Parameter	Value
IP Rating	Not rated
Voltage Rating	Up to 24Vdc
Current Rating	Up to 14mA
Pitch	2.54mm

Table 2.12: Specifications of Push Button switch

2.2.9 Push button

Fig 2.16 Push Button

A push button switch is typically an electrical switch that is activated by pressing a button. It is commonly used to control various functions in electronic devices. In this project it is mainly used to give inputs to the Arduino to increase the value of the volume in the container by a certain amount.

Specifications

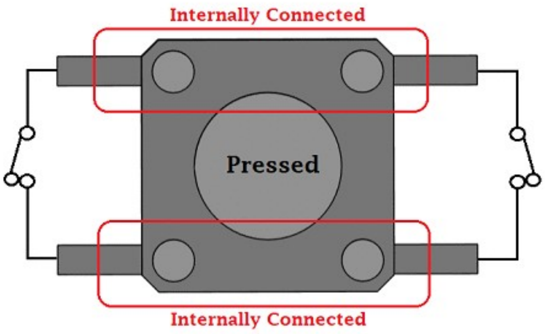

Fig 2.17: Push Button Internal connections

Parameter	Value
Mode of Operation	Tactile feedback
Power Rating	MAX 50mA, 24V DC
Operating Temperature Range	-20°C to +70°C
Storage Temperature Range	-20°C to +70°C

Table 2.13: Specifications of push button

2.2.10 Jumper wires, Wood, Funnel and Container

Jumper wires

Fig 2.18: Jumper Wires

Jumper wires are simple electrical wires with connectors at each end, commonly used in electronics and prototyping projects to establish electrical connections between components on a bread board or circuit board. They are often insulated with PVC or silicone to protect again short circuits.

Wood

Fig 2.19: Wood

Wood was used in our project to balance the load cell balance and to perfectly measure the weight being placed at the load.

Funnel

Fig 2.20: Funnel

Funnel was used in our project in the Quantity measurement device to pour the fuel into the container and to allow fuel to pass through the flow sensor. It is used to ensure that no fuel is wasted outside and flows into the container properly.

Container

Fig 2.21 Container

The container was used in the Quality measurement device, it acts as a fuel tank in the prototype. It is used to measure the weight of fuel being poured in the prototype.

2.3. SOFTWARE REQUIREMENTS

2.3.1. Arduino IDE

The Arduino IDE is an integrated development environment (IDE) commonly used to program Arduino boards. It is an open-source software that is used for the configuration of microcontrollers. The Arduino IDE provides an easy-to-use graphical user interface (GUI) that allows users to write, compile, and code on the Arduino board. The IDE supports a simplified version of the C++ programming language, making it accessible to beginners with no prior programming experience. It also includes a library of prewritten code, called sketches, that can be easily modified and adapted to the needs of the project.

Fig 2.22: Arduino IDE logo

CHAPTER - 3

DESIGN METHODOLOGY

3.1. INTRODUCTION

The chapter describes the steps and procedures followed to develop the fuel quality and quantity measurement system. The project aims to provide a feasible and cheap solution to prevent people from getting duped in petrol stations and to improve the customer satisfaction rate.

3.2. PROPOSED SYSTEM

3.2.1. Real Time Flow Quantity Measurement:

The proposed system comprises a flow quantity sensor that is affixed to a funnel for enhanced functionality. This sensor is linked to a micro controller board, establishing connections with an LCD display to showcase the precise digital data acquired from the sensor. Positioned at the end of the funnel is the sensor and the entire setup consisting of the Arduino board, LCD and other components are cohesively arranged outside the funnel. Notably, the system operates on battery power, ensuring flexibility and portability in its use. Its compact design renders it easily manageable, catering to the user's convenience in using it in real time.

3.2.2 Fuel Quantity and Quality Measurement

Fuel Quantity Measurement

The proposed system offers a distinct advantage over existing fuel monitoring systems by providing an accurate numerical representation of the fuel quantity in the tank. In contrast to conventional systems that rely on level-based sensors to indicate fuel levels, this innovative solution employs a Flow based sensor for precise measurement. The acquired fuel level data is subsequently processed by a micro controller to calculate the exact volume of fuel within the tank. This micro controller is seamlessly integrated with an LCD, which serves as the interface for presenting the fuel volume information in liters, enhancing the user's ability to monitor and manage fuel level efficiently. The main purpose of this fuel quantity measurement device is to accurately measure the quantity of fuel poured through the funnel. This flow based sensor has a rotor inside it which can measure the volume of fuel poured through it.

Fuel Quality Measurement

The proposed system introduces an innovative approach to assess the quality of fuel by quantifying the percentage of adulteration based on density. A pivotal component of this system is a load cell employed to determine the mass of fuel present in the tank. Subsequently, the obtained mass is utilized to calculate the fuel's density, utilizing the volume data acquired from the ultrasonic sensor, following the formula Density = Mass/Volume. The calculated density is then compared with predefined standard density values, giving an idea about the amount of adulteration in the fuel. This is shown on the lcd which helps customer identify the level of adulteration in fuel.

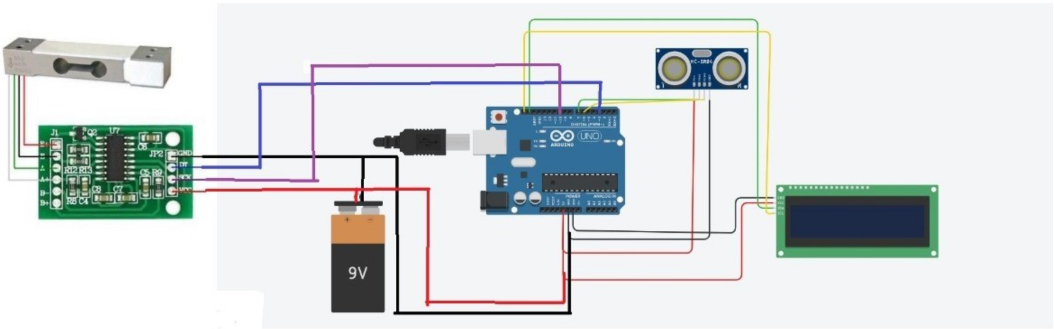

Fig 3.1 : Proposed Circuit diagram for fuel quantity and quality measurement

3.2.3. Block Diagram

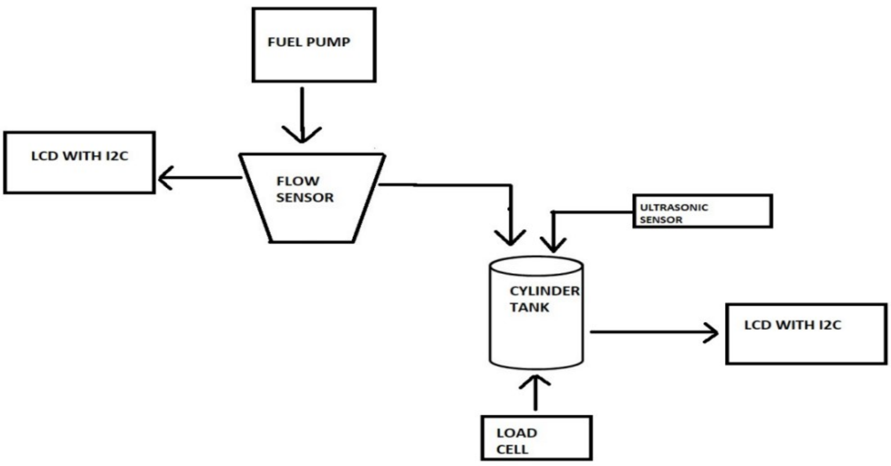

Fig 3.2: Block diagram of the proposed systems

3.2.4 Quality Checking Chart

Fuel	Density @ 26°C(kg/m^3)
Pure Petrol	719
Up to 5%	725
Up to 20%	751
Up to 21-30%	768
Up to 31-40%	774
Up to 41-50%	783
Up to 51-55%	791
10% adulterated	725
20% adulterated	783
Kerosene	795
Turpentine	850

Table 3.1: Density vs adulteration chart

3.2.5 Conceptual Visualization

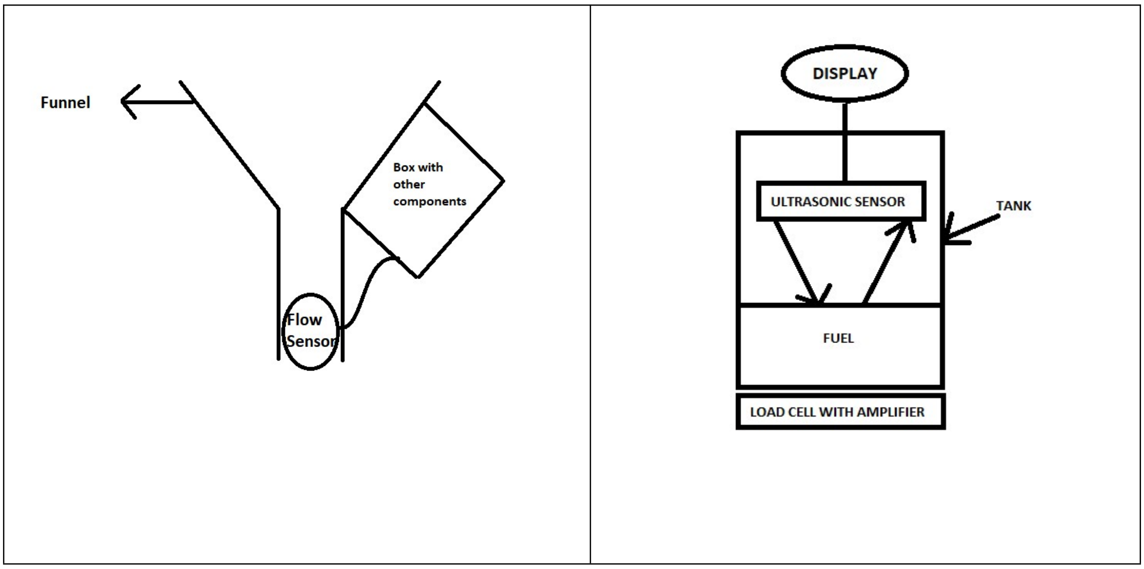

Fig 3.3: Conceptual visualization of proposed system

3.3 NEED FOR ALTERATION

The proposed system originally used an ultrasonic sensor for accurate measurement of volume in the container for the fuel quantity measurement device and needed no external input from the user.

It failed because

1. Ultrasonic sensor cannot accurately calculate the distance of petrol from the sensor, unlike water petrol is an absorbent of ultrasonic waves that the sensor uses to measure distance.

2. Due to this absorbent nature, utilizing ultrasonic sensors was not possible as it gave inaccurate values of the fuel level in the container.

3. Also, petrol vaporizes easily and these vapors interfere with the computation of distance when using ultrasonic sensor.

These factors make ultrasonic sensors ineffective and potentially hazardous when used with petrol.

Fig 3.4 Testing with ultrasonic sensor

Other methods that could be used

1. Capacitance Sensors:

Capacitance sensors operate on the principle of capacitance which is the ability of a system to store an electric charge. Usually, it consists of probes or electrodes that are immersed in the liquid, the capacitance changes according to the level of surrounding liquid. By measuring the change in capacitance in the sensor the level of liquid is determined.

2. Optical Sensors:

Optical Sensors utilize light-based technology to detect the presence of liquid to measure its level. These sensors usually work by transmitting light through the liquid and measuring the amount of light that passes through or by detecting changes in light reflection caused by the liquids surface.

3. Float Sensors:

Float sensors are one of the most common sensors used for indicating the height of a fluid in a tank. It's used in water tanks and fuel tanks. It employs a simple mechanism involving a buoyant object that rises or falls with the liquid level.

4. Pressure Sensors:

Pressure sensors measure the pressure exerted by a fluid on the sensing element. It is usually placed at the bottom of the tank and they measure the pressure exerted by the liquid column above them. It then converts the pressure into appropriate level measurement reading.

5. Conductive Sensors:

Conductive sensors detect changes in electrical conductivity caused by the presence or absence of a liquid. When liquid comes into contact with these electrodes, it creates a conductive path between them, which the sensor can detect.

While each of these sensors has its merits and demerits , factors such as cost and lead time affected the choice of sensor to be chosen for this project. High Lead times and High costs negatively affects the goal of the project which is to be cost effective. So these sensors were not utilized.

3.4. DEVELOPED SYSTEM

3.4.1. Hardware Implementation

Few changes were made to the proposed system as the ultrasonic sensor was not an appropriate component. A few buttons and switches were also added so that the system is more cost efficient and easy to work with.

Fuel Quantity measurement device

The Arduino nano functions as the controller for this setup. A funnel is taken for the petrol to be poured into and a turbo flow sensor is fixed at the nozzle of the funnel for accurate measurement of the fuel being poured. The flow sensor is connected to the Arduino nano. An LCD with I2C is connected to the setup for displaying the results. A battery along with a switch is also connected to the circuit for the power supply of the setup. The system is connected according to the circuit diagram given below.

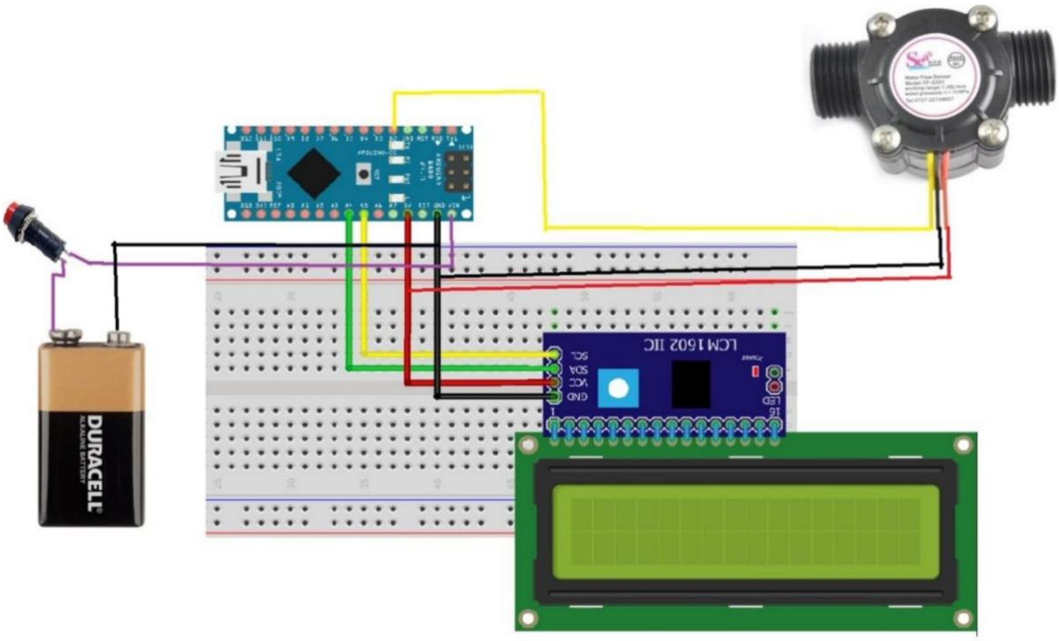

Fig 3.5 Circuit Diagram for Quantity Measurement device

Fuel Quality measurement device

The Arduino Uno functions as the micro controller in this setup. A load cell is used to measure the weight of the fuel in the container which will be placed atop the load cell. A HX711 Load cell amplifier is utilized to amplify the weak signals from the load cell and to convert the analog signals from the load cell into digital signal. A push button is attached to modify the volume to be calculated for density measurement. A buzzer is attached in the circuit which will ring is the density of petrol is in its acceptable range that is 720- 770 kg/m^3 or 0.72 -0.76 kg/litre. Power supply for the system is given from two Li-ion batteries and a switch is also implemented in the circuit for effective power management and to conserve battery for prolonged usage. All the components are attached as shown in the circuit diagram below.

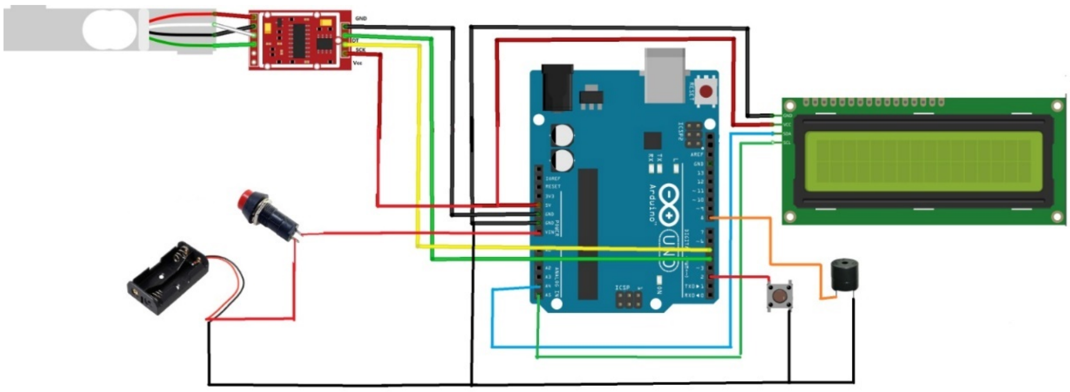

Fig 3.6 Circuit Diagram for Quality Measurement Device

3.4.2. Software Implementation.

Three codes were used in this project using Arduino IDE.

1. Calibration code for load cell.
2. Code for working of Quality measurement system.
3. Code for working of Quantity measurement system

Calibration code

1. It can be directly found from examples in the Arduino IDE
2. Go to File at the top left of the IDE
3. Click on examples under the file option, then go to the HX711_ADC option under the Examples option.

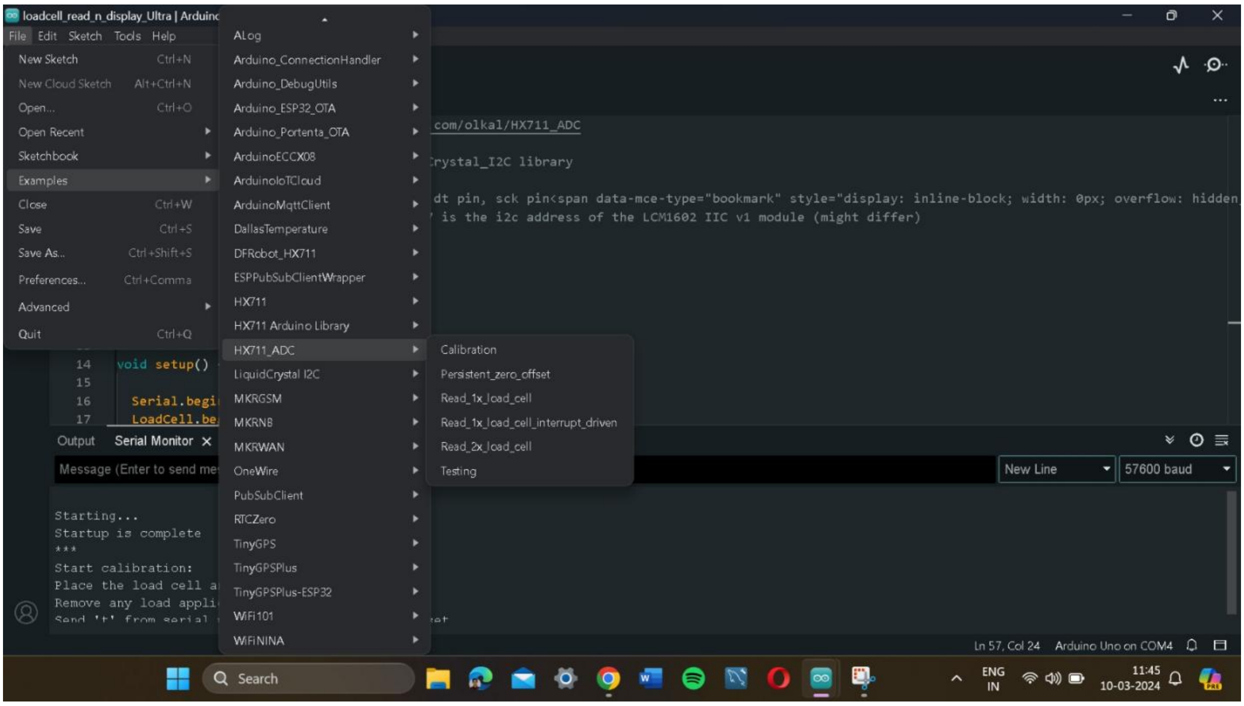

Fig 3.7 Calibration Test in Arduino IDE

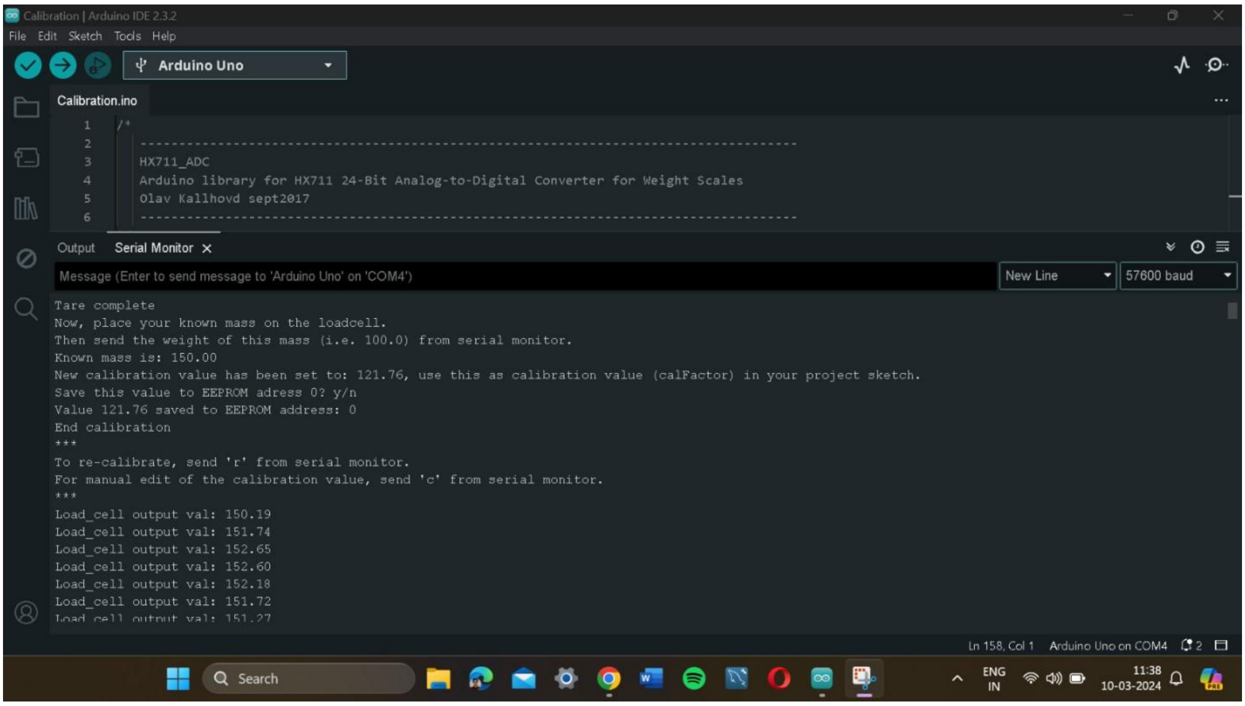

Fig 3.8 Calibrating load cell with Known Mass

4. In the HX711_ADC option go to Calibration Option; A new window will open up.

5. Place the load cell on a level stable surface. Remove any load applied to the load cell, and enter ‘t’ from serial monitor to set the tare offset.

6. Now take an object with a known mass. (We took 150grams)

7. Place it on the load cell, and enter the weight in grams in the IDE. We will get a calibration value which is to be entered into the Quality measurement code later.

8. We then end the calibration process and check if the value we are getting for the known mass is correct or incorrect.

9. Enter the calibration value in the code for Quality measurement.

Code for working of Quality and Quantity measurement system

1. These 2 codes are simple Arduino codes.

2. The Quantity measurement code takes data from the Arduino micro controller and presents the data on the LCD with I2C, Here the output is simply the amount of fuel being poured through the flow sensor in liters.

3. The Quality measurement code takes data from the load cell amplifier which are mass(weight) and then the push button when pressed updates the amount of fuel which is being poured into the container(volume) on the load cell.

4. The code takes both the mass and volume as inputs and gives out density as Density = Mass / Volume.

5. From the calculation from the density, we have taken

   A. 0.72- 0.77: Quality of petrol is GOOD

   B. Else : Quality of petrol is BAD

CHAPTER - 4

RESULTS AND DISCUSSIONS

4.1 DEVELOPED SYSTEMS

This is our prepared model for the Quality measurement device.

Fig 4.1 Model of the Quality measurement device.

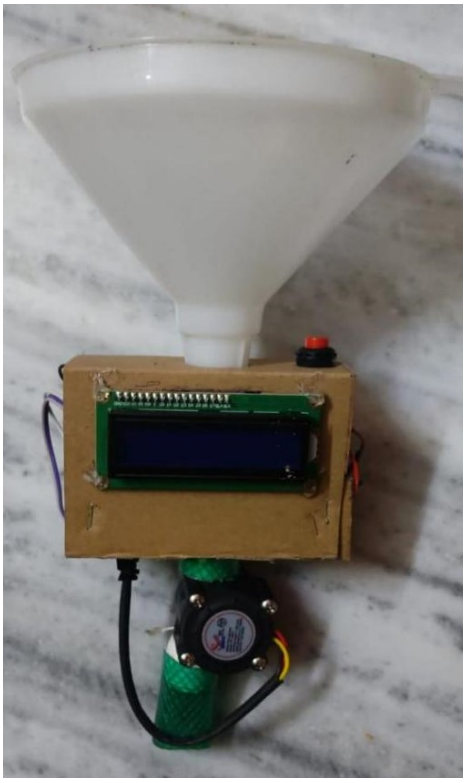

Fig 4.2 Model of the Quantity measurement device

Fig 4.3 Model of the whole setup

4.2 TEST RESULTS

Petrol Readings

S.No	Initial Volume(ml)	Poured Volume(ml)	Flow meter Reading	Mass(gm)	Density (gm/ml)	Quality of Fuel
1	0	200	0.21L	151.93	0.76	GOOD
2	200	200	0.41L	301.72	0.75	GOOD
3	400	200	0.62L	452.69	0.75	GOOD

Table 4.1: Petrol readings

Initially we took 200ml of petrol using a measuring jar and poured it through the fuel Quantity measuring system into the container and it displayed a reading of 0.21L at the LCD. The weight of the fuel in the fuel quality measuring system displayed the mass as 151.93gm , by calculations from the code the density of fuel came out to be 0.76gm/ml . This density is in the range of 0.72 - 0.77 gm/ml so the obtained Quality of Fuel is GOOD.The buzzer starts to ring as the petrol quality is GOOD. Similarly two more tests were conducted by adding 200ml of petrol through the fuel quantity measurement system into the container. The obtained results matched with the fuel density purchased from the petrol bunk, which was 0.75 gm/ml.

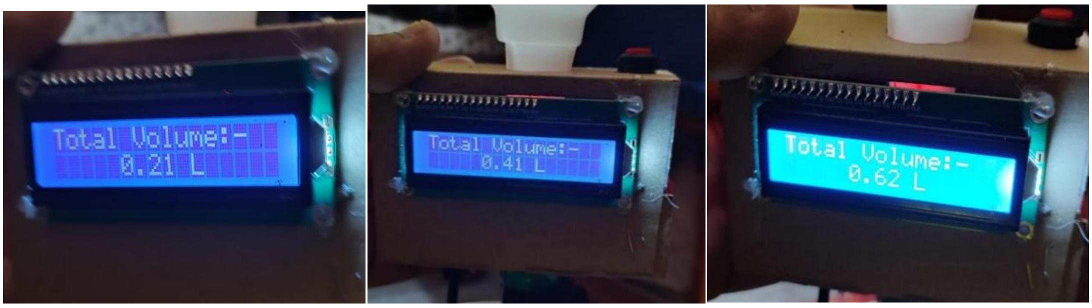

Fig 4.4 Readings of Petrol In Quantity measurement device

Fig 4.5 Readings of Petrol in Quality Measurement device

Quality Measurement device

Turpentine Oil

S.No	Volume(ml)	Mass(gm)	Density(gm/ml)
1	0	0	0
2	200	157.79	0.79
3	400	319.55	0.80
4	600	480.60	0.80

Table 4.2: Turpentine Oil Readings

Initially all the systems were checked and calibrated to be 0 and then we took 200ml of Turpentine oil using a measuring jar and poured it into the container and the weight of the oil in the fuel quality measuring system displayed the mass as 157.79gm , by calculations from the code the density of oil came out to be 0.79gm/ml ..Similarly two more tests were conducted by adding 200ml of oil into the container through a measuring jar. The density of turpentine oil is usually above 0.81 gm/ml , but as there was ethanol mixed in it the density came out to be between 0.79 - 0.8 gm/ml.

Fig 4.6 Readings of turpentine in Quality Measurement device

Measurement for petrol with adulteration

S.No	Volume of fuel(ml)	Volume of turpentine (ml)	Total Volume (ml)	Mass (gm)	Density (gm/ml)	Quality of Fuel
1	500	200	700	551.19	0.79	BAD
2	500	300	800	631.44	0.79	BAD

Table 4.3: Adulterated petrol readings

Initially the amount of petrol in the container was set to 500ml which was tested earlier (density 0.75gm/ml). To this, 200ml of turpentine oil (also tested earlier density 0.8gm/ml) was added through a measuring jar , here the turpentine oil acts as the adulterant to petrol. The total volume of petrol in the container is now 700ml, the mass displayed for this adulterated petrol came out to be 551.19 gm . The density calculated from this mass and volume from the code is 0.79gm/ml. This density does not lie between the range of 0.72-0.77gm/ml indicating the Quality of Fuel is BAD.The Buzzer did not ring in this test as the Quality of Fuel is BAD. One more test was conducted by adding 100ml of turpentine oil again which thereby increases the adulteration ratio in the petrol, now the total adulterant added in the system is 300ml. While we did not find any significant change in the density of the adulterated fuel, it still showed that the Quality of Fuel was BAD.

Fig 4.7 Readings of adulterated petrol in Quality Measurement device

4.3 SUMMARY

We have successfully tested the Fuel Quality and Quantity measurement device on the basis of 3 parameters. Testing with Petrol (Fuel), Testing with Turpentine Oil (Adulterant) and Testing with Petrol mixed with Adulterant (Adulterated Fuel). The readings were accurate and from the observations we were able to conclude that the quality of petrol which we used had a density of 750kg/$m^{3,}$ or 0.75 kg/l which was same as the density of petrol shown in the fuel station. After adding adulterant into the petrol, the density of petrol noted a sharp increase which proved that an adulterant has been added to the petrol. Note that the petrol which we bought from the fuel station was already adulterated with the adulteration being around 20%.

CHAPTER - 5

CONCLUSION AND FUTURE SCOPE

5.1 CONCLUSION

The goal of this project was to develop a cost-effective system that would solve issues faced by consumers all over the world in regards to the quantity and quality of fuel being provided to the public. The project involved development of a quantity and quality detection system that would accurately determine the amount of fuel being poured and also give an idea about its quality by obtaining its density.

The proposed system involved the use of a flow sensor, an ultrasonic sensor and a load cell with amplifier as the data generating devices and Arduino microcontrollers to process the data and display it on LCDs. The flow sensor setup showed the amount of fuel being poured into the system. The ultrasonic sensor was responsible for determination of quantity of fuel present in the container (replicating a tank) and the load cell was responsible for giving out the mass(weight) of the fuel present in the tank. Both the weight and the volume readings would then be used to determine the density of the fuel hence giving an insight on its quality. The final system incorporated the use of the flow sensor setup and the load cell setup but failed to use the ultrasonic sensor-based volume determination setup, the reason being absorbent nature of petrol and unavailability of alternate sensors due to cost and lead time constraints.

Upon testing the fuel quantity and quality system we were able to achieve accurate results demonstrating its effectiveness in improving customer satisfaction by providing them with the necessary data when purchasing fuel. This project can serve as a basis for future research and development of similar technologies.

5.2 FUTURE SCOPE

According to statistics, more than 90% of the total vehicle users across the world are dependent on petrol and diesel as a fuel for their vehicle. As the cost of fuel is skyrocketing in recent times, it becomes more and more important for a more convenient, cost-effective system to assure people of the quality and quantity of fuel they are purchasing.This device can help consumers in that aspect. However, even though our project is a success, there is still room for improvement and innovation in the future.

This project's final goal is to be implemented in a real-life vehicle where the amount of fuel being poured into the vehicle's tank and the quality of the fuel gets displayed into the speedometer of the vehicle in real-time. It should also be able to take other parameters such as the vehicle's mileage, air pressure of the vehicle's wheels, engine condition and any other parameters which might affect the vehicle's working and display the estimated distance the vehicle will be able to go before the fuel tank gets emptied. It should also be able to show the quality of fuel being poured as well as the overall quality of fuel in the fuel tank.

Another aspect where this project can be improved is Integration with IoT and Cloud Services. If it is possible to integrate the project's code with a cloud service which can display the GPS location of the fuel station where the petrol was refilled , as well the density of the fuel at that petrol station and give a rating system, it will be highly beneficial so that the next time someone wants to refuel, he/she can go to a fuel station which has better quality of fuel. It can also be improved in the aspect that by considering the number of times the vehicle needs refueling, one can now accurately understand when one has to take the vehicle for a maintenance check.

An aspect where this project can also be developed is to enhance the user interface and experience it by developing mobile applications for remote monitoring. The user should be able to have a customizable dashboard along with other intuitive calibration procedures to check the fuel history . It should also be able to check for any leaks or to ensure compliance with regulatory bodies related to fuel handling and storage.

For huge enterprises which have a lot of shipment material, it can be a cumbersome task to verify the fuel related costs for each and every vehicle. Integrating a device which can record the amount of fuel dispensed as well as the expenses related to it could streamline fuel tracking, billing and reporting processes. This could help multiple industries which include but not limited to transportation, logistics and agriculture.

Research and implementing more accurate and advanced sensors along with measurement techniques to improve the accuracy and precision of both quantity and quality measurements. This could involve using higher-resolution sensors or integrating sensors for reducing errors and error correction. Though care must be taken that these sensors are cost effective and does not burden the consumer with its cost.

The future scope of this project is not limited to the above ideas. The growing technologies and needs give rise to new innovative solutions in the fuel industry.

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APPENDIX

A.1 QUANTITY MEASUREMENT CODE

```
#include <Wire.h>

#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x27, 16, 2); // Change the address (0x27) based on your I2C
module

const int flowSensorPin = 2;  // Flow sensor signal pin

volatile int pulseCount = 0;

float calibrationFactor = 7.0; // Adjust this based on your sensor's specifications

void setup() {

  Serial.begin(9600);

  lcd.init();                       // Initialize the LCD

  lcd.backlight();                  // Turn on the backlight

  // lcd.setCursor(0, 0);

  // lcd.print("FlowRate:");

  lcd.setCursor(0, 0);

  lcd.print("Total Volume:-");

  pinMode(flowSensorPin, INPUT);

  attachInterrupt(digitalPinToInterrupt(flowSensorPin), pulseCounter, FALLING);

}

void loop() {

  static unsigned long lastTime = 0;
```

```
  unsigned long currentTime = millis();
  if (currentTime - lastTime >= 1000) {
    float flowRate = pulseCount / calibrationFactor;
    float totalVolume = pulseCount / (calibrationFactor * 60);  // in liters
    // lcd.setCursor(9, 0); // Position cursor for flow rate
    // lcd.print("      ");   // Clear previous value
    // lcd.setCursor(9, 0); // Position cursor again
    // lcd.print(flowRate, 2);
    // lcd.print(" L/min");
    lcd.setCursor(5, 1); // Position cursor for total volume
    lcd.print("        "); // Clear previous value
    lcd.setCursor(5, 1); // Position cursor again
    lcd.print(totalVolume, 2);
    lcd.print(" L");
    Serial.println(totalVolume);
    lastTime = currentTime;}}
void pulseCounter() {
  pulseCount++;
}
```

A.2 QUALITY MEASUREMENT CODE

```
#include <HX711_ADC.h>

#include <Wire.h>

#include <LiquidCrystal_I2C.h> // LiquidCrystal_I2C library

HX711_ADC LoadCell(4, 5); // parameters: dt pin, sck pin

LiquidCrystal_I2C lcd(0x27,20,4); // 0x27 is the i2c address of the LCM1602 IIC v1 module (might differ)

float volume[] = {500, 600, 700, 800, 1000};//initially 500ml,100ml PP added=600ml,100ml AP added =700ml

int arraySize = sizeof(volume) / sizeof(volume[0]);

int currentIndex = -1;

const int buttonPin= 2;

const int buzzer= 9;

int x=-1;

float density;

void setup()

{

  Serial.begin(38400); // Starts the serial communication

  LoadCell.begin(); // start connection to HX711

  LoadCell.start(2000); // load cells gets 2000ms of time to stabilize

  LoadCell.setCalFactor(103.71); // calibration factor for load cell => strongly dependent on your individual setup

  lcd.init();
```

```
  lcd.backlight();
  pinMode(buttonPin, INPUT_PULLUP);
  pinMode(buzzer,OUTPUT); //BUZZER
  lcd.setCursor(0, 0); // set cursor to first row
  lcd.print("Mass:");
  lcd.setCursor(0, 1);//fixed volume
  lcd.print("Volume:");
  lcd.setCursor(0, 2);//density
  lcd.print("Density:");
  lcd.setCursor(0, 3); //density
  lcd.print("Quality:"); // print out to LCD
}
void loop()
{
  LoadCell.update(); // retrieves data from the load cell
  float mass = LoadCell.getData(); // get output value
  //Serial.println(mass);
  // Read the state of the push button
  int buttonState = digitalRead(buttonPin);
  // Check if the button is pressed
```

```
if (buttonState == LOW)

{

 // Increment the array index

  currentIndex = (currentIndex + 1) % arraySize;

            x= volume[currentIndex];

}

  density= mass/x;

 if(density>=0.72 && density<=0.77)

 {

   lcd.setCursor(10,3);

   lcd.print("GOOD!");

  digitalWrite(buzzer, HIGH);

 }

 else{

   lcd.setCursor(10,3);

   lcd.print("       ");

   lcd.setCursor(10,3);

   lcd.print("BAD!");

   digitalWrite(buzzer, LOW);

 }
```

```
lcd.setCursor(10, 0); // set cursor to first row

lcd.print(mass); // print out the retrieved value to the second row

lcd.setCursor(10, 1);

lcd.print(x);

lcd.print("      ");

lcd.setCursor(10, 2);

lcd.print("         ");

lcd.setCursor(10, 2);

lcd.print(density);

delay(150);

}
```