Final year project on

Advanced Digital Fuel Meter

(Submitted in partial fulfillment for the award of degree of Bachelor of Technology by Assam Science and Technology University)

Submitted by

Deepjyoti Baruah (200610027003)
Subham Gogoi (210650027002)
Nabadeep Baruah (200610027013)
Tarik Anower (200610027019)

Under the guidance of
Prof.(Dr.) DIPANKAR CHANDA
Professor

Department of Electrical Engineering
(Instrumentation Engineering Discipline)
Assam Engineering College,
Jalukbari, Guwahati – 781013

ACKNOWLEDGEMENT

With heartfelt gratitude, we acknowledge the invaluable contributions of our supervisor, Dr Dipankar Chanda Sir. His unwavering support, insightful guidance, and meticulous supervision were instrumental in the successful completion of our project. We are deeply indebted to his dedication and mentorship, which were a constant source of motivation and inspiration.

Furthermore, we extend our sincere appreciation to Dr Runumi Sarma ma'am, Head of the Department of Electrical Engineering, for providing us with the opportunity to undertake this project and utilize our knowledge and skills. We are grateful for her belief in our potential and her commitment to fostering our academic growth.

Finally, we express our profound gratitude to our friends and family who have provided unwavering support and encouragement throughout this journey. Their presence and belief in us have been a source of strength and comfort.

CERTIFICATE FROM THE SUPERVISOR

This is to certify that the project entitled "ADVANCED DIGITAL FUEL METER" has been carried out and presented by

NAME	ASTU ROLL NO
Deepjyoti Baruah	200610027003
Subham Gogoi	210650027002
Nabadeep Baruah	200610027013
Tarik Anower	200610027019

Students of B.Tech 8th Semester, Instrumentation Engineering Discipline under the Department of Electrical Engineering of Assam Engineering College, under my supervision and guidance in a manner satisfactory to warrant its acceptance as a prerequisite for the award of Bachelor of Engineering in Instrumentation Engineering of the Assam Science and Technology University.

Further, the report has not been submitted or reproduced in any form for the award of any other degree/diploma.

Date:
Place: Jalukbari,Guwahati

Dr. Dipankar Chanda
Professor
Department of Electrical Engineering
Assam Engineering College

CERTIFICATE FROM THE HEAD OF THE DEPARTMENT

This is to certify that the project entitled "ADVANCED DIGITAL FUEL METER" has been carried out and presented by

NAME	ASTU ROLL NO
Deepjyoti Baruah	200610027003
Subham Gogoi	210650027002
Nabadeep Baruah	200610027013
Tarik Anower	200610027019

Students of B.Tech 8th Semester, Instrumentation Engineering Discipline under the Department of Electrical Engineering of Assam Engineering College, under my supervision and guidance in a manner satisfactory to warrant its acceptance as a prerequisite for the award of Bachelor of Engineering in Instrumentation Engineering of the Assam Science and Technology University.

Further, the report has not been submitted or reproduced in any form for the award of any other degree/diploma.

Date:
Place: Jalukbari,Guwahati

Dr. Runumi Sarma
Head of the Department
Department of Electrical Engineering
Assam Engineering College

ABSTRACT

In today's rapidly changing world and rise in demand of fuel especially in a developing nation we perpetually hear about the increasing fuel prices. This topic has become a major issue. With the increasing demand and increased prices, there has been a need to develop a digital fuel indicator to know better about the amount of fuel present and added to the vehicle. Fuel theft by the petrol pump owner is also leading the common man to be cheated as the petrol pump is tempered such that it displays the amount as entered by the provider but the quantity of fuel that is filled in the customer's fuel tank is much lesser than the displayed value. As an analog meter does not show the exact amount, and also it is not possible to cross-check the fuel added thus people are helpless despite knowing the fraud by petrol pump owners which makes them earn a fortune. Fuel theft while parking is also a disturbing fact all over the world. The main objective of the project is to present a proper solution for indicating the exact availability of fuel in the tank digitally which will calibrate the exact amount of fuel contained in the vehicle's tank as well as flowing into the fuel tank with the help of an ultrasonic sensor. The aim of the project is to make it more digital, it becomes possible to demonstrate the measure of fuel in a vehicle when it gets stolen.

TABLE OF CONTENTS

-

LIST OF FIGURES

CHAPTER 1:

INTRODUCTION

In today's fast-paced world where digitalisation is at its peak making things more interactive and easier to deal with, the idea is to develop a digital fuel indicator. A fuel indicator is an instrument used to indicate the amount of fuel present in the tank commonly used in cars and bikes. Various other features are also added like the distance that can be travelled with the corresponding fuel and mileage, and also to know the current position of the vehicle, SMS alert system etc by using GPS. The main objective of the project is to get the real-time amount of fuel present in the vehicle in both the working and ideal conditions with the help of capacitive transducer and the distance that can be travelled by the vehicle. This project helps to avoid many problems like fuel bunk at fuel stations, and fuel theft utilizing SMS alerts. It also prevents from getting into situations where no other option is left but to push the vehicle due to wrong assumptions of the fuel level. As fuel prices are always high in developing countries, where people are also more obsessed with mileage, manual calculations to know the mileage of a particular vehicle is not that easy. In the conventional fuel mileage calculation method, the results are obtained by two successive refuelling of the tank and also by the in-vehicle parameters. The drawback of this process is that the results are obtained after a day or two and also it is time consuming. Thus, demand grows for capability to display fuel mileage consumption in real time which is not only cost effective but also can be used to get the better efficiency of vehicle. Last but not the least, the most important is the GPS system which will also work as anti-theft system for the vehicle in case it is stolen.

1.1 Objective:

This project aims to develop a digital fuel indicator system that overcomes the limitations of conventional fuel gauges and provides additional functionalities to enhance user experience and fuel efficiency.

The specific objectives are:

- Real-time fuel level monitoring: To develop a system using a capacitive transducer to accurately measuring the fuel level in the vehicle's tank in real-time, under both running and idle conditions. This eliminates the ambiguity associated with traditional needle-based fuel gauges.
- Low fuel indication: To integrate a alarm system for low fuel indication .
- Enhanced user experience: To replace the traditional fuel gauge with a digital display that provides clear and easy-to-understand information on fuel level, distance-to-empty, and real-time fuel mileage.
- Potential anti-theft functionality: To explore the possibility of integrating the GPS system with the fuel indicator to create a basic anti-theft system. While not the primary focus, this feature could provide additional value in the future.
- Locating nearest petrol pump: To locate the list of nearest petrol pumps by using the Google Map in the developed Android application.

CHAPTER 2:

LITERATURE SURVEY

1) Sharma A, et.al [1] emphasizes that

a lot of efforts are being made all over the world to maximize the utilization of fuel used in engines of vehicles. Rising fuel prices and depletion of non-renewable resources are the main reasons behind such concerns. Technology plays a very important role in our lives. The proposed project aims to save fuel from being stolen directly from fuel tanks at commercial and individual levels by implementing a system that detects any change in the fuel level in the fuel tanks and reports to the owner through a call and a message immediately. Vehicle fuel theft has always been one of the major concerns for both bike and car owners and especially for goods and transport agencies. The main intention of this project is to avoid theft of fuel and minimize the financial loss

2) Katkar G, et.al [2] points out that

IoT has been a great area of research for providing excellence in area of designing smart cities and intelligent systems. Fuel theft from standing vehicles is a major problem which can be very easily resolved using this technique. In this paper, a system is proposed for detection of fuel theft from vehicle using the concept of IoT as well as wireless sensor networks. The method has shown very good results as compared to other state of the art methods.

3) Huang, H., et.al [3] explains that

a low-power consumption remote home security alarm system developed by applying WSN and GSM technology is presented. It can detect the theft, leaking of raw gas and fire, and send alarm message remotely. The hardware of this system includes the single chip C5081F310, wireless receiving and sending chip CC1100 as well as the SIMENS TC35 GSM module. The system software developed in C51 language has the ability of collecting, wireless receiving and sending data, and can send a piece of alarm short message to the users mobile phone when some dangerous condition has been detected.

4) B.G. Nagaraja, et.al [4] explains that

nowadays, a lot of efforts are being taken all over the world to maximize the utilization of fuel use in engines of vehicles. Rising fuel prices and depletion of nonrenewable resources are the main reasons behind such concerns. Technology plays a very important role in our lives. The proposed project aims in the direction to save fuel from being stolen directly from fuel tanks at commercial and individual levels by implementing a system which detects any change in the fuel level in the fuel tanks and reports to the owner through a call and a message immediately. Vehicle fuel theft has always been one of the major concerns for both bike and car owners and especially for goods and transport agencies. The main intention of this project is to avoid theft of fuel and minimize the financial loss.

5) B.G. Nagaraja, et.al [5] presents

Design & Development of Multi level Anti theft security system to control the theft of a vehicle using GSM and Biometrics. The main objective of this is to offer an advanced security system in multiple levels to protect the car from unauthorized access using GSM technology. It provides a protected password to unlock the car and real time biometric user authentication in second level to start the ignition after finger print verification is done. If the fingerprint does not match with that in database, ARM produces the interrupt signal to disable the ignition and initiates an alarm and also inform the car owner about the unauthorized access via short Message Services (SMS) by means of GSM modem.

6) R. Rilwano, et.al [6] demonstrates that

fuel shortage is a common problem in Indonesia. This prompted many cases of vehicle fuel theft. As a solution to this problem, an Arduino-based vehicle fuel theft detector system is implemented. Arduino-based vehicle fuel theft detector system is a prototype that uses Arduino UNO as a microcontroller, I Com Sat v1.1 SIM900 GSM/GPRS Shield to communicate with mobile phone, fuel level sensor as a volume detector, and push button as a detector to check whether the fuel tanks lid is open or closed. The working principle of this system is to detect the state of the fuel tank lid. When the lid is open, the system will make a phone call. Then, the system will keep track of fuel volume. If there is a drastic decrease in volume, the system will send information about the decreasing volume in the form of a short message to the owner of the vehicle. The success rate of the communication system between Arduino UNO and other electronic devices is 100%. Accuracy of fuel level sensor is 90%. Success rate of push button switch in detecting the state of fuel tanks lid is 100%. Success rate of GSM Shield communication is 90%.

7) A. Avinash Kumar, et.al [7] points out that

today in this digitized world, if the fuel indicator in the automobiles is also made digital it will help to know the exact amount of fuel available in the fuel tank. The above furnished fact is considered in the proposed project and a proper solution is found for indicating the exact availability of fuel in the tank digitally . Here, the amount of fuel in the tank is indicated in litres. This value in litres will be in numerical digits (ex:1.2, 1.3, 1.4). This project mainly concentrates about the indication of fuel level in two- wheeler tanks. Various other features like the distance that can be travelled with the corresponding fuel, is added with this arrangement which will explain the performance of the vehicle to the corresponding available fuel

CHAPTER 3:

METHODOLOGY

3.1 Block Diagram:

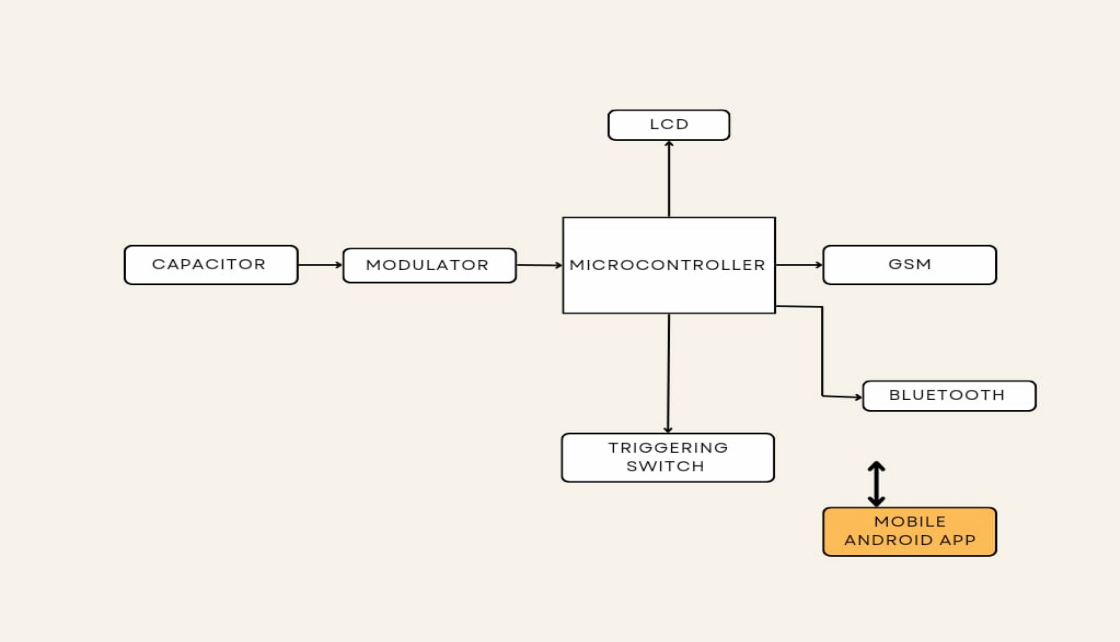


Figure 3.1 Basic block diagram

3.2 Circuit Diagram:

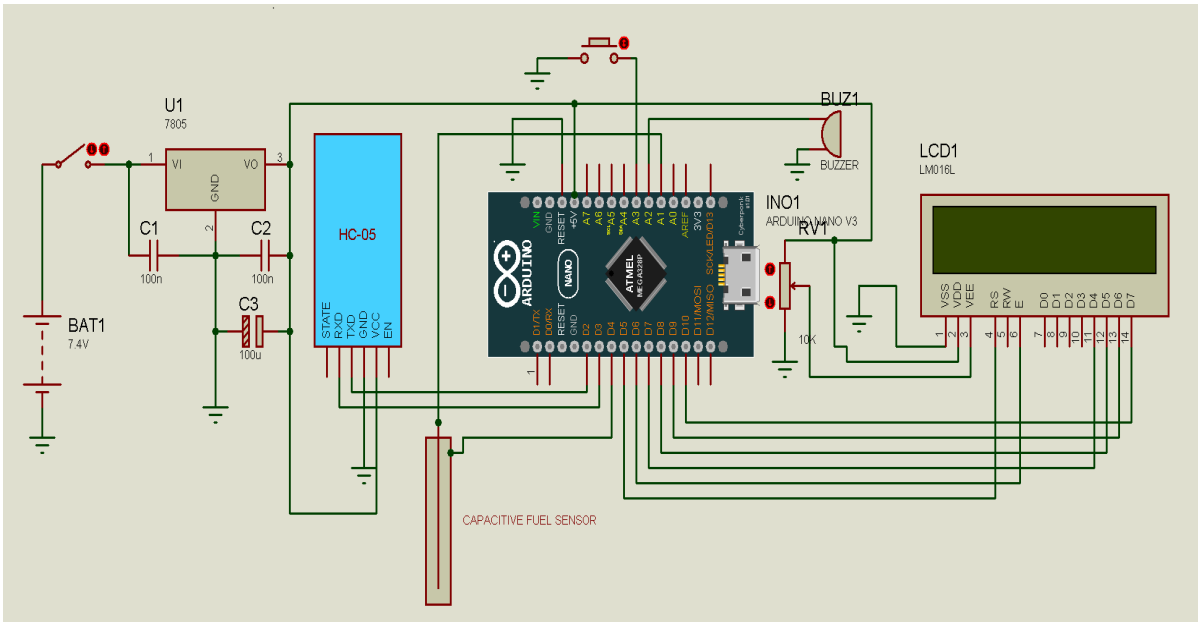


Figure 3.2 Circuit diagram of Advanced Digital Fuel Meter

3.3 Working:

The working principle of a capacitive fuel meter sensor is based on the concept of capacitive characteristics of dielectric material and the arrangement of electronic electrodes.

To construct the capacitive sensor 2 different types of aluminium pipes are used. Different sizes of capacitive sensors can be easily made by increasing and decreasing the length of the Aluminium tube. Copper material is best for this purpose but for the experiment purpose Aluminium tubes are used. As both the electrodes must be insulated properly to construct a capacitive sensor, hence the Aluminium tubes are properly coated with white enamel paint.

The concept of calculating capacitance is related to calculating the time duration of charging and discharging the capacitor (capacitive sensor under test).

In the proposed circuit, Pin 4 is used to discharge the capacitance and analog pin A1 measures the voltage level of the capacitance during charging. When the capacitance is charged near about 64%, it starts discharging the capacitor and tracks the time duration.

When liquid is poured in the container where the capacitive sensor is placed, different values are recorded. Initially the result was not stable but after reducing harmonic noise, it becomes stable. Using AC to DC adaptor, the results are found to be unreliable but with the power supply containing a battery pack, the result becomes stable and reliable. The program executed in the microcontroller is responsible for converting the capacitance value into a presentable fuel level by using mapping. The program keeps checking the fuel level and if it goes below the threshold value, it activates the buzzer. The system is also equipped with a push button switch which can be replaced by any other switch or sensor to detect intrusion.

The system is having HC 05 MODULE which is responsible for establishing communication between a smartphone and the microcontroller. A well-defined Android app is used for receiving the data from the hardware and displaying it in real-time.

The application has features to activate and deactivate the alarm according to the necessity. The software serial of Arduino is used to interface with HC 05. To provide power supply to the components i.e. Arduino, HC 05, and LCD, a linear voltage regulator 7805 is used. 7085 has 3 pins, connecting pin1 is input where 7-18volt regulated or unregulated input is given, pin2 is ground and pin3 is unregulated input.

Irrespective of input voltage at pin1, the output voltage at pin3 is always 5 (± 0.1volt).

To display the fuel level on the circuit, a 16X2 LCD in parallel mode is used. The LCD module uses 4-bit parallel communication with the microcontroller to get commands and display data.

CHAPTER 4:

EQUIPMENTS USED

4.1 Sensors Used:

4.1.1 Capacitive Transducer: This sensor is used to measure the fuel level in the vehicle's tank. Its capacitance changes based on the fuel height, allowing the Arduino to determine the fuel level in real time. The following types of Capacitive transducers are used-

- 10mF electrolytic capacitor
- 100 mF ceramic capacitor

Electrolytic capacitors have high capacitance values but low voltage ratings, while ceramic capacitors have lower capacitance but can withstand higher voltages.

A capacitive transducer is a passive transducer which means it requires external power for operation. The capacitive transducer works on the principle of variable capacitances. The capacitance of the capacitive transducer changes because of many reasons like overlapping of plates, change in distance between the plates, and dielectric constant.

The capacitive transducer uses the following three effects:

- Variation in capacitance of the transducer is because of the overlapping of capacitor plates.
- The change in capacitance is because of the change in distances between the plates.
- The capacitance changes because of the dielectric constant.

Parallel Plate Capacitive Transducer

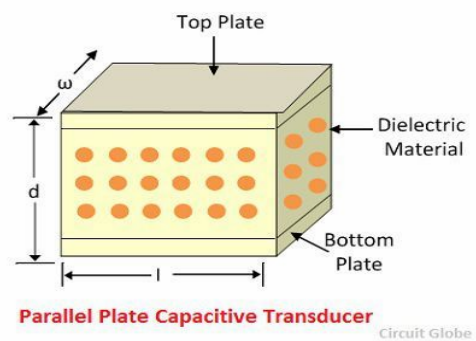


Figure 4.1 Parallel plate capacitive transducer

The equations below express the capacitance between the plates of a parallel plate capacitor

$$C = \varepsilon A/d$$

$$C = \varepsilon_r \varepsilon_0 A/d$$

Where A – overlapping area of plates in m^2

d – the distance between two plates in meter

ε – permittivity of the medium in F/m

ε_r – relative permittivity

ε_0 – the permittivity of free space

Cylindrical Capacitive Transducers

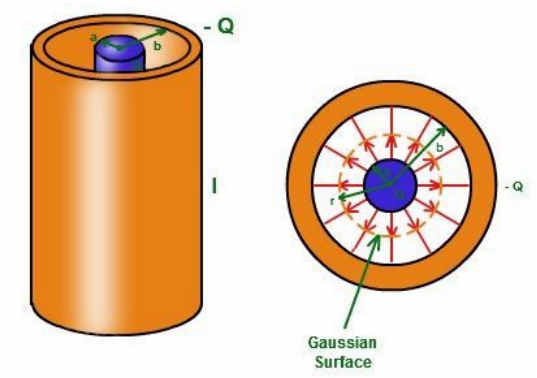


Figure 4.2 Cylindrical capacitive transducer

The capacitor is used to store large amounts of electric current in a small space. The cylindrical capacitor includes a hollow or a solid cylindrical conductor surrounded by the concentric hollow spherical cylinder.

Capacitance of cylindrical capacitor

$$C = 2\pi\epsilon_0 L/ln(\frac{b}{a})$$

Where,

C= capacitance of the cylinder

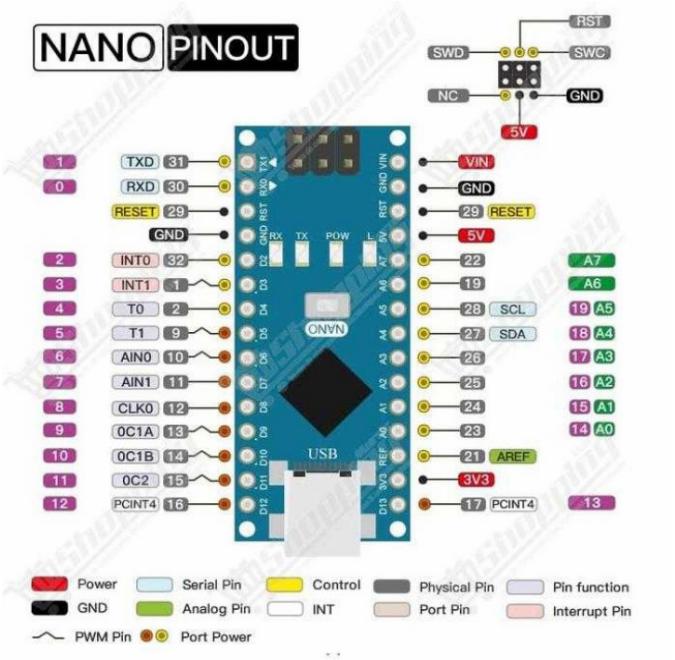
L = length of the cylinder

a = inner radius of the cylinder,

b = outer radius of the cylinder

4.2 Microcontroller:

4.2.1 Arduino Nano v3: This serves as the heart of the system. It's a single-board microcontroller that provides a development platform for reading sensor data, performing calculations, and controlling outputs like the LCD display and buzzer.



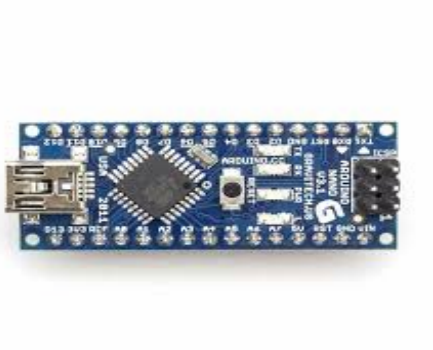


Figure 4.4 Arduino Nano v3 Board

Figure 4.3 Pin diagram of Arduino Nano v3

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack and works with a Mini-B USB cable instead of a standard one.

Power

The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source.

Memory

The ATmega328 has 32 KB, (also with 2 KB used for the bootloader. The ATmega328 has 2 KB of SRAM and 1 KB of EEPROM.

Input and Output

Each of the 14 digital pins on the Nano can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip.
- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.
- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.
- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Nano has 8 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the analogReference() function. Analog pins 6 and 7 cannot be used as digital pins. Additionally, some pins have specialized functionality:

- I2C: A4 (SDA) and A5 (SCL). Support I2C (TWI) communication using the Wire library (documentation on the Wiring website).

There are a couple of other pins on the board:

- AREF. Reference voltage for the analog inputs. Used with analogReference().
- Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Communication

The Arduino Nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provide UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An FTDI FT232RL on the board channels this serial communication over USB and the FTDI drivers (included with the Arduino software) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A SoftwareSerial library allows for serial communication on any of the Nano's digital pins. The ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus. To use the SPI communication, please see ATmega328 datasheet.

Programming

The Arduino Nano can be programmed with the Arduino software

Specifications:

Microcontroller	Atmel ATmega328
Operating Voltage (logic level)	5 V
Input Voltage (recommended)	7-12 V
Input Voltage (limits)	6-20 V
Digital I/O Pins	14
Analog Input Pins	8
DC Current per I/O Pin	40 mA
Flash Memory	32 KB
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz
Dimensions	0.70” x 1.70”

4.3 Power Supply:

4.3.1 Lithium Ion Battery (18650) and Lithium Battery Holder: This rechargeable battery provides power to the entire system. The battery holder ensures safe and convenient installation and removal of the battery.

Figure 4.5 Lithium-ion battery

18650 lithium-ion battery is a standard lithium-ion battery model, where 18 indicates a diameter of 18mm, 65 indicates a length of 65mm, and 0 indicates a cylindrical battery.

Advantages of using Lithium Ion Battery 18650:

1. Large capacity: The capacity of 18650 lithium batteries is generally between 1200mah and 3600mah, while the general battery capacity is only about 800mah. If combined into an 18650 lithium battery pack, the 18650 lithium battery pack can easily exceed 5000mah.

2. Long life: The 18650 battery has a very long service life, and the cycle life can reach more than 500 times in normal use, which is more than twice that of ordinary batteries.

3. High safety performance: 18650 battery has high safety performance. In order to prevent battery short circuits, the positive and negative electrodes of the 18650 lithium battery are separated. Therefore, the possibility of a short circuit phenomenon has been reduced to the extreme. A protection board can be installed to avoid overcharging and over-discharging of the battery, which can also prolong the service life of the battery.

4. High voltage: The voltage of 18650 batteries is generally 3.6V, 3.8V, and 4.2V, which is much higher than the 1.2V voltage of NiCd and NiMH batteries.

5. No memory effect: It is not necessary to empty the remaining power before charging, which is convenient to use.

6. Small internal resistance: The current internal resistance of the 18650 battery that performs well is about 12 milliohms, and generally around 13-15 milliohms; since the impedance will affect the performance of the battery, generally speaking, 50 milliohms is normal. 50-100 milliohms can be used, but the performance begins to decline. When it is above 100 milliohms, it needs to be used in parallel, and it is basically unusable if it is greater than 200 milliohms.

7. It can be combined in series or parallel to form a 18650 lithium battery pack.

4.3.2 LM7805 Voltage Regulator: This component regulates the voltage from the Lithium Ion battery to a constant 5V, which is the required operating voltage for most of the other components.

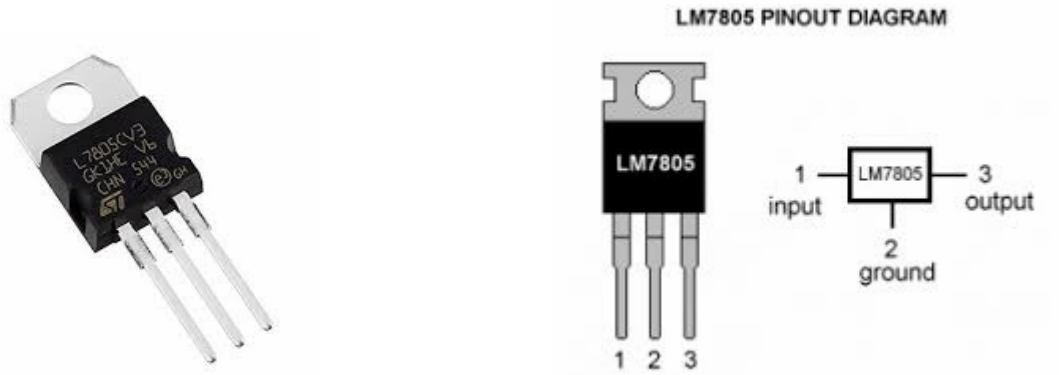


Figure 4.6 LM7805 Voltage Regulator and pin out diagram

Like most other regulators in the market, it is a three-pin IC; input pin for accepting incoming DC voltage, a ground pin for establishing ground for the regulator, and output pin that supplies the positive 5 volts.

The LM7805 is a linear voltage regulator.

Features of LM7805:

- 3-Terminal Regulators
- Output Current up to 1.5A
- Internal Thermal-Overload Protection
- High Power-Dissipation Capability
- Internal Short-Circuit Current Limiting
- Output Transistor SAFE-Area Compensation

4.4 Communication and Display:

4.4.1 HC-05 Bluetooth Module: This module is used for wireless communication between the Arduino and a smartphone app. The app displays real-time fuel data, receives SMS alerts, and offers additional functionalities.

Figure 4.7 HC-05 Bluetooth Module

HC-05 is a Bluetooth module that is designed for wireless communication. This module can be used in a master or slave configuration.

Bluetooth serial modules allow all serial-enabled devices to communicate with each other using Bluetooth.

It has 6 pins,

1. Key/EN: It is used to bring the Bluetooth module into AT commands mode. If the Key/EN pin is set to high, then this module will work in command mode. Otherwise, by default, it is in data mode. The default baud rate of HC-05 in command mode is 38400bps and 9600 in data mode.

HC-05 module has two modes,

- Data mode: Exchange of data between devices.
- Command mode: It uses AT commands which are used to change the setting of HC-05. To send these commands to module serial (USART) port is used.

2. VCC: Connect 5 V or 3.3 V to this Pin.

3. GND: Ground PIN of the module.

4. TXD: Transmit Serial data (wirelessly received data by Bluetooth module transmitted out serially on TXD pin)

5. RXD: Receive data serially (received data will be transmitted wirelessly by Bluetooth module).

6. State: It tells whether the module is connected or not.

HC-05 Bluetooth Module Interfacing with Arduino Nano v3

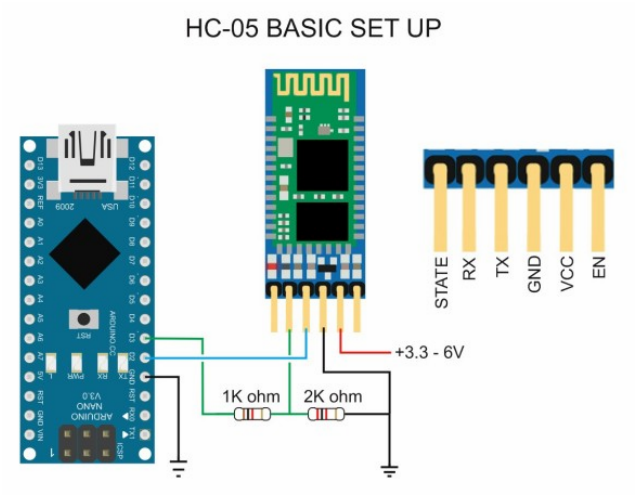


Figure 4.8 Basic set up of HC-05

4.4.2 LCD Display: This display will present the user with crucial information such as real-time fuel level, distance-to-empty, and real-time fuel mileage.

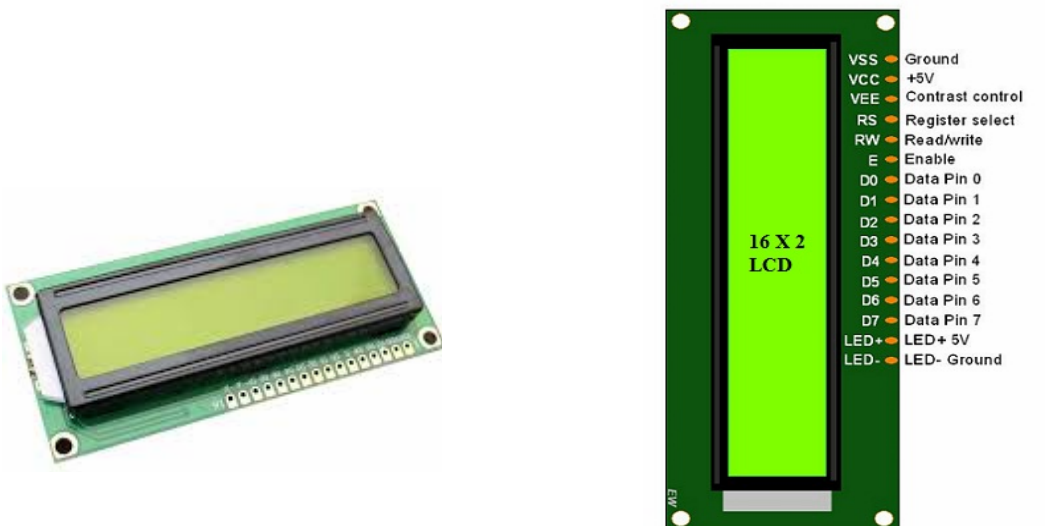


Figure 4.9 LCD Display

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly but instead, use a backlight or reflector to produce images in color or monochrome.

LCD 16×2 Pin Diagram

The 16×2 LCD pinout is shown above.

- Pin1 (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.
- Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.
- Pin3 (V0/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to 5V.
- Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 1(0 = data mode, and 1 = command mode).
- Pin5 (Read/Write/Control Pin): This pin toggles the display among the read or writes operation, and it is connected to a microcontroller unit pin to get either 0 or 1 (0 = Write Operation, and 1 = Read Operation).
- Pin 6 (Enable/Control Pin): This pin should be held high to execute Read/Write process, and it is connected to the microcontroller unit & constantly held high.
- Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two-wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like 0 to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.
- Pin15 (+ve pin of the LED): This pin is connected to +5V
- Pin 16 (-ve pin of the LED): This pin is connected to GND.

Features of LCD16x2

The features of this LCD mainly include the following.

- The operating voltage of this LCD is 4.7V-5.3V
- It includes two rows where each row can produce 16 characters.
- The utilization of current is 1mA with no backlight
- Every character can be built with a 5×8 pixel box
- The alphanumeric LCDs alphabets & numbers
- Is display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue & Green Backlight
- It displays a few custom-generated characters

LCD Interfacing with the Arduino Nano v3

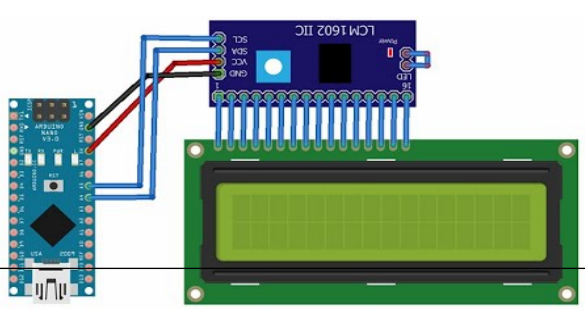


Figure 4.10 LCD Interfacing with the Arduino Nano v3

4.5. Other Components:

4.5.1 10kΩ Potentiometer: This variable resistor is used for interfacing Arduino Nano with LCD, for calibration purposes, allowing fine-tuning of the sensor readings for optimal accuracy.

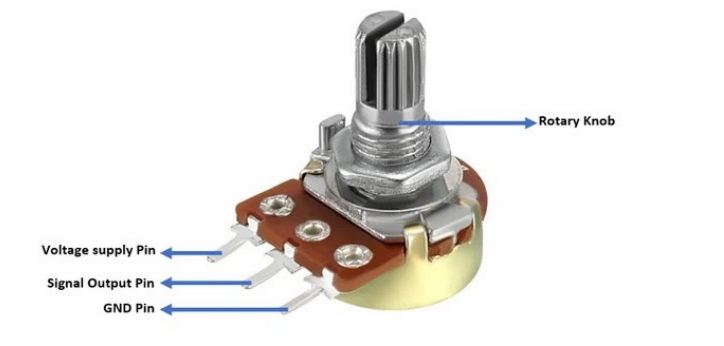


Figure 4.11 Potentiometer

A 10k potentiometer is a type of variable resistor that is used to adjust the resistance in an electrical circuit. The "10k" in the name refers to the resistance of the potentiometer, which is 10,000 ohms (10k ohms).

4.5.2 Buzzer: This can be used to provide audible alerts for low fuel levels, potential fuel theft (if using an SMS alert system), or other system notifications.

Figure 4.12 Buzzer

It is a sound device that can convert audio signals into sound signals. It is usually powered by DC voltage.

4.5.3 Male and Female Jumper Wires: These wires facilitate easy connection between various components on the breadboard or PCB during development and prototyping.

Jumper wires typically come in three versions: male-to-male, male-to-female, and female-to-female. The difference between each is in the end point of the wire. Male ends have a pin protruding and can plug into things, while female ends do not and are used to plug things into.

CHAPTER 5:

SOFTWARE & TOOLS USED

5.1 ARDUINO IDE:

Figure 5.1 ARDUINO IDE Logo

The ARDUINO IDE is a part ARDUINO Project started by MASIMO BANZI, ARDUINO is not only hardware, or software, ARDUINO is an integrated system that includes Hardware, IDE, Project as well and a community. The ARDUINO makes it easier for the newcomer and the hobbyist who is having limited knowledge of the technical background. Because of ARDUINO people from different fields of Engineering are successfully designing and implementing the power of electronics and embedded systems. With the improvement of ARDUINO IDE and different hardware platforms, it become popular among IT and CS students. Earlier, Arduino Embedded system was a complicated system for both CS and Electronics students. Where Electronics student do not have proper programming knowledge, the CS/IT student was not having proper knowledge of Electronics circuit and sensors. The ARDUINO minimizes the gap between these two distinct faculties.

The Arduino Integrated Development Environment is a cross-platform IDE designed for Arduino microcontrollers. The IDE uses a combination of the C standard library and C++. It is used to write and upload programs to Arduino-compatible boards, but also, with the help of third-party cores, other vendor development boards.

The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, which is compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. By default, avrdude is used as the uploading tool to flash the user code onto official Arduino boards.

Arduino IDE is a derivative of the Processing IDE, however, as of version 2.0, the Processing IDE will be replaced with the Visual Studio Code-based Eclipse Theia IDE framework.

With the rising popularity of Arduino as a software platform, other vendors started to implement custom open-source compilers and tools (cores) that can build and upload sketches to other microcontrollers that are not supported by Arduino's official line of microcontrollers.

In October 2019, the Arduino organization began providing early access to a new Arduino Pro IDE with debugging and other advanced features.

5.2 PROTEUS DESIGN SUITE:

Figure 5.2 PROTEUS Logo

Proteus is one of the most famous simulators. It can be used to simulate almost every circuit on electrical fields. It is easy to use because of the GUI interface that is very similar to the real prototype board. Moreover, it can be used to design a Print Circuit Board (PCB) Proteus is a Design Suite also known as Virtual System Modelling (VSM) offering the ability to simulate micro-controller code and circuits. In this case, Proteus ISIS is for simulation from the schematic form of the hardware and also the micro-controller code. It is possible to develop and test designs before a physical prototype is constructed. Proteus ISIS (Intelligent Schematic input system) is used to draw schematics and simulate the circuits in real-time. The simulation allows human access during run time, thus providing real-time simulation.

5.3 MIT APPLICATION INVENTOR:

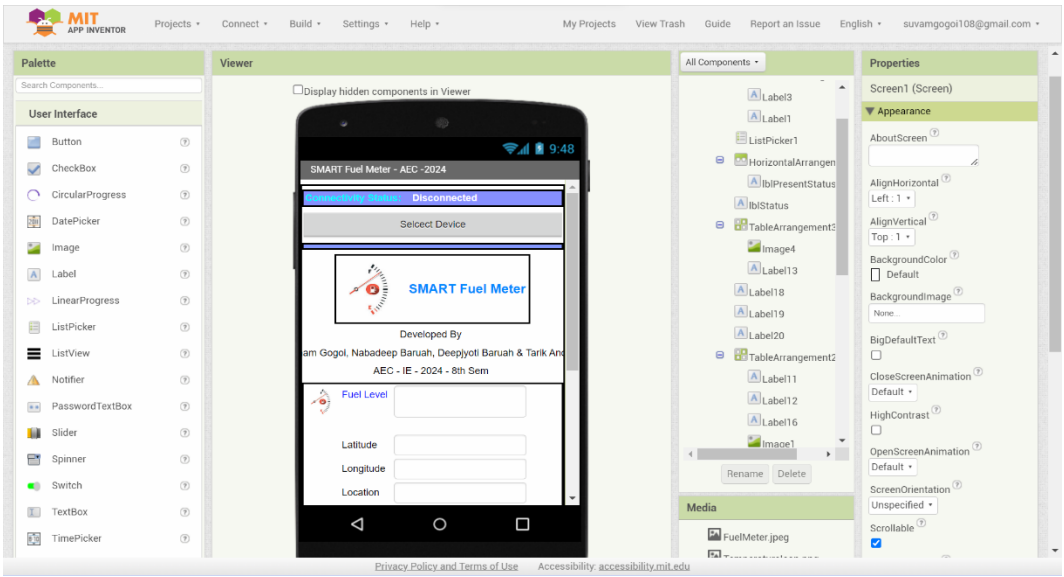


Figure 5.3 MIT APPLICATION INVENTOR

The MIT App Inventor is an easy-to-use drag-and-drop visual programming tool for designing and building mobile apps for android and iOS. It can convert one's idea into a working application without the need of coding or programming skills. The App Inventor was first introduced as an open-source tool by Google in 2010, and now being maintained by the Massachusetts Institute of Technology (MIT). The App Inventor provides a graphical user interface with all the necessary components required to build mobile apps and enables anyone to build a mobile phone application to meet their needs. The apps developed using this tool can easily be ported to the phone, shared with others, or even sent to the Google Play Store for distribution Worldwide All we need to experience MIT App Inventor is a valid Gmail Account and an active Internet connection. One can log in to the App Inventor using their existing Gmail ID and password and click on the 'Create App' option to create their first app. The App Inventor programming environment has three vital parts: i) A 'Designer' for selecting the components to the Application and specify their properties ii) the 'Blocks Editor'to specify how the components should behave (e.g., what happens when a user clicks a button). App Inventor provides an additional app called the iii) 'AI Companion' for developers to test their applications in real-time .One can also try their application using the emulator that comes with the system. In this way, anyone can quickly build a mobile app and immediately begin to rehearse and test. The android application will collect the current geographical Location from the inbuilt GPS receiver of the smart phone. The internet system of the smartphone will process the latitude and longitude as well as the name of the area (if available) and stored in internal memory. If the panic button is detected to be pressed the GSM modem will send SMS to a particular mobile number along with the geographical location having google map link. After receiving the message by the recipient, he/she can click on the link to visit the current location of patient with the help of google map.

CHAPTER 6:

OBSERVATIONS AND RESULTS

6.1 ANDROID APPLICATION AND ITS FEATURES:

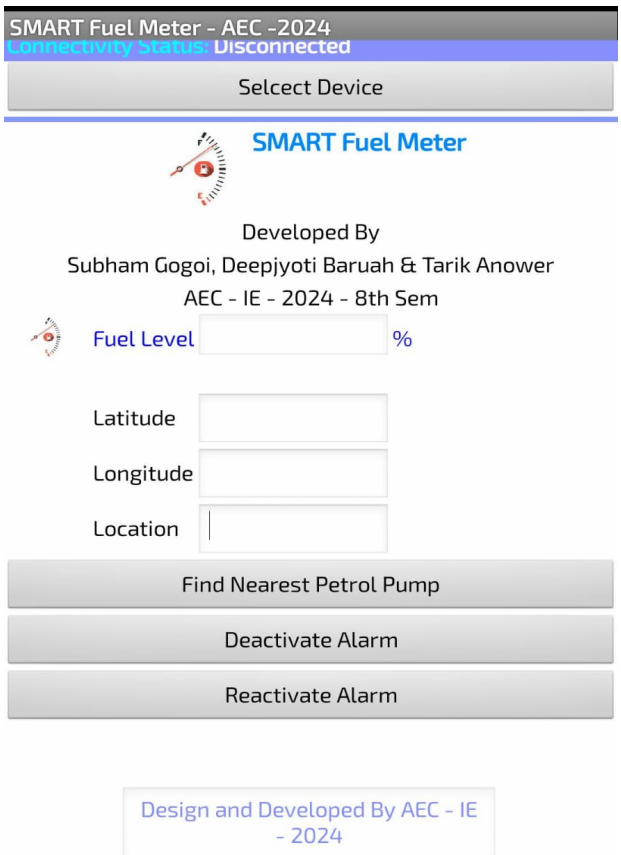


Figure 6.1 Android application interface

A specially designed Android application is responsible for connectivity, and the information/ signal from the hardware section. The Android application is developed using MIT App Inventor. The application allows the user to observe the fuel percentage in the tank.

The Android application detects the location of the user's vehicle in terms of Latitude, Longitude, and Address name providing security against intruders. It alerts the user with a beeping sound in case of a stealing attempt by an unknown person. The feature to disable the intruder alarm system is also provided in the application and the user can deactivate the alarm through the application.

There is also a feature in which the application shows the user a list of the nearest petrol pumps for refueling the vehicle when the petrol in the tank is below the threshold limit.

6.1.1 LOCATING NEAREST PETROL PUMPS USING THE APPLICATION

- Opening the Application on the Android phone
- Clicking on the “Nearest Petrol Pump” option
- Clicking on the search option on the redirected page
- The list along with the distance and location details will be shown on the app.

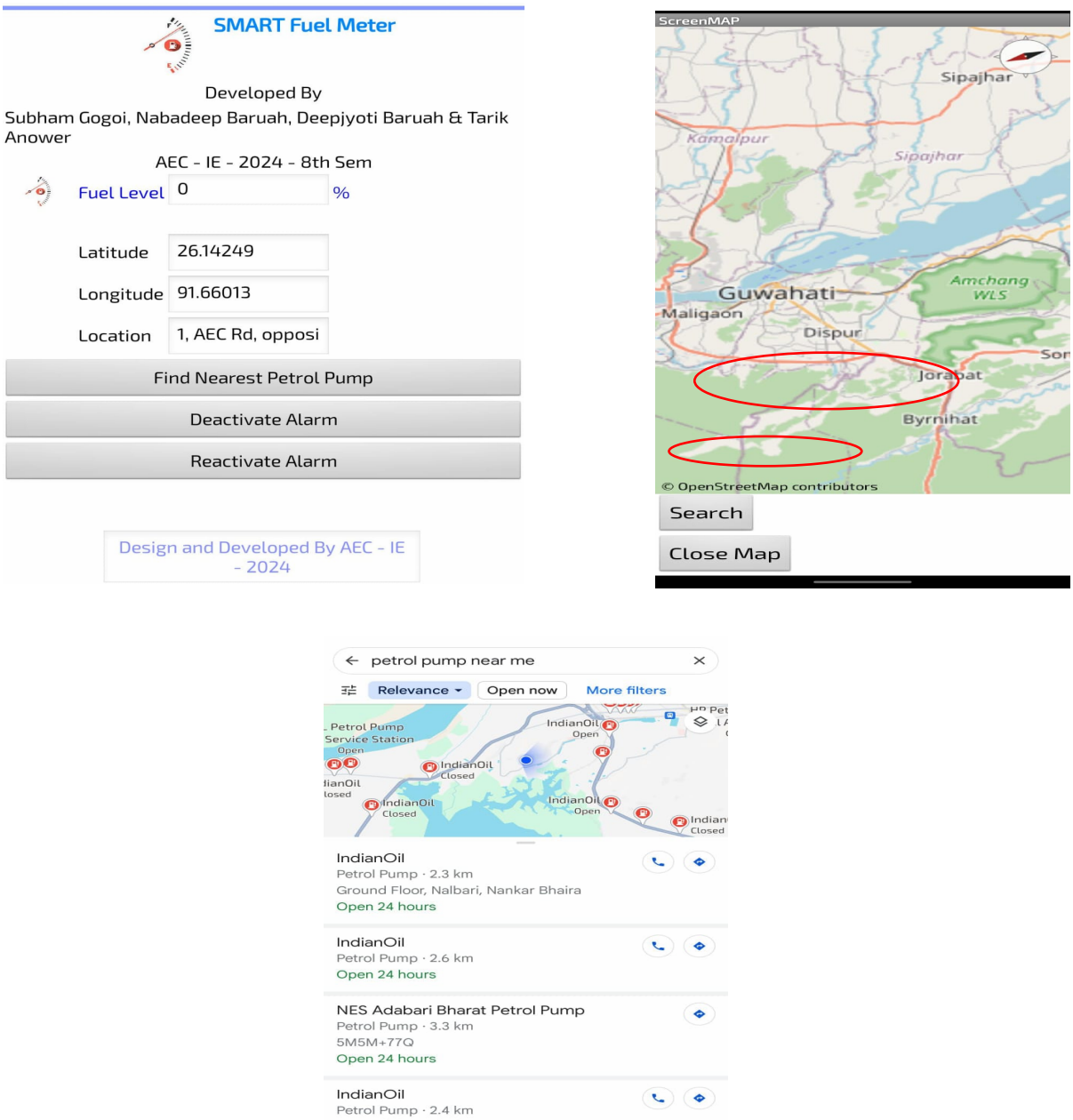


Figure 6.2 Locating nearest petrol pumps using the application

6.2 HARDWARE AND APPLICATION READINGS:

READING 1:

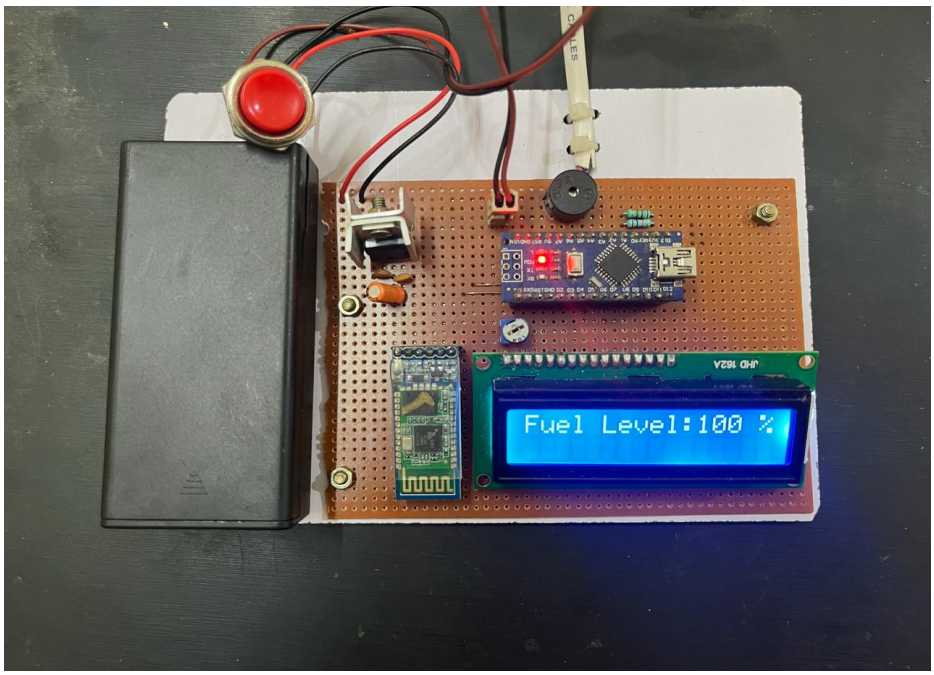


Figure 6.3
Fuel reading in Hardware

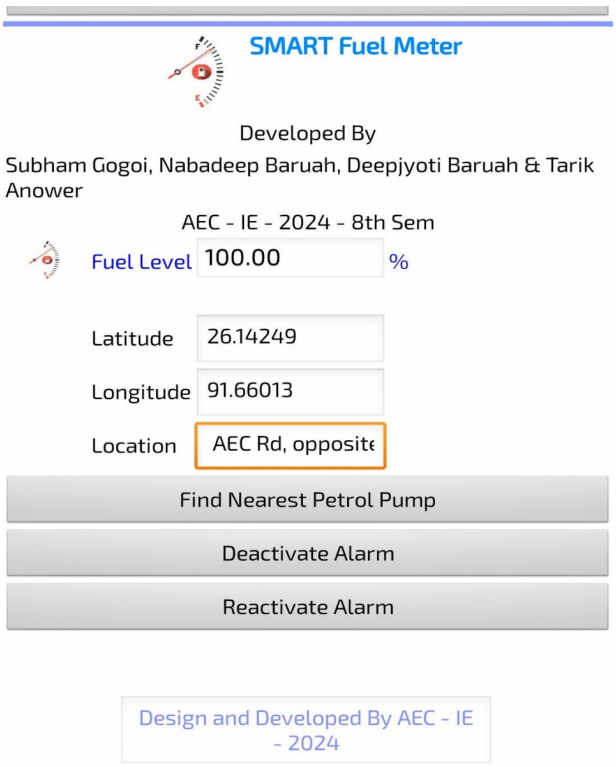


Figure 6.4 Fuel reading in Application

READING 2:

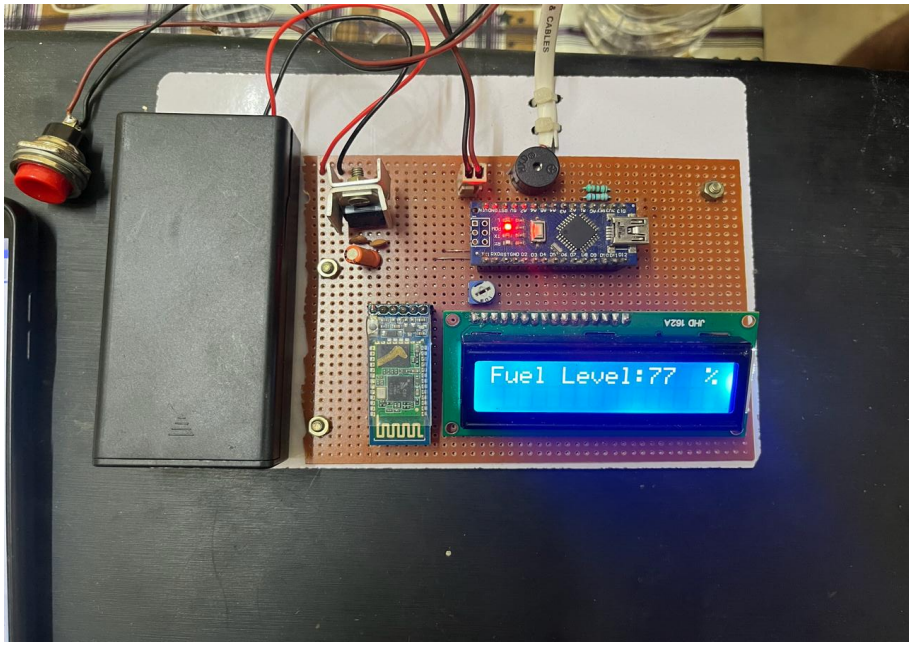


Figure 6.5 Fuel reading in Hardware

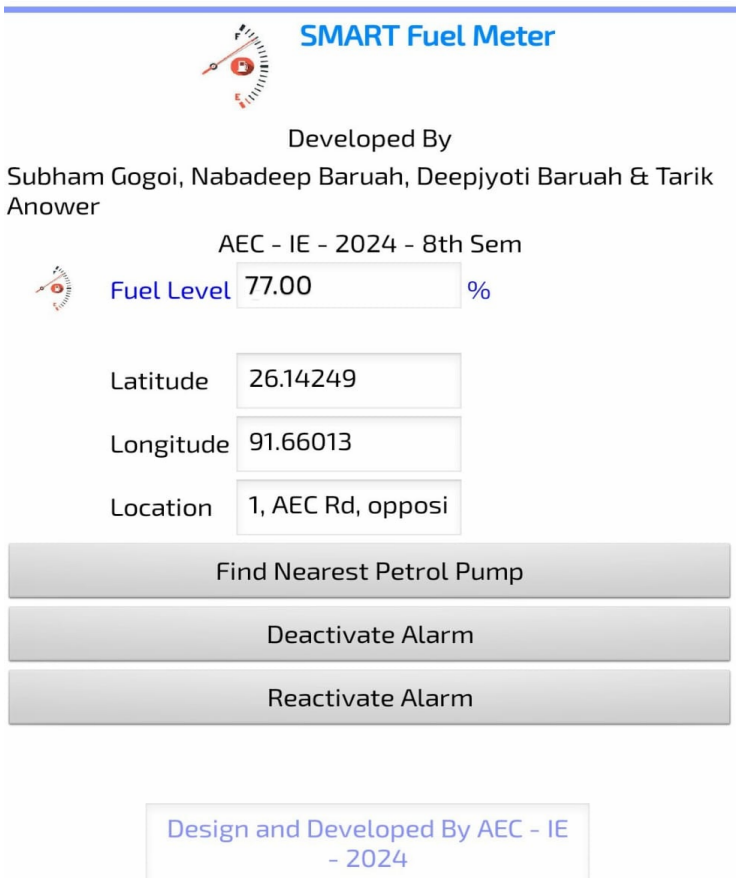


Figure 6.6 Fuel reading in Application

READING 3:

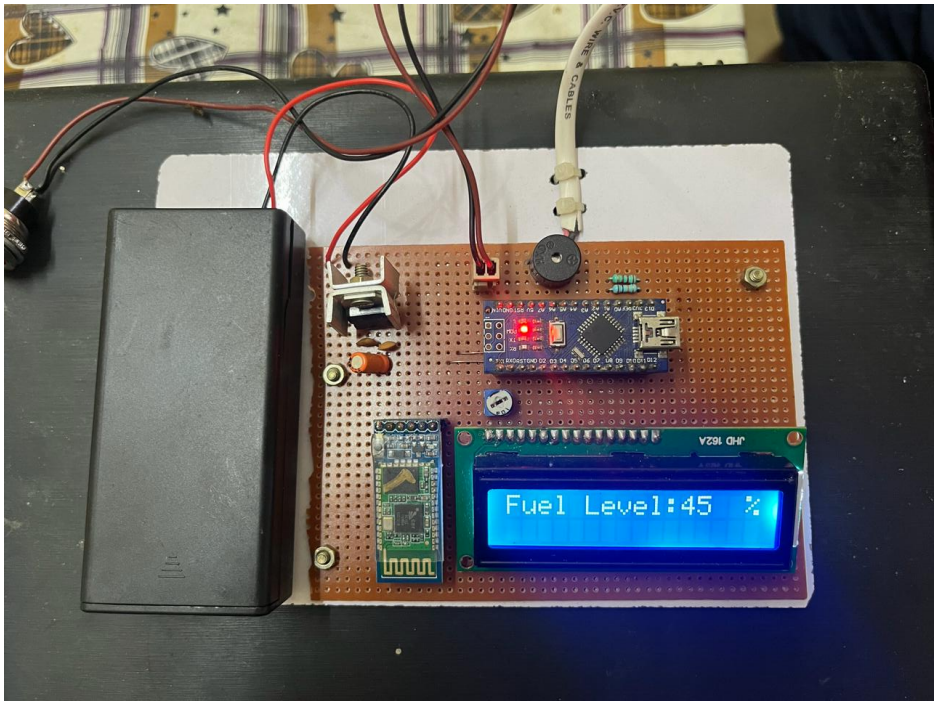


Figure 6.7
Fuel reading

in Hardware

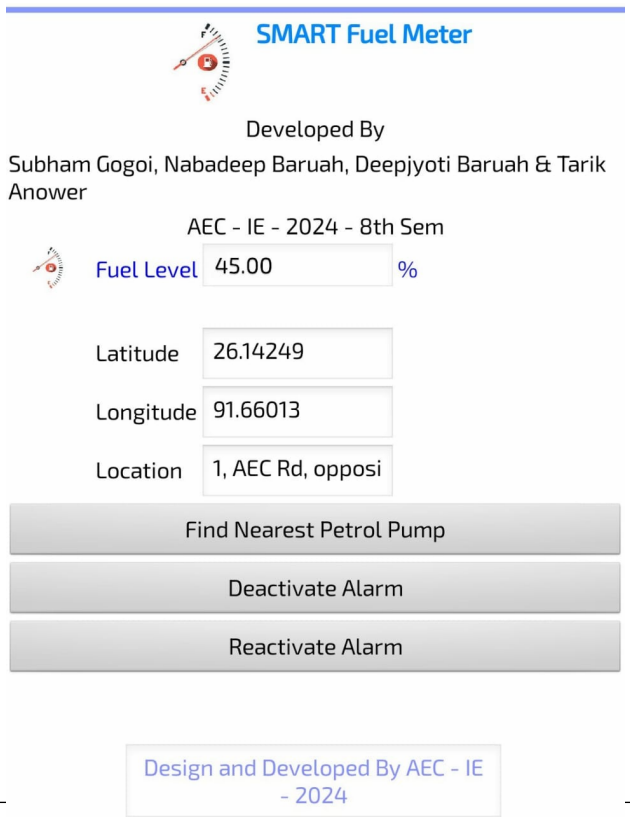


Figure 6.8 Fuel reading in Application

READING 4:

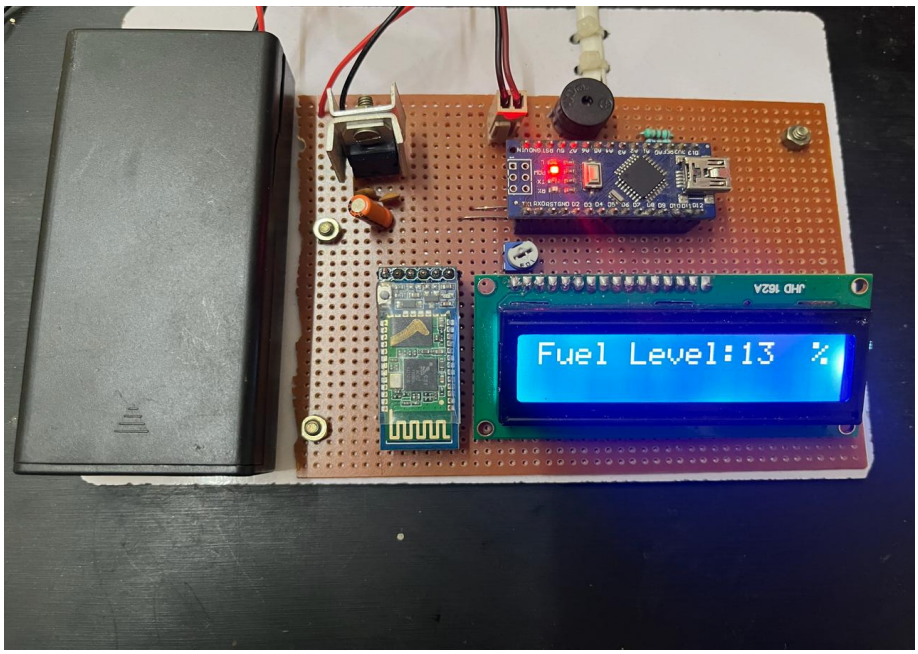


Figure 6.9 Fuel reading in Hardware

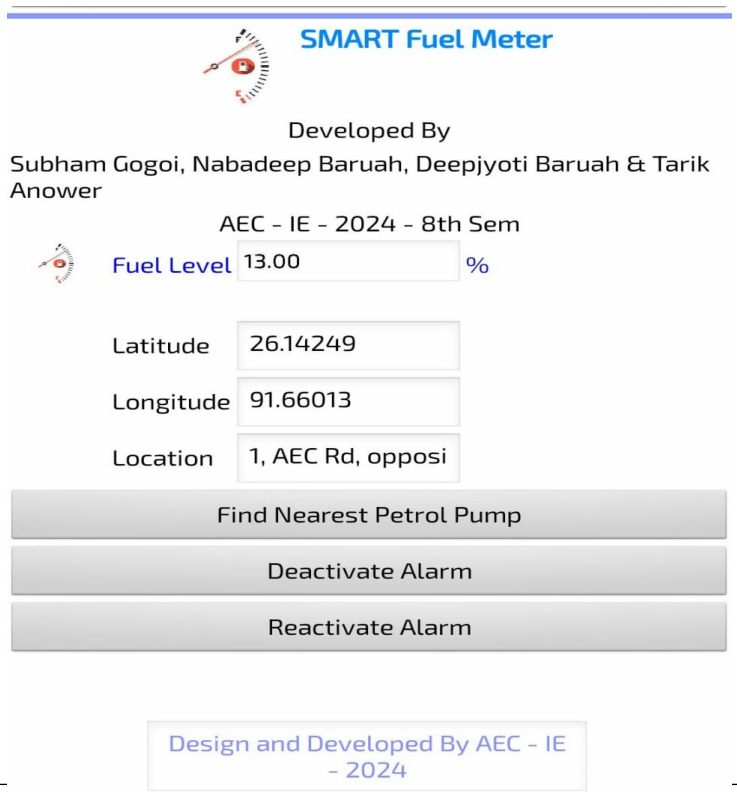


Figure 6.10 Fuel reading in Application

READING 5:

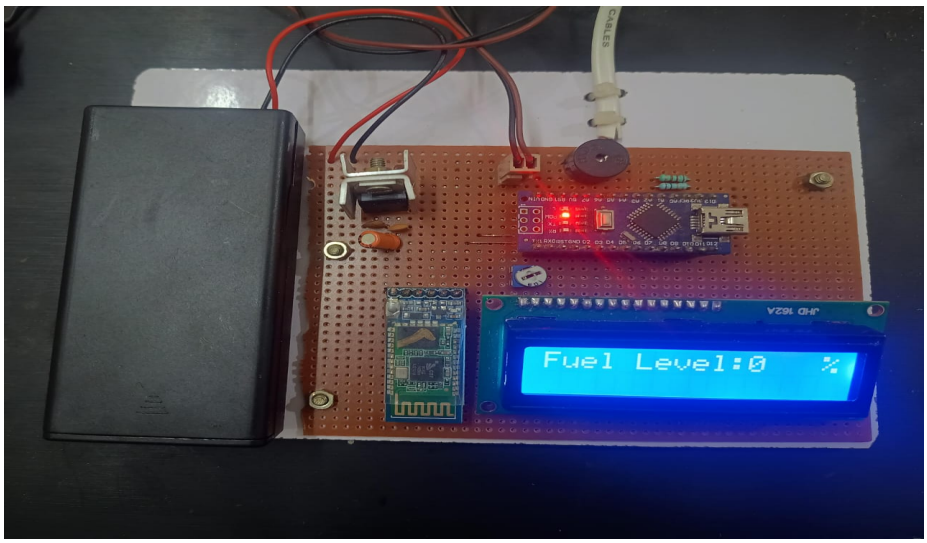


Figure 6.11 Fuel reading in Hardware

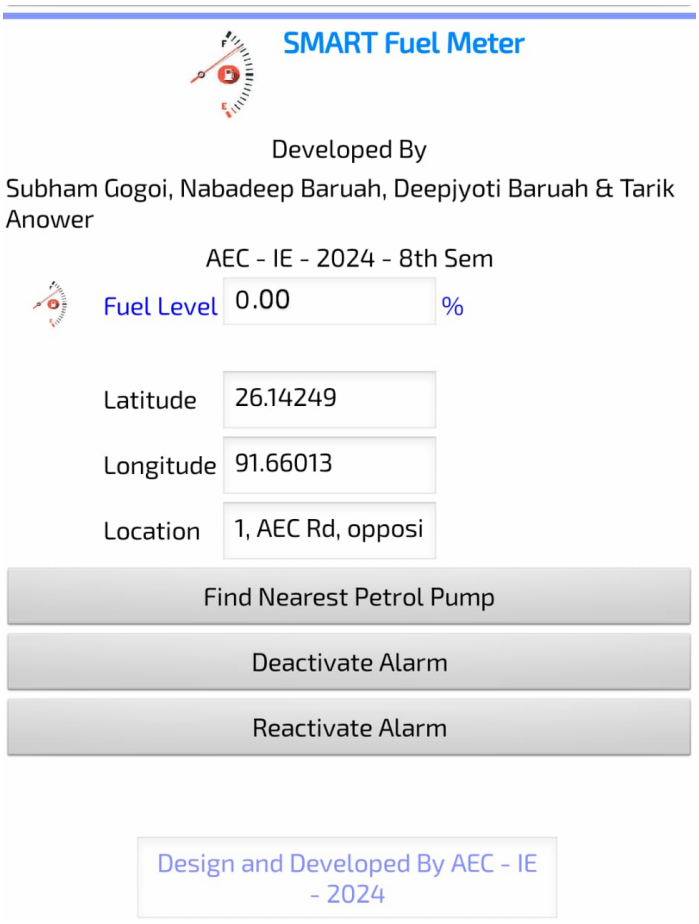


Figure 6.12 Fuel reading in Application

CHAPTER 7:

HARDWARE PROTOTYPE

7.1 HARDWARE PROTOTYPE DESIGNED IN THE 7TH SEMESTER:

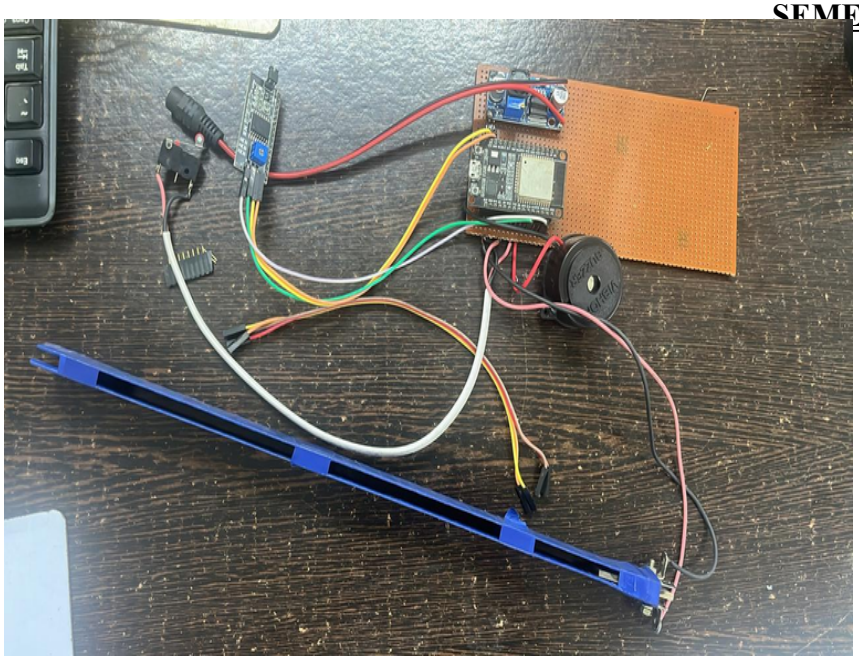


Figure 7.1 Hardware prototype designed in the 7th semester

The hardware prototype consists of flat steel plates, an AVR microcontroller, a buzzer, an HC 05 Bluetooth module and battery. AVR microcontroller is used as it offers better functionality and efficiency. Map component is implemented in the Android app. Google map service shows the location of the nearest petrol pump through the mobile application developed.

7.2 FINAL HARDWARE DESIGN:

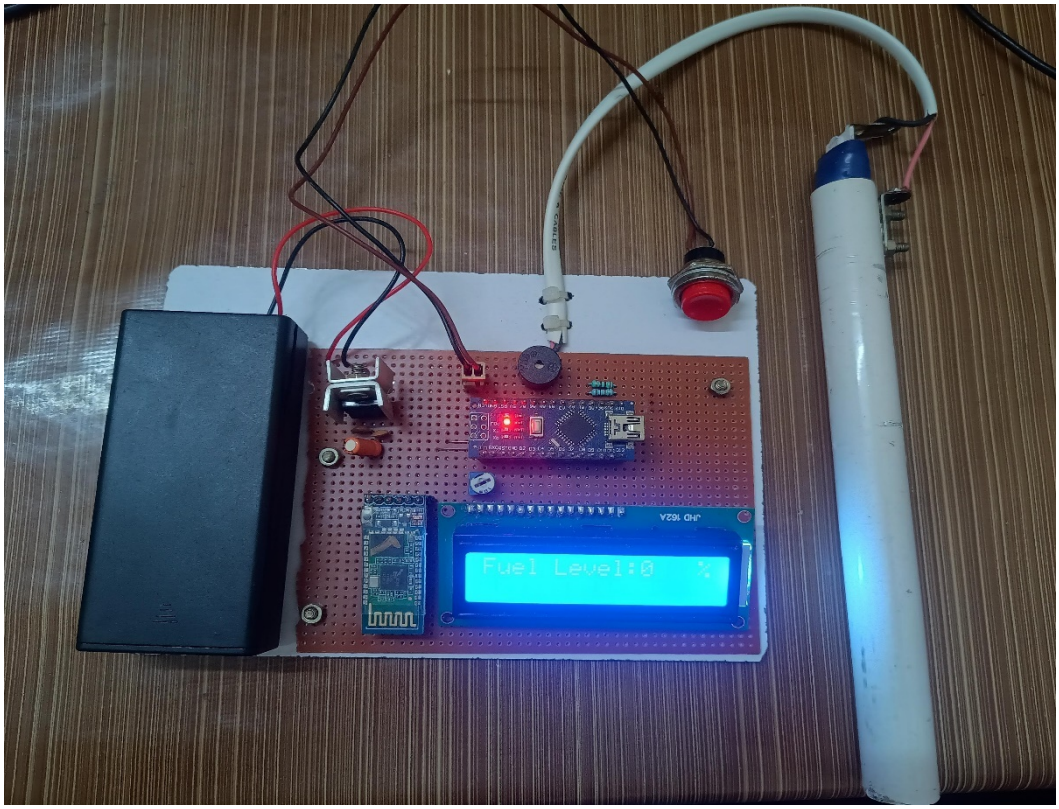


Figure 7.2 Final Hardware Design

The final hardware consists of an 8-bit Arduino Nano v3 microcontroller, cylindrical aluminium pipes, HC 05 Bluetooth module, a 10 kΩ potentiometer, a Lithium-ion battery 18650 and holder, LM7805 voltage regulator, a buzzer, a PCV, a LCD.

The steel plates are replaced by two cylindrical pipes of different diameters as electrodes for better functioning.

The system starts the timer when discharging start and stops the timer after completely discharging the capacitor so that the complete duration of the discharging process can be calculated.

CHAPTER 8:

FUTURE SCOPE

The proposed project of the advanced digital fuel meter lays a foundation for further development and potential commercialization. Some of the possibilities for future exploration are as follows:

- Implementation of machine learning algorithms to analyze historical fuel consumption data and driving patterns. This could lead to personalized fuel efficiency recommendations and predictive maintenance alerts.
- Refinement of the calibration process of the capacitive sensor to account for temperature variations and fuel types, further enhancing the accuracy of fuel level measurements
- Exploring integration with cloud platforms for data storage and remote monitoring capabilities. This could allow users to track fuel consumption and vehicle health over longer periods and access data from anywhere.
- Investigation of the feasibility of integrating GPS tracking with a real-time anti-theft system. In case of theft, the system could send location alerts and potentially disable the vehicle remotely (subject to legal and safety regulations).
- Consideration integrating features like fuel station locators and fuel price comparisons into the mobile app to enhance user convenience.

CHAPTER 9:
CONCLUSION

A prototype for an advanced digital fuel meter system is developed in this project and is found to work satisfactorily. The system utilizes a capacitive sensor to measure fuel level in real-time, overcoming the limitations of traditional needle gauges. It incorporates additional functionalities like a low-fuel level alarm and the potential for smartphone connectivity through an HC-05 Bluetooth module. This project demonstrates the feasibility of incorporating readily available components to create a user-friendly and informative fuel management system.

The device is simple and also easy to operate and cost-effective.

While the current prototype establishes a strong foundation but there is potential for future advancements also by integrating more sophisticated sensors, implementing machine learning tool for data analysis, and exploring advanced user interfaces and connectivity options, this system can provide an efficient, comprehensive and intelligent fuel management solution

Overall, the proposed project serves as a stepping stone towards the development of a next-generation fuel management system that empowers users with valuable insights and promotes fuel efficiency.

BIBLIOGRAPHY

[1] Sharma A, Sharma P, Bhardwaj D, Mishra D, Soni A. Load Cell Based Fuel Theft Detection System Journal of Electronics and Communication Systems MAT Journals.2016; 3(1):1-4

[2] Katkar G, Lanke S, Kumar A, Khawate S. Fuel Checker and Theft Detection IJARIIE.2017; 9(3):1813-1815

[3] Huang, H., Xiao, S., Meng, X., and Xiong, Y., "A Remote Home Security 3 System Based on Wireless Sensor Network and GSM Technology", Proceedings of Second International Conference on Networks Security, Wireless Communications and Trusted Computing, 2010

[4] B.G. Nagaraja, Ravi Rayappa, M. Mahesh, Chandrasekhar M. Patil, Dr.T.C. Manjunath:- "Design & Development of a GSM Based Vehicle Theft Control System" 978-0-7695-3516-6/08 ©2008 IEEE, DOI 10.1109/ICACC.2009.154,pp.148-15

[5] B.G. Nagaraja, Ravi Rayappa, M. Mahesh, Chandrasekhar M. Patil, Dr. T.C. Manjunath:- "Design & development of a gsm based vehicle theft 4 control system" 978-0-7695-3516-6/08 ©2008 ieee, doi 10.1109/ icacc.2009.154,pp.148-15

[6] R. Rilwano, "Arduino-based fuel consumption measurement system for motorbikes". Diploma thesis, Universitas Andalas, Padang, 2016.

[7] A. Avinashkumar, U. Singaravelan, T.V. Premkumar and 5 K. Gnanaprakash, Digital fuel level indicator in two-wheeler along with distance to zero indicator. IOSR Journal of Mechanical andCivil Engineering (IOSRJMCE), 11:80-84 Mar- Apr. 20**14**

[8] Liu, M., & Tsinghua University (Beijing). Department of Electronic Engineering. (2014). Embedded Systems: Design and Programming (1st ed.). Springer.

[9] Akyol, M. A., & Dinleyici, M. F. (2016). A high-sensitivity, low-cost fuel level sensor using a capacitive probe. Sensors and Actuators A: Physical, 247, 348-355. (https://www.mdpi.com/366504)

[10] Park, J., Kim, H., & Kim, C. (2018). A highly sensitive fuel level sensor using a split cylindrical dielectric resonator for automotive applications. Sensors (Switzerland), 18(1), 142. (https://doi.org/10.3390/s18010142)

[11] Wang, C., Li, X., & Sun, C. (2019). Design of a fuel level sensor based on the improved impedance method. Measurement: Journal of the International Measurement Confederation, 147, 116823.

[12] Smith, A., & Brown, R. (2020). A novel low-cost fuel level sensor for in-vehicle applications. In 2020 IEEE International Conference on Electronics, Circuits and Systems (ICECS) (pp. 1-4). IEEE.

[13] Arduino SoftwareSerial library reference: arduino.cc. (n.d.). SoftwareSerial.Retrieved fromhttps://wikicontent.arduino.cc/en/Tutorial/LibraryExamples/SoftwareSerialExample