SYSTEM DESIGN FOR DETECTION OF FUEL FRAUD AT FILLING STATION USING IOT MODULATORS

Session: BSc. Electrical Communication Engineering
2020-2024

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Certification

This is to certify that **Hilal Behram**, **Reg No. 20 BNELE0963, Syed Jalal Shah, Reg No. 20BNELE0960** and **Mesbah Ullah**, **Reg No. 20BNELE0979** have successfully completed the final project **System Design for Detection of Fuel Fraud at filling station using IoT Modulators,** at the **University of Engineering and Technology Peshawar Bannu Campus** to fulfill the partial requirement of the degree **BSc. Electrical Communication Engineering.**

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Abstract

Fuel prices are soaring day by day. Because of this, there is a great deal of increment in fuel fraud cases. In order to aid people in their vehicle's fuel theft detection, this design examines the ability of the system to perform a task which detects the fraud at the filling station.

The real-time problem which is now happening in the filling station is the Fuel Level in the fuel tank. The appliance has a display screen which is used to show the amount of fuel already existing in the tank of the vehicle before filling and after filling the tank it shows the total level of fuel in the tank that is already existing plus the amount after filling accurately thereby knowing the exact amount of fuel which was filled in the vehicle.

The difference in total fuel and amount already existing in the tank gives the amount of fuel filled. This helps to reduce the fraud at the filling station. The Arduino stage has gotten very famous with individuals simply beginning with gadgets, and all things considered. We used the Ultrasonic sensor and Flow Meter which is placed above the tank temporarily as it is a cost-effective solution.

Keywords: Fuel station, Fraud detection, Real time data monitoring, Ultrasonic sensor, Flow meter

Undertaking

I certify that the project **System Design For Detecting Fuel Fraud At Filling Station using IoT Modulators** is our own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged/ referred.

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Acknowledgement

We truly acknowledge the cooperation and help make by **Engr Aamir Rashid, Designation** of **UET Peshawar Bannu Campus.** He has been a constant source of guidance throughout the course of this project.

We are also thankful to our friends and families whose silent support led us to complete our project.

Table of Contents

List of figures

Number *Page*

List of tables

Chapter 1

Introduction

1.1 Filling stations

One of the most important services you can do for your vehicle is finding a reliable gas station. What makes one reliable? It's all about their ability to constantly supply people with fuel each day. While it's hard to tell where that fuel comes from, multiple gas stations across the U.S. have been doing it the same way for years. A filling station, also known as petrol station or gas station (US), is a facility that sells fuel and engine lubricants for motor vehicles. The most common fuels sold in the 2010s were gasoline (or petrol) and diesel fuel [1].

Fuel dispensers are used to pump gasoline, diesel, compressed natural gas, CGH2, HCNG, LPG, liquid hydrogen, kerosene, alcohol fuel (like methanol, ethanol, butanol, propanol), biofuels (like straight vegetable oil, biodiesel), or other types of fuel into the tanks within vehicles and calculate the financial cost of the fuel transferred to the vehicle. Besides fuel dispensers, one other significant device which is also found in filling stations and can refuel certain (compressed-air) vehicles is an air compressor, although generally these are just used to inflate car tires [2].

1.1.1 Working

The working of the petrol fuel is shown in the figure 1.1. Most filling stations are built in a similar manner, with most of the fueling installation underground, pump machines in the forecourt and a point of service inside a building. Single or multiple fuel tanks are usually deployed underground. Local regulations and environmental concerns may require a different method, with some stations storing their fuel in container tanks, entrenched surface tanks or unprotected fuel tanks deployed on the surface. Fuel is usually offloaded from a tanker truck into each tank by gravity through a separate capped opening located on the station's perimeter. Fuel from the tanks travels to the dispenser pumps through underground pipes. For every fuel tank, direct access must be available at all times.

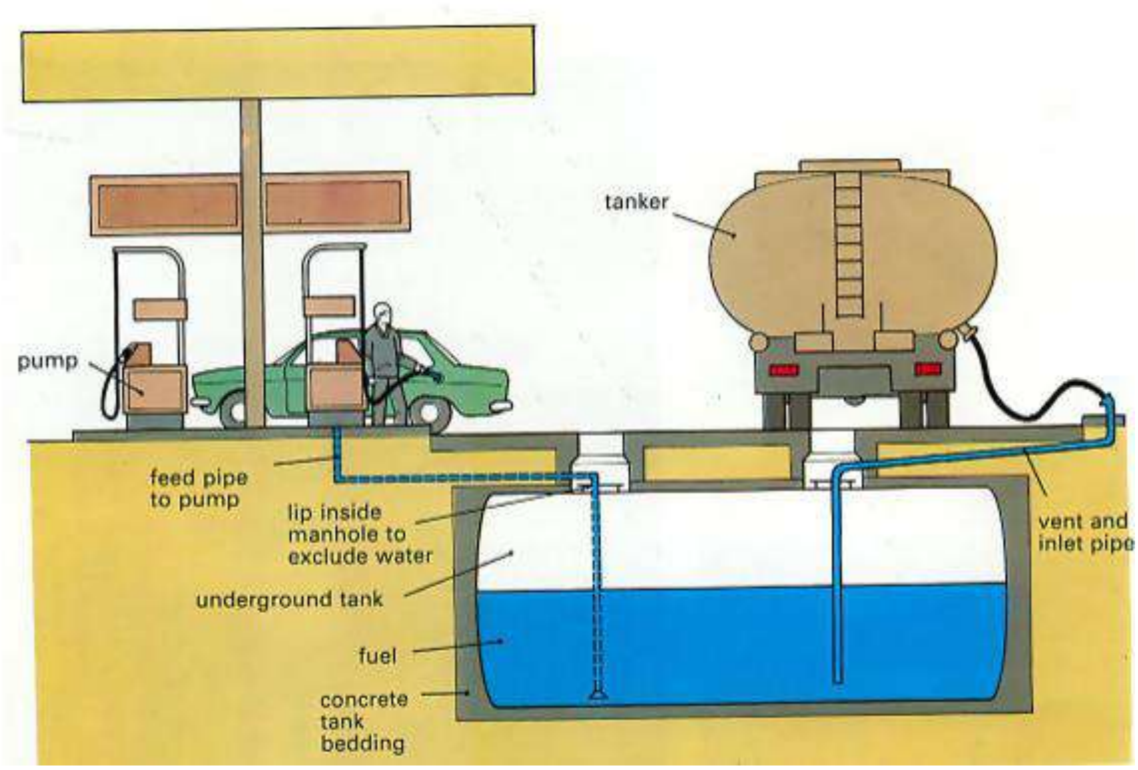

Figure 1.1 Filling station

Older stations tend to use a separate pipe for every kind of available fuel and for every dispenser. Newer stations may employ a single pipe for every dispenser. This pipe houses a number of smaller pipes for the individual fuel types. Fuel tanks, dispenser and nozzles used to fill car tanks employ vapor recovery systems, which prevents releases of vapor into the atmosphere with a system of pipes. The exhausts are placed as high as possible. A vapor recovery system may be employed at the exhaust pipe. This system collects the vapors, liquefies them and releases them back into the lowest grade fuel tank available. The forecourt is the part of a filling station where vehicles are refueled. Fuel dispensers are placed on concrete plinths, as a precautionary measure against collision by motor vehicles. Additional elements may be employed, including metal barriers. The area around the fuel dispensers must have a drainage system. Since fuel sometimes spills onto the pavement, as little of it as possible should remain. Any liquids present on the fore court will flow into a channel drain before it enters a petrol interceptor which is designed to capture any hydrocarbon pollutants and filter these from rainwater which may then proceed to a sanitary sewer, storm water drain, or to ground. If a filling station allows customers to pay at the dispenser, the data from the dispenser may be transmitted via RS232, RS485 or Ethernet to the point of sale, usually inside the filling station's building, and fed into the station's cash register operating system. The cash register system gives a limited control over the fuel dispenser, and is usually limited to allowing the clerks to turn the pumps on and off. A separate system is used to monitor the fuel tank's status and quantities of fuel. With sensors directly in the fuel tank, the data is fed to a terminal in the back room, where it can be downloaded or printed out. Sometimes this method is bypassed, with the fuel tank data transmitted directly to an external database. [4][5]

1.1.2 Under Ground Filling stations

The underground modular filling station is a construction model for filling stations that was developed and patented by U-Cont Oy Ltd in Finland in 1993. Afterwards the same system was used in Florida, US. Above-ground modular stations were built in the 1980s in Eastern Europe and especially in Soviet Union, but they were not built in other parts of Europe due to the stations' lack of safety in case of fire.

The construction model for underground modular filling station makes the installation time shorter, designing easier and manufacturing less expensive. As a proof of the model's installation speed an unofficial world record of filling station installation was made by U-Cont Oy Ltd when a modular filling station was built in Helsinki, Finland in less than three days, including groundwork. The safety of modular filling stations has been tested in a filling station simulator, in Kuopio, Finland. These tests have included for instance burning cars and explosions in the station simulator. [6]

1.2 Goal

Petrol pump frauds were very common in now days. Many of the petrol pumps today temper the pumps such that it displays the amount as entered, but in actual, the quantity of fuel filled in the consumer’s tank is much lesser than the displayed value. The pumps are cheating for the profit of the petrol pump owner. This results in great profits for the petrol pumps, but at the same time the petrol consumers are being cheated. So we are developing a project named “Real Time Anti Fuel Theft Device”. It consists of creating a System for the exact volume of fuel filled in the fuel tank.

1.3 Block Diagram

The block diagram for this project is shown in fig 1.7.

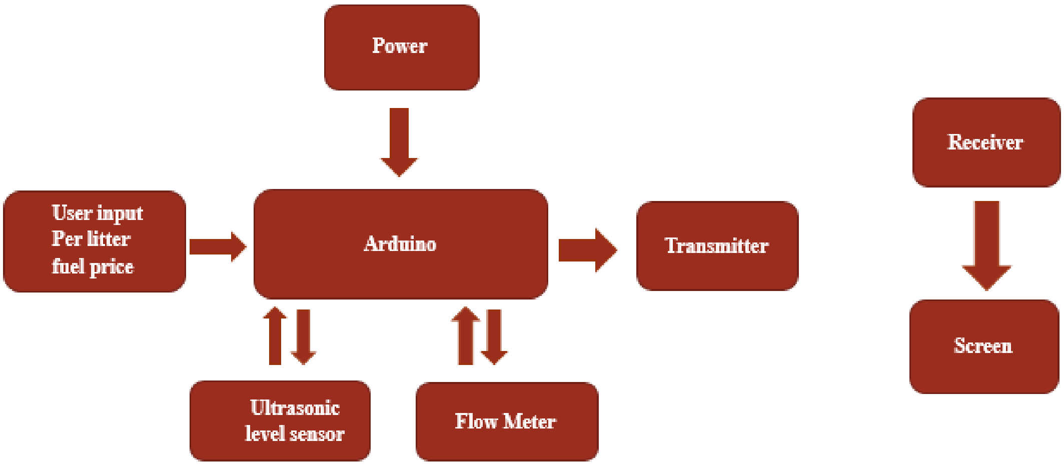

Figure 1.2 Block diagram

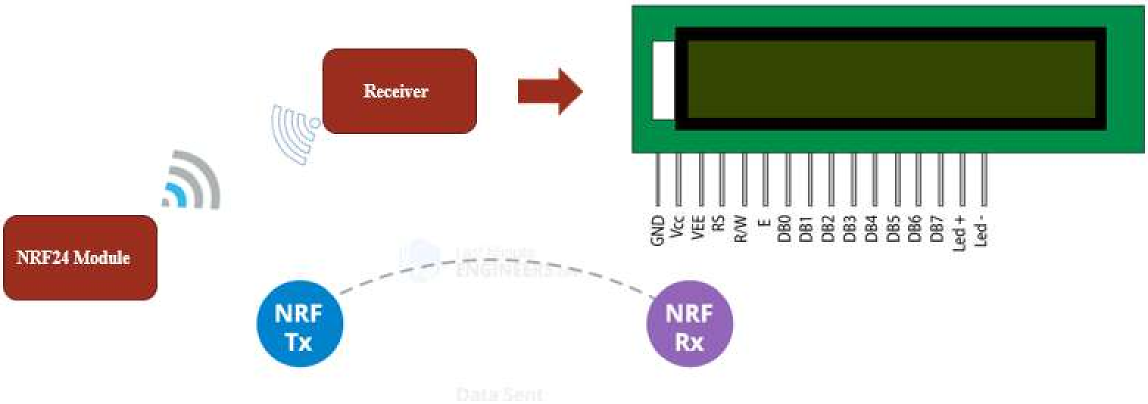

Figure 1.3 NRF24 Module sending data

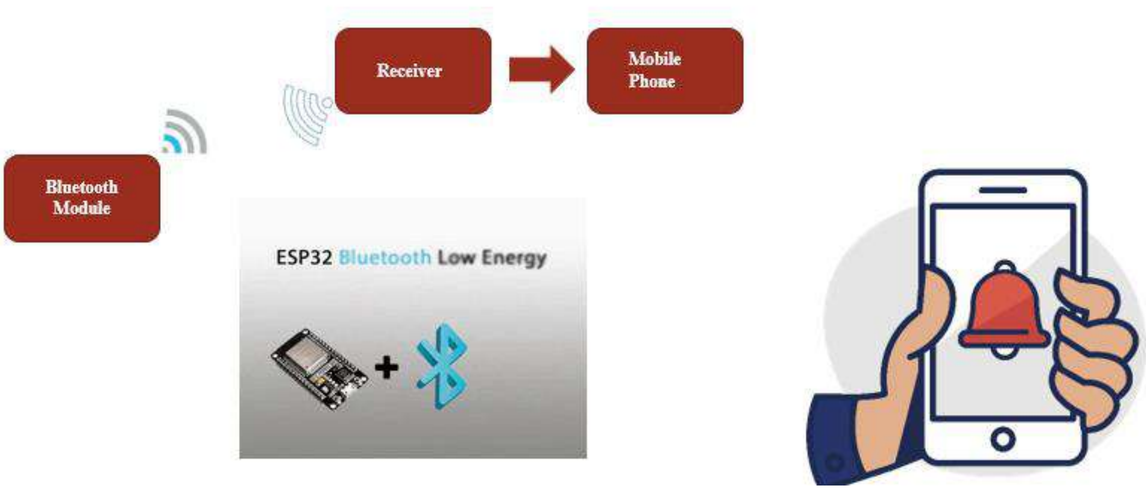

Figure 1.4 Bluetooth Module and Mobile phone data transferring

Chapter 2

Literature review

2.1 Literature Survey

2.1.1 Fuel dispenser

Fuel dispensers as shown in figure 2.1 are interesting pieces of technology. You begin pumping gas into your vehicle, and somehow the pump knows when to turn off to avoid overfilling your tank and causing the gas to overflow.

Figure 2.1 Fuel dispenser

Fuel dispensers are composed of two different components. One part consists of the electronics. This component controls the displays, reading from sensors in order to display the fuel volume and pressure. The second component is a mechanical system consisting of a pump and valves, and an electric motor that controls the fuel. The most common fuel dispenser type works using unequal pressure to create suction. The lower pressure inside the fuel tank causes the fuel to push up the pipe to the nozzle. It is a surprisingly simple way to move the fuel, but it is incredibly efficient. [7]

2.1.2 Storage tanks

The gasoline sold at service stations is stored underground in buried tanks as shown in figure 2.2. Each holds several thousand gallons of gas. There are at least two of these tanks per station and each tank usually holds a different grade of gas. Having the gas tanks underground presents an obvious problem: If the gas must get to a dispenser (and your car's gas tank) located above ground, it has to defy gravity in order to get there -- like a waterfall flowing uphill. But moving the gas from its subterranean hideaway up to street level isn't as difficult as you might think.

Most service stations do the job using one of two types of pump -- a submersible pump or a suction pump:

A submersible pump, as its name implies, is submerged below the surface of the liquid, where it uses a propeller like device called an impeller to move the fuel upward. Slanted blades on the rotating impeller push the water the way the blades on an electric fan push air.

A suction pump moves the gas using the principle of unequal pressure. A pipe is inserted in the water. A motor above the fluid level removes enough air from the pipe to decrease the air pressure above the gasoline. The motor continues to remove air until the air pressure above the gasoline is lower than the air pressure pushing down on the gas outside the pipe. The weight of the surrounding air forces the gas inside the pipe upward even as gravity tries to pull it back down. When the air pressure inside the pipe is low enough, the gas simply climbs up into the aboveground dispenser. [8]

The major advantage of a submersible pump over a suction pump is that the impeller can push water over longer vertical distances. However, because the gas tanks at most service stations are located only a few feet below the dispenser, a suction pump is usually more than adequate for the task at hand.

Figure 2.2 Storage tank

2.1.3 The Check Value

The route that the gas takes from the tanks to the aboveground dispenser isn't terribly complicated, though it may take a few minor twists and turns. When pumping is complete and the pump motor is turned off, the gas inside the pipe doesn't simply fall back into the tank. Instead, it's held inside the pipe by a check valve. The check valve, which is located above the gas inside the pipe, creates an airtight seal above the fluid. Although the bottom of the pipe remains open, the vacuum pressure created by the check valve holds the gas in place. This is a process known as keeping the prime.

Using a check valve to hold the gas inside the pipe prevents unnecessary wear and tear on the suction pump and assures that a supply of gas will remain in the pipe so that the next customer won't have to wait for it to be drawn all the way up from the tank. It may not seem like a big deal, but the process can take 10 to 15 seconds. That isn't a very long wait by any means, but it can be an eternity when you're waiting for gas to be pumped.

The power that drives the pumps usually comes from the same electric grid that powers the lights and appliances in your home, though a few states require that service stations maintain a backup power supply in case of power failure.

2.1.4 The Flow Meter

The goal of the service station owner and the company that supplies the gas, however, is to know just how much gas you've pumped so they can properly charge you for it. That's where the flow meter comes in.

As the gasoline travels upward into the dispenser, it passes through a flow control valve that regulates the gasoline's flow speed. It does this via a plastic diaphragm that gets squeezed more and more tightly into the pipe as the flow of gas increases, always leaving just enough room for the proper amount of gasoline to get through. If you've set a predetermined amount of gas to be pumped, the flow of gas will slow down as you approach the limit.

This pipe also contains the flow meter, which is a cast iron or aluminum chamber containing a series of gears or a simple rotor that ticks off units of gas as they pass through. Information about the gas flow is passed on to a computer located in the dispenser, which displays the metered amount of gas in tenths of a gallon. As the temperature of the gas changes -- on particularly hot and cold days, for instance -- the density of the gas may change, causing an error in the amount of fluid measured by the flow meter. The computer compensates this error by taking the gas temperature into account as it records the flow and adjusts the price accordingly.

Wear and tear on the meter may degrade its accuracy over time, which is why periodic inspections are necessary. Typically, inspectors will use a container of a certain volume, pump gas into it and compare the amount in the container with the amount metered on the dispenser. If the amounts don't match, the flow meter will need to be recalibrated and possibly refurbished or replaced. Although regulations for pump calibration come from the National Institute for Standards and Technology (NIST), the actual inspections are performed locally, usually by a state's Department of Weights and Measures. [9] [10]

Figure 2.3 Flow meter

2.1.5 The Blend Valve

One of the first things that a customer will notice at the pump is the variety of choices offered. In most cases, a dispenser will offer several grades of gas -- sometimes as many as five -- each with a different octane rating. The desired octane rating is usually chosen simply by pushing a button. Does this mean that there are five different underground tanks feeding into that dispenser, each offering a different grade of gas? That's not usually the case. In fact, the dispenser can produce as many grades as it wants from as few as two underground tanks, as long as one tank contains the highest grade of octane available at that station and the other contains the lowest. The grades are blended together at the pump -- not unlike the way you'd blend gin and vermouth to make a martini -- producing a kind of octane cocktail. The precise proportion in which the grades are blended determines the octane of the gas that enters the customer's tank.

This feat of gas pump bartending is performed by something called a blend valve. This valve has inputs consisting of two grades of gasoline, each from different tanks. A single, moveable barrier called a shoe is connected to both in such a way that it can be moved across the inputs with a single motor-driven ratchet. As the ratchet opens one valve, it closes the other valve in precise but opposite proportion. This means that when one valve is, for example, 90 percent open, the other valve is 10 percent open, creating a mixture that consists of 90 percent of one octane and 10 percent of the other. By shifting the ratchet back and forth, the blend valve can produce any octane of gas, ranging from the highest to the lowest grades stored in the tanks -- and all octanes in between.

Keep reading to find out how the dispenser makes sure that you don't overflow the gasoline capacity of your tank.

2.1.6 The Automatic Shut-off

When the customer removes the pump handle from its place on the side of the dispenser, this action activates a switch that starts the dispenser operation. (In some cases the switch is spring-loaded and activates automatically; in others, the customer must raise a small lever manually to begin the process.) At that point, the customer simply inserts the nozzle into the car's gas tank and pulls the lever. Stopping the flow of gas is just as simple -- the customer need only release the lever to cut off the stream of fuel.

But what if the tank fills unexpectedly to the brim and the gasoline threatens to overflow? As anyone who's ever operated a gas pump knows, the pump will switch off automatically. But how does the pump know when to stop pumping?

As the gas level in the tank rises, the distance between the dispenser nozzle and the fuel grows smaller. A small pipe called a venture runs alongside the gas nozzle. When the end of the venture pipe becomes submerged in the rising gas, it chokes off the air pressure that holds the nozzle handle open and shuts down the flow of gas. Unfortunately, this shutdown can sometimes happen before the tank is full as the rapidly flowing gas backs up on its way into the tank. This can cause the gas handle to spring open before pumping is complete, leaving the annoyed customer to squeeze the handle again and risk the possibility of overflow. Pausing briefly will allow the gas to continue into the tank and the pump nozzle to start pouring gas again. [11] [12]

2.2 Our Target

We almost hear more often that in Pakistan Filling stations are involved in short measurement of fuel. And statements like these are more common “My car's fuel tank has a 50-litre capacity according to the automobile’s manual but I am paying for 60 liters to get it filled,” So they either draw your attention to something else or trick you or they temper with the nozzle or flow meter of the dispenser. So we come up with as project called real time anti fuel theft which is

- Real time measuring of fuel
- Wireless Display
- Getting data through Mobile Phone Application
- Real time fuel price

Chapter 3

Components of the project

3.1 Arduino UNO

The Arduino Uno is a board the microcontroller based on atmega328 (datasheet). Arduino Uno have 14 digital pin input / output (6 of which can be used as output pwm), 6 analog input a crystal oscillator 16 MHz, a USB connection, a power jack, a icsp, header and a reset switch. Arduino Uno contain everything we need to ensure that the microcontroller, easily connect it to a computer with a USB cable or with an AC adapter to DC or using the battery to begin with. Arduino UNO different from all board before, Arduino UNO did not use chip driver USB-to-serial. On the contrary, features - features Atmega16u2 (Atmega8u2 until to version r2) programmed as a modifier to serial. USB the revision of 2 of board Arduino Uno has a resistor that draw a line 8u2 to ground, who make it easier to put into. Mode the revision of 3 of board Arduino UNO having new features – features [13-21] as follows.

3.1.1 Item specification

- Pin out 1.0: plus, pin scl natural resources and that is close to the pin and two other new pin placed close to the pin reset, that allows to adjust voltages provided from.

Board for in the future, shield will be made compatible / match board who uses are operating at 5v and with Arduino due are operating at 3.3v. Who to - two it is a pin which are not connected, provided for the purpose in the future

- Same reset stronger
- Atmega 16u2 replace 8u2
- "Uno" means one in Italian and is named to indicate the next Arduino 1.0 product. Arduino UNO and version 1.0 will be references for future versions of Arduino. Arduino UNO is the latest series of Arduino USB boards and reference models for Arduino boards, for a comparison with previous versions, see the index of the Arduino board.

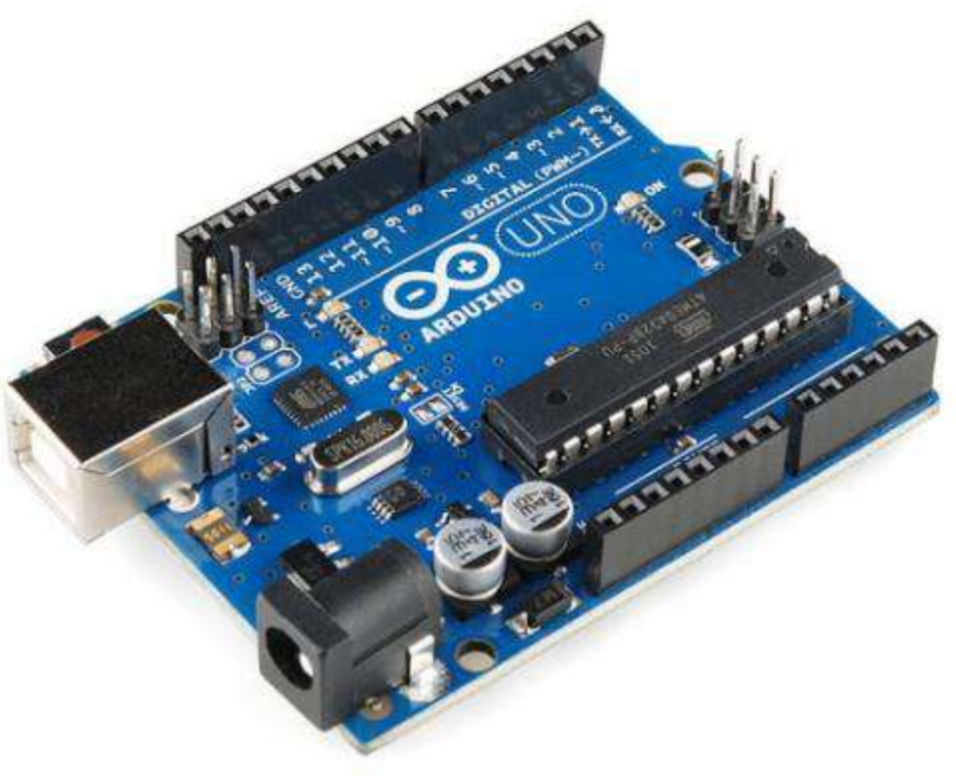

Figure 3.1 Arduino UNO

Arduino Uno can be supplied by through USB connection or as with a power external supply. Resources selected automatically. External supply (non-USB) can be obtained from an AC adapter of to DC or battery. Adapter of can be connected to a plug center-positive plug it which is 2,1 to power jacks from board. Cable lead of a battery can be inserted in the head of a pin header / ground (gnd) and pin vin of power connector. Board Arduino UNO can operate on an external supply 6 to 20 volts. If is supplied with smaller than v 7, may pin 5 volts maybe a volts and supplying 5 board Arduino UNO can be unstable. If using large supply more than 12 volts, voltage regulator can excess of heat and jeopardized Arduino UNO board. The approach recommended is 7 to 12 volts. Pin power is as follows:

- VIN Voltage input to Arduino board when board was on supply from external (as 5 volts of the connection USB or the source of energy other regulated). We can supply voltage through the pin, or if supply voltage through power jack.
- 5v. Pin output voltage is 5 volt arranged on regulatory on board. Board is supplied with one can supply of dc power jack (7-12v), (sub connector, or pin 7-12) (board of VIN 5v). Supply voltage through a pin or 3.3v regulator, and could endanger the board it is not advisable.
- 3V3. A supply 3.3 Volt produced by regulator in board. Flow maximum that can be taken is 50 mA.
- GND. Pin ground.
- Memory EEPROM (electrically erasable programmable read only memory), is the type of nonvolatile memory which is used to store data that is fundamentally not often removed, for example to store certain, configuration the password, or other important data. The microcontroller Atmel furnished small amounts of ROM, and can be accessed using EEPROM library on Arduino.
- Every 14 pin digitally on Arduino UNO can be used as input and output, use function pin mode (), digital write (), and digital read (). To operate the function - function in voltage 5 volts. Every pin can deliver or receive a maximum flow 40 ma and have a resistor pull-up (cut off by default) 20-50 ohm. In addition, some have special: function - function pin.

- Serial: 0 (RX (TX)) and 1. Used to receive (RX) and emits (TX) serial data transistor logic. Both pin was connected to the corresponding pin USB to Atmega8u2 serial of a chip.
- External interrupts: 2 and 3. Pin-pin this triggered a configured to interrupt (disorder) on an inferior value, a great increase or decrease, or a change in value. (see function attach interrupt) for more details.
- Pwm: 3, 5, 6, 9, 10, and 11. Give 8-bit pwm of the output to the with the functioning of analog write ().
- Spi: 10 (the ss), 11 (a motion), 12 (miso), 13 (sck). Pin-pin this support communication by using the upper library.
- LEDs: 13. There is a health clinic LEDs to which it is attached, connected to a pin digital 13. When a pin is said to be worth the high LEDs lighted wax candle, when a pin is said to be worth LEDs. Replace the top of using a pin range with aref and functions analog reference (). On the other hand, some pin has special function
- Pin a4 or natural resources and pin a5 or. Supportive communication by using wire library there are a pair of another pin on board.
- Aref. A reference to voltage. Analog input used with analog reference ().
- Reset brings this channel low to reset the microcontroller. Specifically used to add a reset switch to protect the blocking something on board

3.2 LCD 16X2

LCD stands for Liquid Crystal Display is a type of viewer that uses liquid crystals as material to display data in the form of text or images. Application in everyday life that is easily found, among others, on calculators, game bot, television, or computer screens.

There are types of these devices that will be discussed and discussed in this Arduino Tutorial on accessing a 16 × 2 LCD easily, which is easily found in the nearest electronic shop

For our project we have selected one 16x2 i2c LCD shown in figure **3.2.**

3.2.1 Item Specifications:

- Consisting of 16 columns and 2 line
- Furnished with back light
- 192 characters
- Addressable 8-bit 4-bit with mode
- There is character program generator
- Information
- Gnd cables: the power supply 0 vdc
- The power supply vcc
- Positive Contrast: to contrast the writing on
- LCD the hospital or register select:
- High: to send data
- Low: to send instructions
- R / W or read / write
- High: sends data
- low: send instructions

- hooked up with low to the sending of data to the screen
- E (disable): to control to lcd when worth low, LCD inaccessible
- D0 - D7 = bus data 0 - 7
- Backlight +ve: plugged into vcc to ignite the backlight
- Backlight –ve: plugged into gnd cables to light the backlight

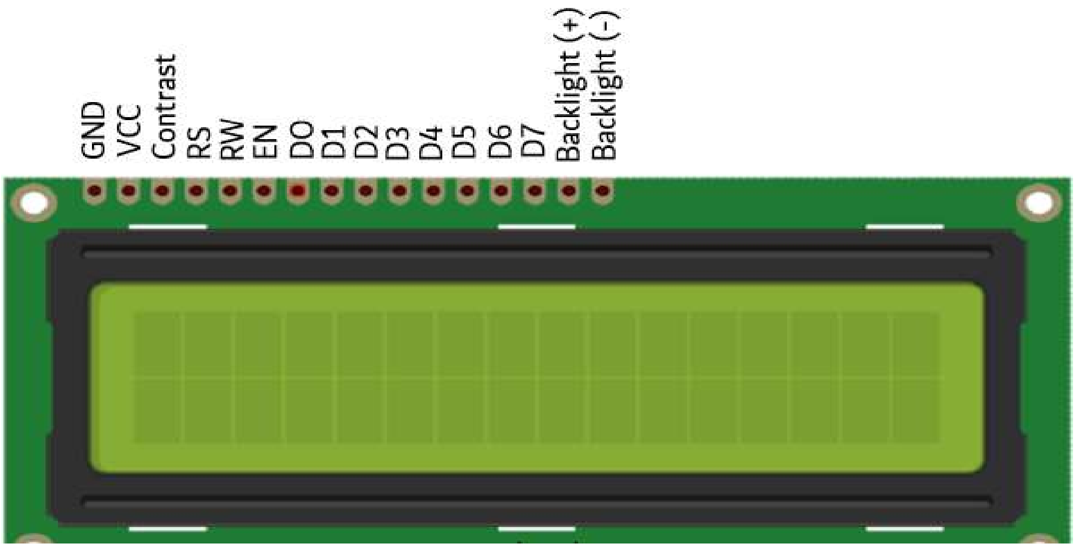

Figure 3.2 i2c 16x2 LCD

3.3 Flow meter

Thousand years ago, people know the concept of flow meter and their measurement when farming, irrigation, and water conservancy became essential to humans. In Egypt country, ancient people used weir rudiments to evaluate the flow of water in the Nile River. So it indicates whether the harvest would be favorable (or) unfavorable. These meters are mainly used for two purposes the process control and verify & product quality improvement so that the material cost will be reduced and efficiency will be increased. The applications of flow meters mainly include in industries like pharmaceuticals, metallurgy, petrochemicals, home energy, pulp & building. Day by day, the development of meters and their application has changed but their necessity remains the same as accuracy.

A device that is used to gauge the mass of liquid or gas or volume is known as a flow meter. Alternate names of this device are flow rate sensor, liquid meter, flow gauge, indicator based on the industry but the working principle is the same. These meters are used to measure open channels such as streams or rivers. Some types of meters mainly focus on liquids and gases in a pipe. The main benefits of these meters are improving the accuracy, resolution, and precision of the liquid.

The working principle of flow meter is to measure the amount of gas; liquid otherwise streams around the device. These devices work with the same end goal but in different ways. They offer repeatable & accurate flow measurements for different applications like semiconductor processing, process control, etc.

This meter calculates either mass or volume. The liquid flow in the pipe can be equal to the cross-sectional area within a meter & the velocity of the liquid flow ($Q = A * v$). The flow of mass can be calculated by using this formula like $\dot{m} = Q * \rho$ (Q = the flow rate of liquid & ρ is the density of the fluid). In many cases, the flow of mass is the main consideration, particularly in gases selling/buying, chemical reactions, combustion, etc.

These are classified into different types based on its application like a mechanical, optical and open channel.

1) Mechanical Flow Meters:

These types of meters measure the flow of liquid with the help of moving parts arrangement, known liquid volumes through a sequence of chambers or gears. These meters are classified into four types which include the following.

Positive Displacement: The PD (positive displacement) flow meters work by counting or isolating identified volumes of a gas or liquid. Flow measurement can be obtained by counting the no. of accepted isolated volumes. Each meter includes its distinct mechanism to count liquid volumes in a specific no. of cycles. These meters give high accuracy & good repeatability and they do not need a power supply for their function and straight-up & downstream pipe for their installation.

Mass Flow Meter: This type of meter is used to provide an estimated flow rate to the consumer by measuring the volume of the substance flowing through them. These are weight-oriented meters used where weight oriented measurement is required like in chemical industries.

Differential Pressure Flow Meter: This meter works on incompletely blocking the flow of liquid within a pipe to create a disparity in the static pressure among the up & downstream part of the device. The difference in the differential pressure can be measured to decide the liquid flow rate.

At present 40% of these meters are used in industries to measure different fluids like gases, highly thick liquids. These are very popular due to their simple design & less cost. This meter works on incompletely blocking the flow of liquid within a pipe to create a disparity in the static pressure among the up & downstream part of the device. The difference in the differential pressure can be measured to decide the liquid flow rate. At present 40% of these meters are used in industries to measure different fluids like gases, highly thick liquids. These are very popular due to their simple design & less cost.

Figure 3.3 Mechanical Flow meter

Velocity Flow Meter: This meter is used to measure the velocity of the stream to analyze the volumetric rate of liquid flow. These meters are less sensitive when the internal liquid movement is higher. These meters mainly include paddlewheel, turbine, electromagnetic, vortex shedding & sonic or ultrasonic flow meters. [13] [14]

2) Optical Flow Meter

In industrial liquid flow measurement, an optical type meter is a recent development to measure the liquid's velocity through a pipe. This technology is named as L2F or Laser-Two-Focus and it uses two laser rays for detecting the light diffusion particles carried by the flowing liquid.

3) Open Channel Flow Meter

This kind of meter is used to measure the flow of liquid that is open to the environment at some end in the liquid flow measurement lane. This liquid can be completely open to the atmosphere or enclosed in a closed tube with partially filled liquid and simply unlock to the atmosphere at the fitting end of the meter itself.

The best type of water flow meter to use depends upon the specific application. For instance, some flow meters work well when measuring different things. To learn more, customers are advised to read white papers, watch videos and use selection tools to identify the right Sierra flow measurement product for their liquid and water flow application. For our project we have selected **flow meter shown in figure 3.4.**

3.3.1 Item Specifications:

- Model: YF-S201C
- Color: Transparent
- The Lowest Rated Working Voltage: DC4.5 5V-24V
- Maximum Operating Current: 15 mA (DC 5V)

- Working Voltage Range: DC 5~18 V

Figure 3.4 Flow meter

3.4 NRF24 Transceiver Modules

The nRF24L01+ module is designed to operate in 2.4 GHz worldwide ISM frequency band and uses GFSK modulation for data transmission. The data transfer rate is configurable and can be one of 250kbps, 1Mbps and 2Mbps. The module's operating voltage ranges from 1.9 to 3.6V, but the good news is that the logic pins are 5-volt tolerant, so you can use it with your favorite 3.3V or 5V microcontroller without worry.

The module supports programmable output power i.e. 0 dBm, -6 dBm, -12 dBm or -18 dBm. At 0 dBm the module consumes only 12 mA during transmission which is less than the consumption of a single LED. And the best part is that it consumes 26 µA in standby mode and 900 nA in power down mode. That's why it's a go-to wireless device for low-power applications.

The nRF24L01+ communicates over a 4-pin SPI (Serial Peripheral Interface) with a maximum data rate of 10Mbps. All parameters such as frequency channel (125 selectable channels), output power (0 dBm, -6 dBm, -12 dBm or -18 dBm), and data rate (250kbps, 1Mbps, or 2Mbps) can be configured through the SPI interface. The SPI bus uses the concept of a master and a slave. In most of our projects the Arduino is the master and the nRF24L01+ module is the slave.

For our project, we have selected **Nrf24 transceiver module shown in figure 3.5.**

3.4.1 Item Specification

- Receiver channel count: 6 channels
- Low operating voltage: 1.9V-3.6V
- High rate: 2 MBPS
- Transmit power: (max) 4.5: +7 dB
- Transmission distance: (250kbps) 4.5: ~ 250M

With this version you will be able to communicate over a distance of 100 meters. Of course that is outdoors in an open space. Its range becomes a bit weak inside the house especially due to the walls.

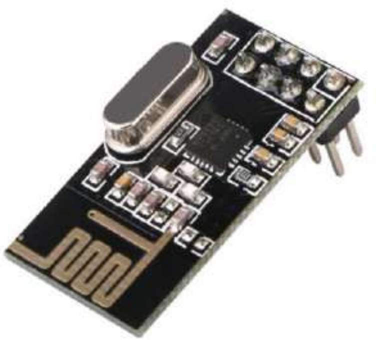

Figure 3.5 NRF24 Module

The second version comes with an SMA connector and a duck-antenna but that's not the only difference. It comes with a special RFX2401C range extender chip that integrates PA, LNA and transmit-receive switching circuitry. This chip helps the module to achieve a much larger transmission range of up to 1000 meters.

PA stands for Power Amplifier. It only amplifies the signal strength being transmitted from the nRF24L01+ chip. Whereas LNA stands for Low-Noise Amplifier whose function is to take an extremely weak signal from the antenna (usually below microvolts or -100 dBm) and amplify it to a more useful level (usually around 0.5 to 1 V). The nRF24L01+ module transmits and receives data on a certain frequency called a channel. For two or more modules to communicate with each other, they must be on the same channel. This channel can be any frequency in the 2.4 GHz ISM band, or to be more precise, it can be between 2.400 to 2.525 GHz (2400 to 2525 MHz). Each channel takes up a bandwidth of less than 1MHz. This gives us 125 possible channels with 1MHz spacing.

- GND is the ground pin. It is marked with a square to identify it from the other pins.
- VCC supplies power to the module. It can be anywhere from 1.9 to 3.9 volts. You can connect it to the 3.3V output from your Arduino. Remember that connecting this to the 5V pin will probably destroy your nRF24L01+ module!
- CE (Chip Enable) is an active-high pin. When selected, the nRF24L01 will either transmit or receive, depending on which mode it is currently in.
- CSN (Chip Select Not) is an active-low pin and is normally kept HIGH. When this pin goes low, the nRF24L01 starts listening on its SPI port for data and processes it accordingly.
- SCK (Serial Clock) accepts clock pulses provided by the SPI bus master.
- MOSI (Master Out Slave In) is the SPI input to the nRF24L01.
- MISO (Master In Slave Out) is the SPI output from the nRF24L01.
- IRQ is an interrupt pin that can alert the master when new data is available to process.

3.5 BATTERY

The battery provides electrical power to the motors and all electronic components of the quadcopter. Lithium ion (Li-ion) batteries are used almost exclusively, because they have high specific energy. Li-ion batteries have a capacity rating and discharge rating. The capacity rating, in milliamp-hour (mAh) indicates how much current the battery may output for one hour. Discharge rating, denoted by "C", shows how fast the battery may be safely discharged. To determine max. Allowed current, multiply C value with the capacity. For our project, we have selected **Li-ion 2000mah 8.2v battery pack as shown in figure 3.6**

3.5.1 Item Specification

- Weight: 266 grams

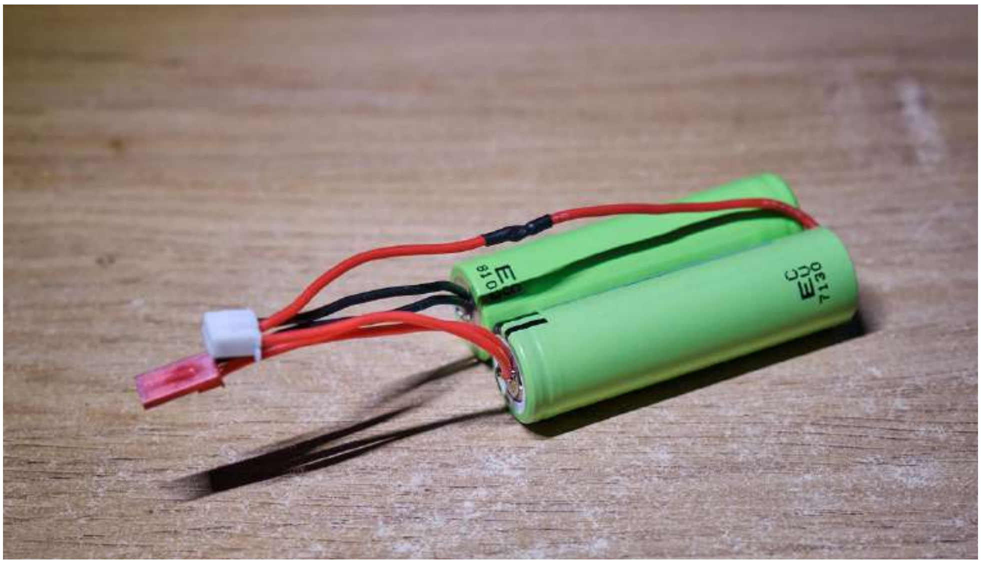

Figure 3.6 Li-ion battery

3.6 XL6009 DC-DC Step Up Boost Converter

The XL6009 is a DC-DC step-up boost converter integrated circuit (IC) commonly used in electronics projects to increase the voltage level of a DC power source. As shown in Fig 3.7 below.

3.6.1 Item specification

- Module type: Non-isolated step-up (Boost)
- Rectification: Non-synchronous rectification
- Input voltage: 5V-32V
- Output voltage: 5V-35V
- Input current: 4A (max), No-load current18mA (4A requires cooling)
- Conversion-efficiency: 94% (highest)
- Switching frequency: 400KHz
- Output ripple: 50mV (max, factory specification)
- Load regulation: ± 0,5%
- Voltage regulation: ± 0,5%
- Operating temperature: -40 °C tot +85 °C
- Dimensions: 43 x 21 x 14 mm
- Short circuit protection: None

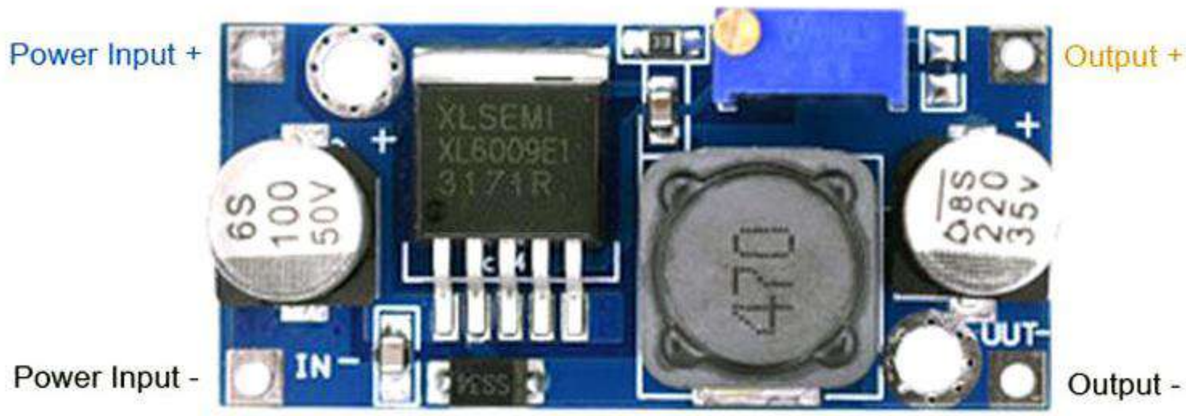

Figure 3.7 DC-DC Step Up Boost Converter

3.7 HC-05 Master / Salve Bluetooth Module

The HC-05 is a class 2 Bluetooth module designed for transparent wireless serial communication. It is pre-configured as a slave Bluetooth device. Once it is paired to a master Bluetooth device such as PC, smart phones and tablet, its operation becomes transparent to the user. All data received through the serial input is immediately transmitted over the air. When the module receives wireless data, it is sent out through the serial interface exactly at it is received. No user code specific to the Bluetooth module is needed at all in the user microcontroller program.

The HC-05 supports two work modes: Command and Data mode. The work mode of the HC-05 can be switched by the onboard push button. The HC-05 is put in Command mode if the push button is activated. In Command mode, user can change the system parameters (e.g. pin code, baud rate, etc.) using host controller itself of a PC running terminal software using a serial to TTL converter. Any changes made to system parameters will be retained even after power is removed. Power cycle the HC-05 will set it back to Data Mode. Transparent UART data transfer with a connected remote device occurs only while in Data Mode.

The HC-05 can be re-configured by the user to work as a master Bluetooth device using a set of AT commands. Once configured as master, it can automatically pair with a HC-05 in its default slave configuration or a HC-06 module, allowing a point to point serial communications.

The HC-05 will work with supply voltage of 3.6VDC to 6VDC, however, the logic level of RXD pin is 3.3V and is not 5V tolerant. A Logic Level Converter is recommended to protect the sensor if connect it to a 5V device (e.g. Arduino Uno and Mega). The power to the HC-05 will cut off if the "EN" pin is pulled to logic 0.

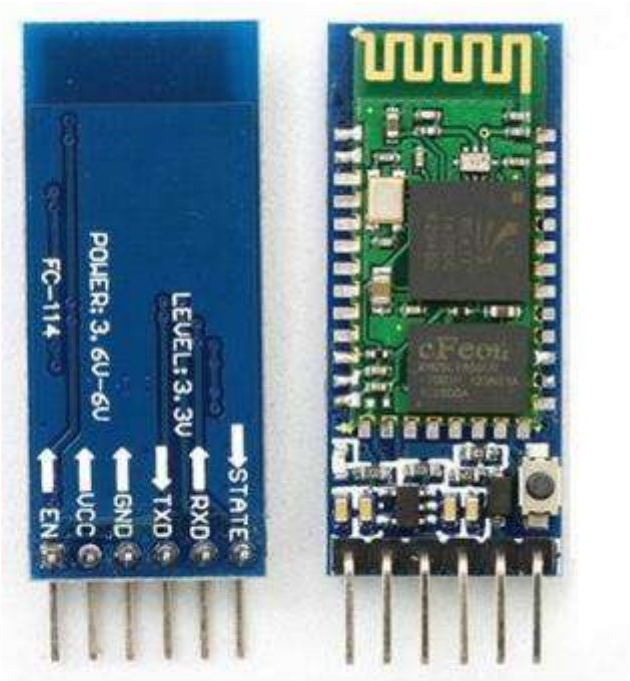

Figure 3.8 HC-05 Bluetooth

3.7.1 Item specification

- Serial Bluetooth module for Arduino and other microcontrollers
- Operating Voltage: 4V to 6V (Typically +5V)
- Operating Current: 30mA
- Range: <100m
- Works with Serial communication (USART) and TTL compatible
- Follows IEEE 802.15.1 standardized protocol
- Uses Frequency-Hopping Spread spectrum (FHSS)
- Can operate in Master, Slave or Master/Slave mode
- Can be easily interfaced with Laptop or Mobile phones with Bluetooth
- Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.

Chapter 4

The Fraud Detection Device Hardware

4.1 Circuit Diagram

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with AC-to-DC adapter or battery.

For this project we have selected Arduino UNO as the main controller, which can read the data from the flow meter sensor and then process it and send to the wireless module.

It also has user input buttons to insert the fuel price per liter. The circuit diagram is shown in figure 4.1.

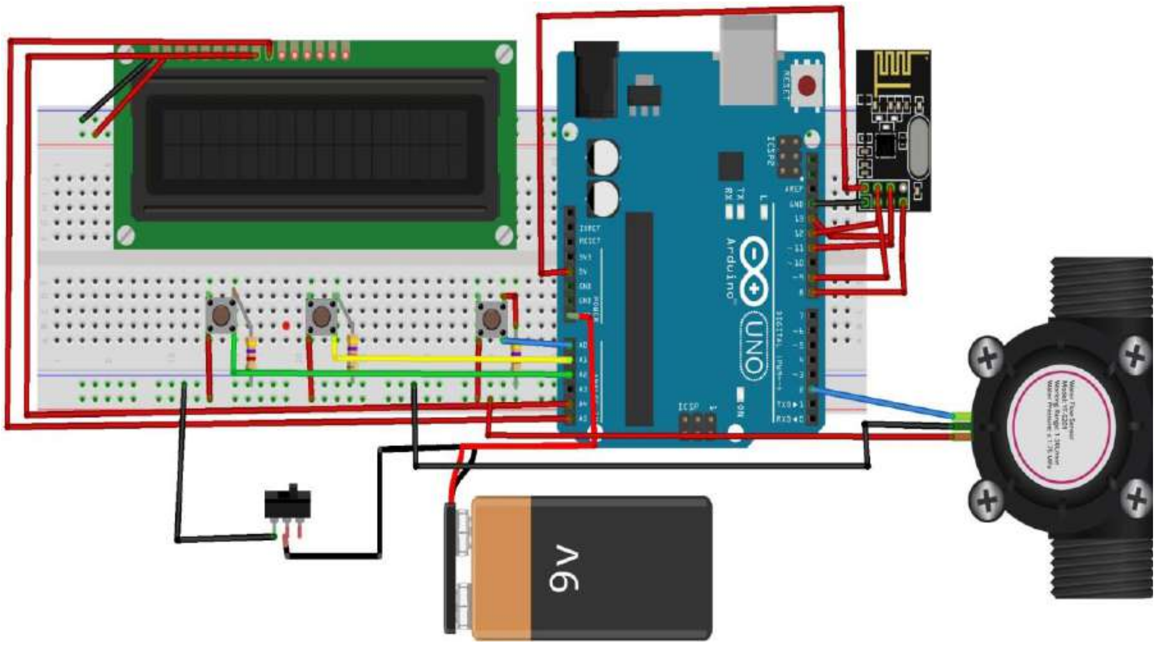

Figure 4.1 Circuit diagram

4.2 Block diagram

The block diagram is shown in fig 4.1. In which the signals received at receiver are transferred to Arduino UNO for processing. The battery provides power to all components.

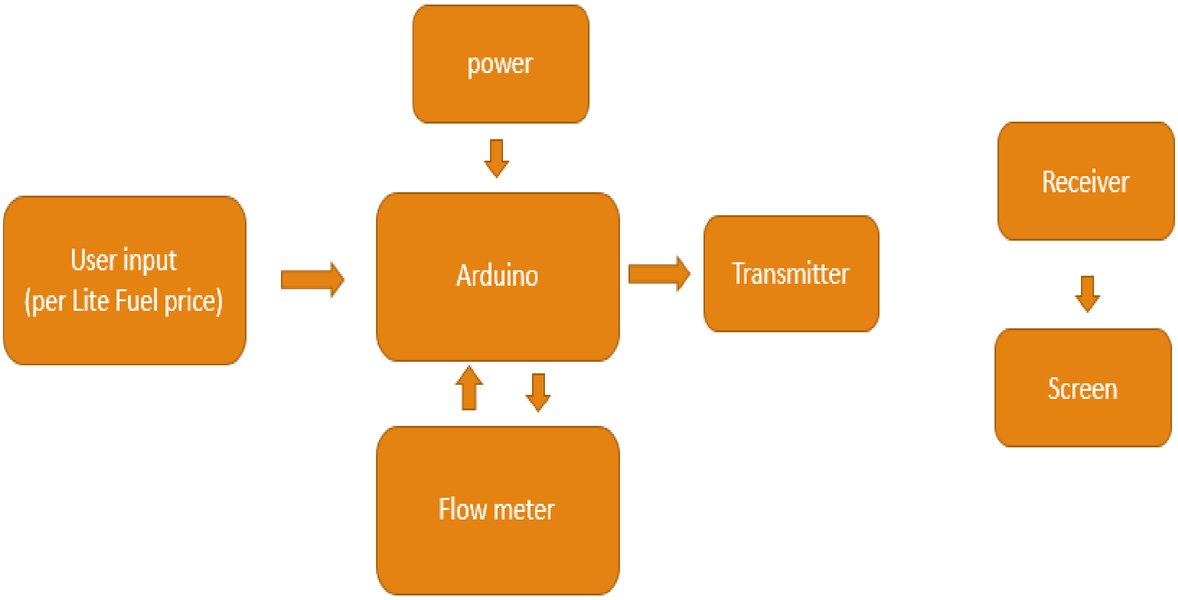

Figure 4.2 Block diagram

4.3 Flow sensor fitting

By using a flow sensor with a microcontroller like Arduino, we can calculate the flow rate, and check the volume of liquid that has passed through a pipe, and control it as required. The sensor has 3 wires RED, YELLOW, and BLACK as shown in the figure below. The red wire is used for supply voltage which ranges from 5V to 18V and the black wire is connected to GND. The yellow wire is used for output (pulses), which can be read by an MCU. The water flow sensor consists of a pinwheel sensor that measures the quantity of liquid that has passed through it.

The water flow sensor works on the principle of hall-effect. Hall-effects the production of the potential difference across an electric conductor when a magnetic field is applied in the direction perpendicular to that of the flow of current. The water flow sensor is integrated with a magnetic hall-effect sensor, which generates an electric pulse with every revolution. Its design is in such a way that the hall effect sensor is sealed off from the water, and allows the sensor to stay safe and dry.

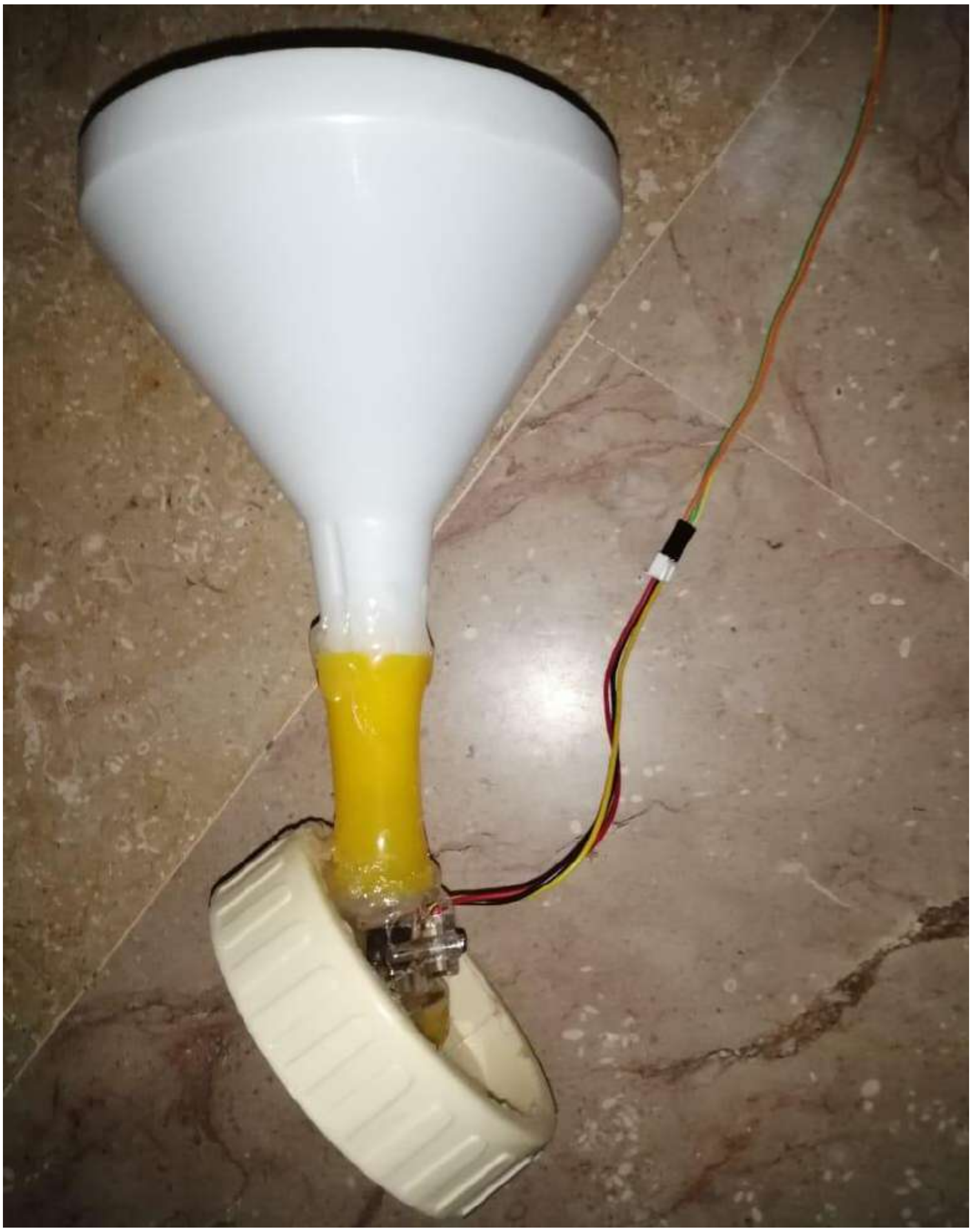

Figure 4.3 Flow meter

4.4 User input

The User must the fuel price by the push button installed in the breadboard as shown in fig 4.4.

On button is for incrementing the price and other one for the decrement. And the third button is for starting the system.

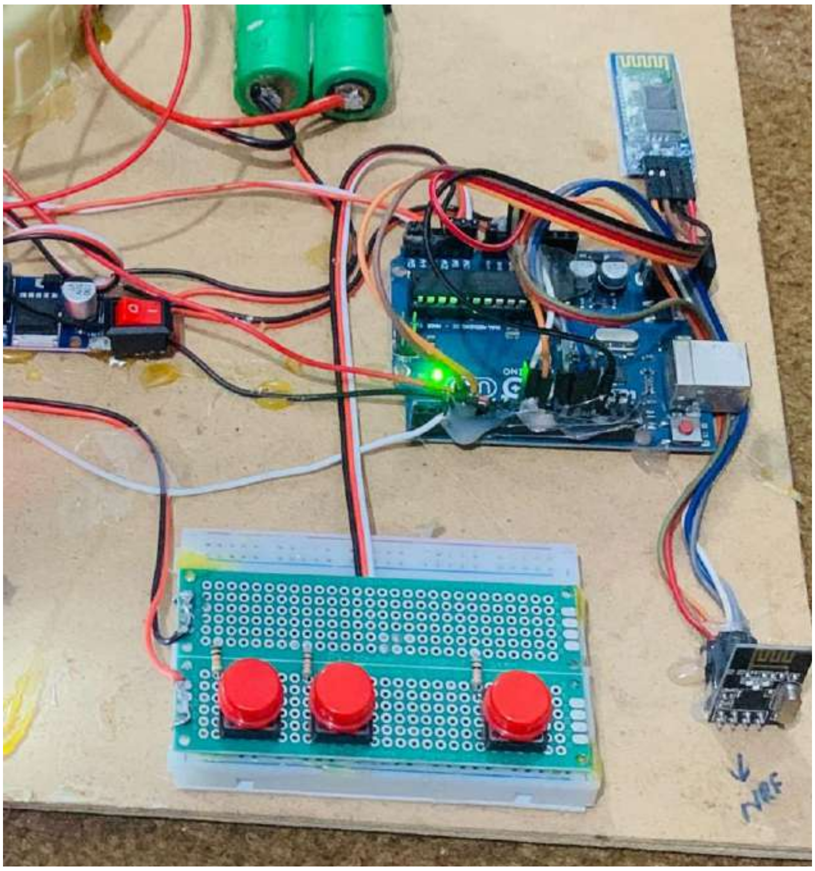

Figure 4.4 Push Buttons

4.5 Complete TX module

The complete transmitter module with flow meter and nrf24 is shown in figure 4.5. It basically does the following functions.

- Take user input data
- Take data from the flow meter
- Convert the data from the meter into Liter
- Calculate the price

- Show it on the screen
- Transmit the total amount to the other module

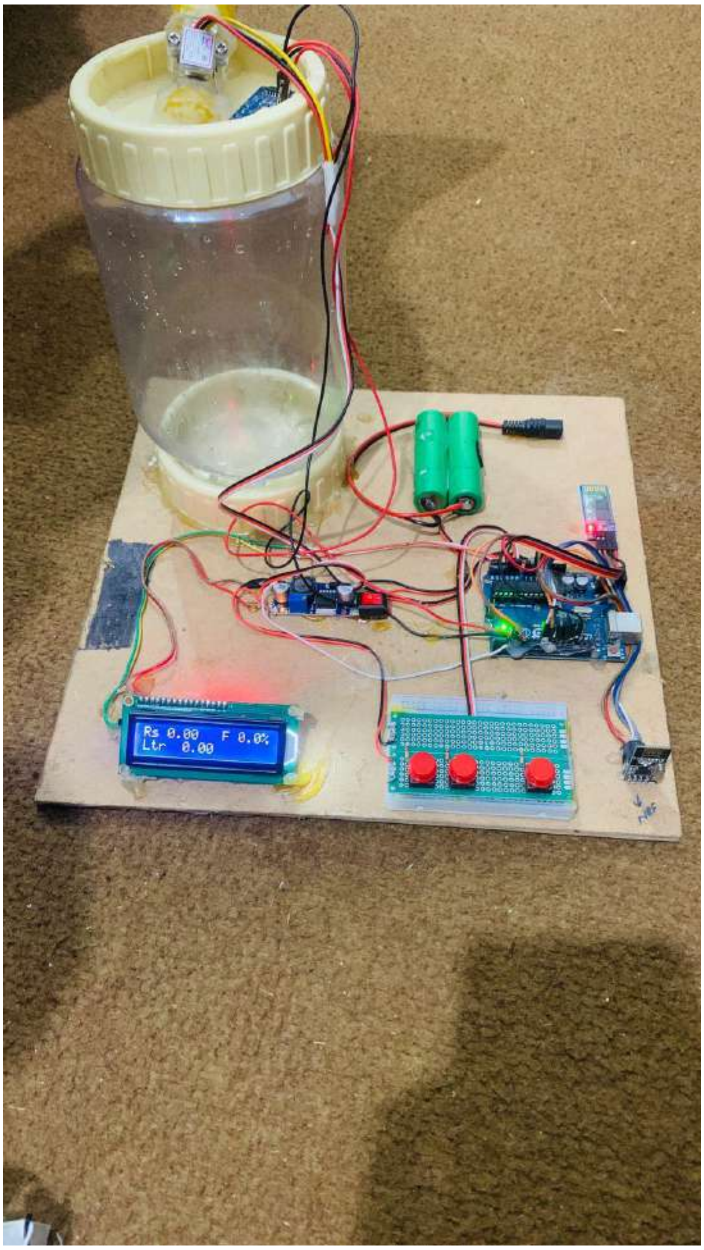

Figure 4.5 TX module

4.6 Receiver module

The receiver module as shown in figure 4.6 will be placed inside the car dash board. That will be for the convenience of user to remain inside the car. It has three main components:

1) Arduino UNO
2) NRF24
3) LED 16 x 4

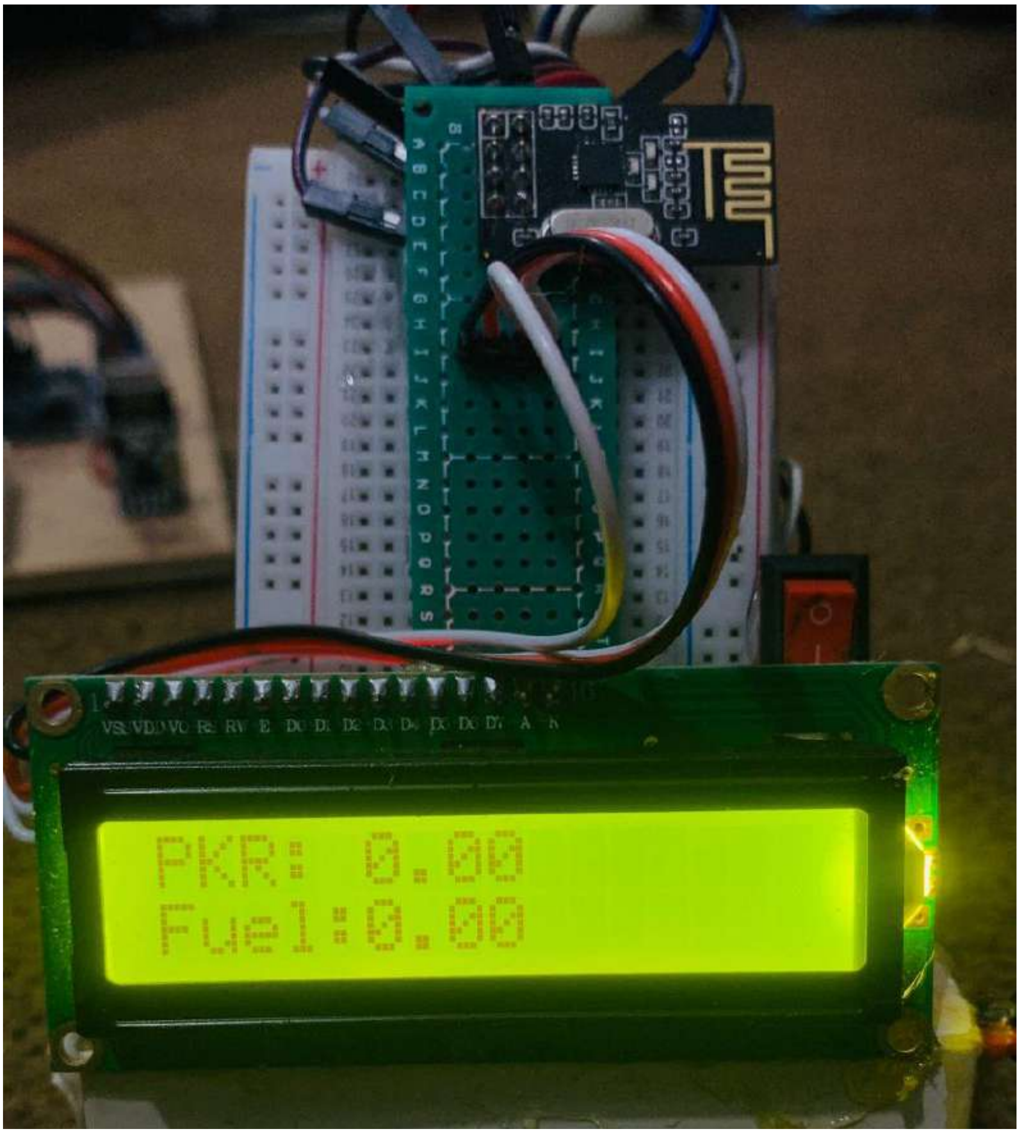

Figure 4.6 RX module

4.7 Working

The project works by first taking the input from the user as shown in table 4.1. After pushing the start button the system execute the process by following steps

1) Take Price for 1 L fuel from user
2) After pressing start button data from sensor is taken
3) Calculate the price for the amount of fuel
4) Display it on LCD
5) And send it to RX module
6) Also send the data to Mobile Phone application through Bluetooth Module

Table 4.1 Button Sequence/Operation

S.no	Button	Function
1	Button 1	0.1 increment
2	Button 2	0.1 decrement
3	Button 3	Start the system

4.8 Software

Arduino IDE and Fritzing simulator were used in this project.

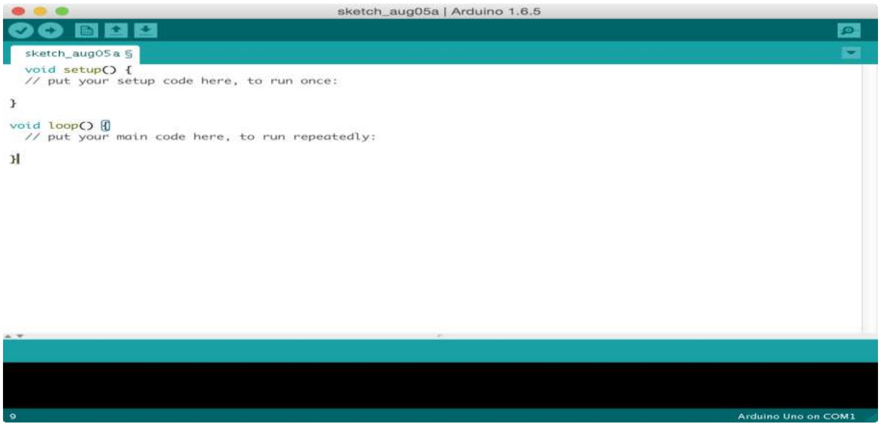

Fig 4.7 Arduino IDE

Chapter 5

Conclusion & Future Work

5.1 Conclusion

Petrol pump frauds were very common in now days. Many of the petrol pumps today temper the pumps such that it displays the amount as entered, but in actual, the quantity of fuel filled in the consumer's tank is much lesser than the displayed value. The pumps are cheating for the profit of the petrol pump owner. This results in great profits for the petrol pumps, but at the same time the petrol consumers are being cheated. So we made a project named "Real Time Anti Fuel Theft Device". It consists of creating a System for the exact volume of fuel filled in the fuel tank.

The project was tested and checked multiple times. And the results were accurate and acceptable.

5.2 Future work and Recommendations

Future research work can improve the performance of this project by installing high quality of Ultrasonic Sensor that can detect the fuel before filling and after filling. GSM and GPRS can be also used in this project for transport companies which will help them in collecting the correct amount of fuels and locations of their filling stations. Through this the companies can be safe from frauds by the drivers.

This system can be also installed in your own vehicles which will help you in avoiding the frauds happening at the filling stations.

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Abbreviations

Abbreviations should be placed at the end. Sample is given below:

DB: distribution board

EED: Electrical Engineering Department

TX: Transmitter

RX: Receiver

PWM: Pulse Width Modulation

SPI: Serial Peripheral Interface

IIC: Inter Integrated Circuit

PCB: Printed Circuit Board

LED: light Emitting Diode

USB: Universal Serial Bus

Appendix

Arduino code:

TX Side:

```
#include <SoftwareSerial.h>

SoftwareSerial mySerial(3, 4); // RX, TX

char w;

#include <SPI.h>

#include <nRF24L01.h>

#include <RF24.h>

const int TRIG_PIN   = 6;

const int ECHO_PIN   = 7;

float duration_us, distance_cm;

RF24 radio(9, 8); // CE, CSN

double flow; //Liters of passing water volume

unsigned long pulse_freq;

float tank;

const byte address[6] = "00001";

// Max size of this struct is 32 bytes - NRF24L01 buffer limit

struct Data_Package {

  float a = 0;

float b=0;
```

```
};
Data_Package data;
#include <LCD_I2C.h>
LCD_I2C lcd(0x27, 16, 2);
#include <Wire.h>
//#include <LiquidCrystal_I2C.h>
//LiquidCrystal_I2C lcd(0x27,16,2);
int Select_btn;
int inc;
int dec;
int btn_pres=1;
float cur_price=290.00;
int s =A0;
int i =A1;
int d =A2;
float t=0.00;
float tlvl=0.00;
void setup()
{
  pinMode(TRIG_PIN, OUTPUT);
  pinMode(ECHO_PIN, INPUT);
```

```
  radio.begin();
  radio.openWritingPipe(address);
  radio.setPALevel(RF24_PA_MIN);
  radio.stopListening();
  pinMode(s,INPUT);
   pinMode(i,INPUT);
    pinMode(d,INPUT);
    pinMode(2, INPUT);
  attachInterrupt(0, pulse, RISING);
   Serial.begin(9600);
  mySerial.begin(9600);
 lcd.begin();
  lcd.backlight();
  lcd.setCursor(0,0);
  lcd.print("Real Time Anti");
  lcd.setCursor(0,1);
  lcd.print("Fuel Theft device");
delay(1000);
lcd.clear();
  }
  void loop()
```

```
 {
 if (Serial.available()) {
   w = Serial.read();
   mySerial.println(w); //Phone
   delay(10);
   //commands with mySerial.println(); show on the device app
 }
 mySerial.print("PKR: ");
mySerial.print(t);
mySerial.print("   Fuel: ");
mySerial.println(tlvl);
digitalWrite(TRIG_PIN, HIGH);
 delayMicroseconds(10);
 digitalWrite(TRIG_PIN, LOW);
 duration_us = pulseIn(ECHO_PIN, HIGH);
 distance_cm = 0.017 * duration_us;
 if (distance_cm<9)
 {
   distance_cm=9;
   }
    if (distance_cm>18.5)
```

```
  {
    distance_cm=18.5;
    }
   tank= map(distance_cm,9.5,17.5,100.0,0.0);
  tlvl=tank;
  Serial.print(distance_cm);
  Serial.print("   ");
Serial.println(tlvl);
    flow = .00 * pulse_freq;
    //Serial.print(flow);
    //Serial.println("L");
    //delay(500);
Select_btn = digitalRead(s); //read selectio btn and store its value in Select_btn
if (Select_btn==1) //if Select_btn is pushed
{
  btn_pres++; //change btn_pres varial and add 1 to it
  delay(150);
  if (btn_pres>2) //restrict the btn_press variable between 1 and 2
  {
    btn_pres=1;
    }
```

```
  }
if (btn_pres==1)// if btn_press variable value is 1 then ask for current price
{
    inc  = digitalRead(i);
    dec = digitalRead(d);
    lcd.setCursor(0,0);
  lcd.print("Cur Price=");
    lcd.setCursor(11,0);
  lcd.print(cur_price);
if (inc==1)   // if increment button is pushed start incremneting the price
{
  cur_price=(cur_price + (0.1));
 Serial.println(cur_price);
  delay(150);
  lcd.clear();
    lcd.setCursor(11,0);
  lcd.print(cur_price);
  }
  if (dec==1) // if decrement button is pushed start decremneting the price
{
  cur_price=(cur_price - (0.1));;
```

```
  Serial.println(cur_price);
  delay(150);
  lcd.clear();
 lcd.setCursor(11,0);
  lcd.print(cur_price);
  }
}
  if (btn_pres==2) // if btn_press variable value is 2 then start calculating the fuel amount
    {
        lcd.setCursor(0,0);
  lcd.print("Rs");
  lcd.setCursor(3,0);
  lcd.print(t);
   lcd.setCursor(10,0);
  lcd.print("F");
  lcd.setCursor(12,0);
  lcd.print(tank);
  lcd.setCursor(15,0);
    lcd.print("%");
   lcd.setCursor(0,1);
  lcd.print("Ltr");
```

```
 lcd.setCursor(5,1);
lcd.print(flow);
  //lcd.setCursor(14,1);
//lcd.print(flow);
delay(200);
lcd.clear();
   calculate(); // funtion for flow meter
   send_data(); // function for sending dta via nrf24
    }
    //delay(2000);
  }
  void calculate()
  {
   t= cur_price*flow; // Price is calculated by multiplying volume and current price
    }
    void send_data()
    {
        data.a=t;
        data.b=tlvl;
// Send the whole data from the structure to the receiver
radio.write(&data, sizeof(Data_Package));
```

```
        }
        void pulse () // Interrupt function
{
  pulse_freq++;
}
```

RX Side:

```
#include <SPI.h>
#include <nRF24L01.h>
#include <RF24.h>
#include <LCD_I2C.h> // Include the LCD library
RF24 radio(9, 8); // CE, CSN
const byte address[6] = "00001";
// Max size of this struct is 32 bytes - NRF24L01 buffer limit
struct Data_Package {
  float a = 0;
  float b=0;
};
Data_Package data; //Create a variable with the above structure
// Initialize LCD
LCD_I2C lcd(0x27, 16, 2); // Set the LCD address to 0x27 and define its size as 16x2
```

```
void setup() {
  Serial.begin(9600);
  radio.begin();
  radio.openReadingPipe(0, address);
  radio.setPALevel(RF24_PA_MIN);
  radio.startListening();
  // Initialize LCD
  lcd.begin();
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("PKR: ");
    lcd.setCursor(0, 1);
  lcd.print("Fuel: ");
}
void loop() {
  // Check whether there is data to be received
  if (radio.available()) {
    radio.read(&data, sizeof(Data_Package)); // Read the whole data and store it into the 'data'
structure
  }
  // Display data on Serial monitor
  lcd.setCursor(0, 0);
```

```
lcd.print("PKR: ");
  lcd.setCursor(0, 1);
lcd.print("Fuel: ");
// Display data on LCD
lcd.setCursor(5, 0); // Set cursor position for displaying data
lcd.print(data.a);    // Display data.a on LCD
  lcd.setCursor(5, 1); // Set cursor position for displaying data
lcd.print(data.b);    // Display data.a on LCD
delay(300);
lcd.clear();
}
```