Non Contact Water Level Monitoring For Rain Water Storage System Using Labview With Arduino & Ultrasonic Sensor

A Project report submitted in partial fulfillment of the requirements for the degree of B. Tech in Electrical Engineering

by

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CERTIFICATE

To whom it may concern

This is to certify that the project work entitled **Non Contact Water Level Monitoring For Rain Water Storage System Using Labview With Arduino & Ultrasonic Sensor** is the bonafide work carried out by **Surjay Boral (11701616018), Abhishek Sardar (11701616070), Analprabha Roy (11701616068), Rajatsubhra Maiti (11701616044),** the students of B.Tech in the Department of Electrical Engineering, RCC Institute of Information Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India, during the academic year 2019-20, in partial fulfillment of the requirements for the degree of Bachelor of Technology in Electrical Engineering and that this project has not submitted previously for the award of any other degree, diploma and fellowship.

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We are very thankful to our Department and to the authority of RCCIIT for providing all kinds of infrastructural facility towards the research work.

Thanks to the fellow members of our group for working as a team**---**

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To

The Head of the Department
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Respected Sir,

In accordance with the requirements of the degree of Bachelor of Technology in the Department of Electrical Engineering, RCC Institute of Information Technology, We present the following thesis entitled "**Non Contact Water Level Monitoring For Rain Water Storage System Using Labview With Arduino & Ultrasonic Sensor**". This work was performed under your valuable guidance Dr. Debasish Mondal sir, Associate Professor, Dept. of Electrical Engineering.

We declare that the thesis submitted is our own, expected as acknowledge in the test and reference and has not been previously submitted for a degree in any other Institution.

Yours Sincerely,

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Abbreviations & Acronyms

IC- Integrated Circuit

IDE- Integrated Development Environment

PLC- Programmable Logic Controller

AI- Artificial Intelligence

HMI- Human Machine Interface

DCS- Distributive Control System

IoT- Internet of Things

NO- Normally Open

NC- Normally Closed

LED- Light Emitting Diode

I/O- Input/Output

PWM- Pulse Width Modulation

USB- Universal Serial Bus

MCU- Microcontroller Unit

VI- Virtual Instrument

ABSTRACT

Rain water storage is an important issue now-a-days. In this project it is planned to store and collect rain water and utilise it for house hold uses. To overcome the difficulty of manual handling automatic ON-OFF control scheme is used to measure & control water level in two tanks.

There will be two tanks---- Over Head Tank and Under Ground Reservoir. There is another tank provided for filtration and collection of sediments & flocks from the rain water. The rain water flowing from the roof of the building through the rain water pipe directly comes into the first tank having Activated Carbon Filter and sediment filter. From this tank filtered water comes to the Underground Reservoir under gravity.

For the further two tanks Over Head Tank and Under Ground Reservoir the automation system has been enabled. There will be two different ultrasonic sensors (HCSR-04) for measuring water level in two different tanks. There will be a pump which will automatically enable the flow of water from the underwater reservoir to the over head tank on the roof. There will be two conditions of two different ultrasonic sensors depending on which the pump will operate or not. The whole automation process will be controlled by Arduino-UNO.

The water levels in the tanks will be directly monitored in the LABVIEW Software. The graphical representations of the tank conditions will be shown & analyzed in this software.

CHAPTER-1

(INTRODUCTION)

1.1 INTRODUCTION

Water Level Monitoring System is one of the common systems now a day. This system is implemented everywhere in domestic and commercial buildings. During our busy schedule it is not possible to look over the tank water levels and operate the pump accordingly. Our project is based on an automation system to be implemented in a domestic water circulation system. This project proposes an efficient automation system for water flow and storage system in a domestic or commercial building or in a housing society. Rain water collection, storage and utilization are perfectly done in this proposal. This automation system uses LabVIEW software as a user interface. Rain water storage is also done in this project which of great concern now a day. So keeping all this in mind the title of the project is given as— **"Non Contact Water Level Monitoring for Rain Water Storage System Using Labview with Arduino & Ultrasonic Sensor."**

The external data like water heads in the tanks are measured by Ultrasonic Sensors (HC SR-04). These sensors make use of ultrasonic sound for calculating the distance of the first medium from where the sound is reflected back. Thus there are two different pins named TRIGGER & ECHO for transmitting and Receiving of sound waves. Arduino-UNO is the most basic kind of controllers used for the automation purpose. Mainly we have used the digital pins for transmission of data. Arduino IDE is an open source software in which the programming part is done for this prototype. The pump will be operated by UNO and is given supply accordingly from a 12 Volts source through a single channel Relay module. LabVIEW software is used for graphical representation of the tank water levels and other signals generated while processing. This is one of the expensive softwares used for prototype models.

Rain water collection is another aspect of our project. Here we are collecting rain water from the roof of the building and taking it to a filtration tank where the rain water is filtered through several stages of filtration. Filtration tank will consist of 3 stages of filtration. The 1st stage is Activated Carbon Filter which will filter out all the dust particles mixed with the rain water. The 2nd stage is Mixed Acid Filter which will neutralize the basic components and cat ions present in the rain water. The 3rd stage is Mixed Base Filter will neutralize the acid components and anions present in the rain water. After all the stages of filtration the rain water is purified up to an extent. Here we are using a DC pump for our purpose but the original system will be provided with an AC pump. The pump we are using is of centrifugal type. But we can also use either a centrifugal or sub-marshal AC pump. Type of the Pump will not hamper our automation system. So we need not to consider about the pump. The selection of pump will depends on the availability of several factors on the physical site of implementation.

1.2 ULTRASONIC SENSOR BASED WATER LEVEL MONITORING SYSTEM

Ultrasonic Sensor is a continuous measurement type sensor used for measuring distance of certain material or obstacle that would be imposed on the path of the sensor. The water level here is measured using the ultrasonic sensor. We can also implement the system using other type of level measuring and sensing transducer, however we have selected to implement the system using ultrasonic sensor due to various advantages Ultrasonic Sensor. The system is best tested with Ultrasonic sensor with much precision and lesser cost. The continuous measurement gives much more accurate results for our purpose. The system is much cheaper and précised with Ultrasonic sensors. Ultrasonic sensor based water level monitoring system is implemented in several domestic and commercial buildings.

This system not only monitors the water level it also controls the relay and operates the pump at required conditions. Here we are using Arduino UNO as the controlling unit which is directly getting data from the Ultrasonic sensor module HC SR-04. This sensor module is used as a continuous distance measuring unit.

Although here we are using two different ultrasonic sensor modules for two different tanks used in our project. In case of the original system there are also two different tanks- Over head tanks and the underground reservoir. There are two different HC SR-04 modules are placed at the top of the tanks. The distance measured by the sensor is the gap between the water level of the tank and the sensor. The water level is measured by calculating the difference of the tank height and the measured value of the sensor module.

Instead of using the Ultrasonic sensor module HC SR-04, we can use the float switch of any kind. The float switch is installed at the top of the water level tank and which gives certain discrete data of the tank height. The Tank level data is passed to the controlling unit and the process is maintained. But here we may face several problems like mechanical defect in the float due to repeated operation, erosion of the float, accumulation of dust and external substances on the float etc. that would not occur in case of an Ultrasonic sensor module as it is non-contact type sensor. Thus due to several advantages we have decided to design the water level monitoring system using the Ultrasonic sensor. This sensors and system has been described in details in later chapters.

1.3 MICROCONTROLLER BASED AUTOMATION SYSTEM

Automation Systems are implemented everywhere in this era of Technology. From Domestic to Commercial uses Automation systems are implemented. There is no other industry which does not have automation system implemented. In any of the Industry Automation is used in office rooms, conference rooms, Assembly Lines, Machines, Furnaces, Converters, Generators, Boilers and Control Rooms etc. The Automation system can be implemented by any kind of microcontroller, any kind of development boards, any kind of logic controller and lastly by Artificial Intelligence which is the recent technology in automation industry.

In industries the automation system implemented using some kind of logic controllers or some kind of Artificial Intelligence technology. In most of the industries Programmable logic controllers (PLC) are used. But PLC is not suitable for domestic or commercial applications. The PLC panels costs very high for any kind of domestic applications. So we use different kind of microcontrollers for these applications which are very cheaper for these applications.

Microcontroller that can be used for household and domestic applications are any development board from Arduino Corporation, Raspberry Pi, Texas Instruments Boards etc. Arduino Corporation Boards that are used mainly and cheaper are Arduino UNO, Arduino NANO and Arduino MINI etc. Some boards from Arduino Corporation are also expensive. These are Arduino MEGA, Arduino DUE, Arduino LEONARDO, Arduino LILY PAD etc. Some of the Arduino boards are also there which can access the Wifi for IoT applications. These are Node MCU, Wifi Shields like Arduino Ethernet Shield, Arduino Yun Shield etc. In case of some heavy and précised applications Raspberry Pi are used. For this applications Raspberry Pi versions 0, 1, 2, 2B, 3, 3B and $3B^+$ are available. Raspberry Pi can handle several times more data than an Arduino Board. It can directly access Wifi without using any kind of Wifi module. It can be compared to a small computer having 6 GB of ROM. There are many more development boards from Texas Instruments, National Instruments etc. We can also use microcontrollers like 83C51, 83C52, 83S51, 83S52 from ATMEGA for Automation purpose. For using these ICs we need to connect some peripheral devices and some of the circuitry with it. These 8051 microcontrollers are widely used for domestic purposes.

But in this project we have decided to use Arduino UNO board as the controlling unit. Due to some advantages and cost issues UNO board is the best choice for our purpose. Whenever the sensor gives a specific signal the UNO board operates and give signal to a single channel relay module. The relay module then regulates the supply and the pump starts operating. Then the water level changes accordingly. This system will be discussed in details in later chapters.

1.4 LabVIEW BASED GRAPHICAL REPRESENTATION

For any kind of Industrial System there must be a special kind of system which can represent the Equipments graphically. All the quantities of the equipments should have a graphical or physical representation which will provide ease in operation. Someone always monitors the equipments from a remote location. For this purpose there should be any kind of HMI system.

A Human Machine Interface (HMI) is the user interface that connects an operator to the controller for an industrial system. Industrial control systems (ICS) are integrated hardware and software designed to monitor and control the operation of machinery and associated devices in industrial environments, including those that are designated critical infrastructure. An HMI includes electronic components for signalling and controlling automation systems.

Some HMIs also translate data from industrial control systems into human-readable visual representations of the systems. Through the HMI, an operator can see schematics of the systems and turn switches and pumps on or off, for example, or raise or lower temperatures. HMIs are usually deployed on Windows-based machines, communicating with programmable logic controllers (PLC) and other industrial controllers.

LabVIEW is a general purpose programming language with a vast selection of premade user interface widgets that can be interacted with by the user and from the programming side. So LabVIEW can be and is used extensively to create various forms of HMI.

In our project we are using LabVIEW as an HMI which can represent the system virtually. The tank levels can be shown in this software and the consecutive values of the tank water level will be displayed and stored in this software. It also shows the LED indicator level can also be shown in this software.

The purpose of using LabVIEW is not only using it as a Human Machine Interface, it can also be used as the control unit. For this we need to enter a simple logic into the software. This will easily replace the Arduino UNO board.

Description of LabVIEW software will be given in another chapter, where every point and detail will be covered.

1.5 PROBABLE BENEFITS OF THE PROJECT

Automation Technology and Rain water storage systems in such a high alert now a day can make money for you and your business:

No Manual Engagement

This system reduces human effort. Within such a busy schedule it is hardly possible to always look after the pump and tank levels. So it is having a market value.

Extended range

Unlike much of the equipment on the market, this Technology being simple can be extended any time as desired after installation.

Eliminate the need for Remote Controlling

Remote Controllers are expensive and high maintenance. If IoT is also merged there then it would be much more expensive.

Less maintenance and servicing

As this system works on itself so there is less chance of getting damaged through human interference. So less maintenance and servicing is required.

Reliability and Compatibility

All this components Ultrasonic Sensor Module, Arduino UNO, DC pump are all reliable equipments. These equipments are compatible with any kind of system and weather.

Water Level Display

Tank water level is displayed in a LED indication Panel as well as in LabVIEW software.

Precise System

Arduino UNO, Ultrasonic sensor module makes this system much more précised and accurate. In case UNO fails to operate LabVIEW operates and controls the entire system.

1.6 SALIENT OBJECTIVES OF THE PROJECT

Our system “Non Contact Water Level Monitoring for Rain Water Storage System Using Labview with Arduino & Ultrasonic Sensor” has several objectives—

- To operate the pump automatically according to tank level of the Over head tank and the underground reservoir.
- To harvest the rain water and utilize it in the water supply system of a domestic building.
- To show the water level of the tanks in the LabVIEW software.

To complete these objectives we have done our project in the following manner. At first we have focused on the Automation part of our system. Next we have planned to design the rain water filtration part of our system. Then we have made the structure of our system. Lastly we interfaced the system with LabVIEW software.

1.7 ORGANIZATION OF THE PROJECT REPORT

This project report is organized into several chapters including the chapter of introduction. Each chapter is different from the other and is described along with the necessary theory required to comprehend it.

Chapter 2

This chapter includes The LITERATURE REVIEW. This chapter deals with the data of the researchers and manufacturers who else already have done this project. This chapter also described how our project is related to their work and what the modifications we are going to do.

Chapter 3

This chapter is all about THEORY & HARDWARE. This chapter deals with the theory of Automation, Fluid level Measurement and sensors, Theory of control unit, Switching Relay and all about the pump. This chapter also compares same kind of components together and give reasons against choosing the components.

Chapter 4

This chapter describes the Programming Software where the Control unit is to be programmed. This chapter also deals with LabVIEW software. The detailed description, functions and working principle of this software is given here. Lastly the function of this software in our project is described. Rest of the softwares are also described here.

Chapter 5

This chapter deals with the Logic & Operations of our project work. Here the logic is written in detail. This also shows how the System operates. The algorithm of procedure is described here. The flow chart of operation is drawn here.

Chapter 6

This chapter concludes the cost estimation and work performed so far. The possible advantages and limitations in implementing this work are discussed. The future work that can be done in improving the current scenario is mentioned. The future potential along the lines of this work is also discussed.

References

CHAPTER-2

(LITERATURE REVIEW)

The reference [1] proposed Rain Water Storage, Collection, Purification and Utilization in a household, commercial or industrial water supply system. This system uses some filtration tank for purification of the rain water. The filtration Tank Consists of Activated Carbon Filter, Mixed Base and Acidic Filter for making the rain water almost dust and ion free. Then the rain water is circulated and used through normal water supply system of the building.

The project work in [2] represents the water tank depth sensor system design for measurement of water level using Arduino and LabVIEW software. Ultrasonic sensor is used to measure the water depth, and from that measurement it calculates how full the tank is. Depending on the sensor reading LabVIEW program sends the data to Arduino and switches ON the pump when the water level in the tank goes low and switches it OFF as soon as the water level reaches a predetermined level.

The Automation in Water Supply system in a building has been described in [3]. This work makes the use of Ultrasonic Sensor Module HC SR 04 and Arduino Uno for this purpose. There are two tanks---- Over Head Tank and Under Ground Reservoir. The rain water flowing from the roof of the building through the rain water pipe directly comes into the first tank having Activated Carbon Filter and sediment filter. From this tank filtered water comes to the Underground Reservoir under gravity.

For the further two tanks Over Head Tank and Under Ground Reservoir the automation system has been enabled. There will be two different ultrasonic sensors (HCSR-04) for measuring water level in two different tanks. There will be a pump which will automatically enable the flow of water from the underwater reservoir to the over head tank on the roof. There will be two conditions of two different ultrasonic sensors depending on which the pump will operate or not. The whole automation process will be controlled by Arduino-UNO.

The use of LabVIEW software for monitoring the water level in the tanks from the corresponding sensor data has been reported in [4]. The Input card of this software is connected to the sensor outputs and then they are calibrated accordingly. Thus the software shows the graphical presentation of the tank water levels.

A prototype system for a water supply in a domestic building has been demonstrated in [5]. In such a busy schedule of a man normal or manual operation of a domestic pump is not done properly. So this automation system reduces the human efforts and adds a high market value to this project.

CHAPTER-3

(THEORY & HARDWARE)

3.1. AUTOMATION

3.1.1. BASIC PRINCIPLE OF AUTOMATION

Automation system is mainly based on the theory of closed loop control [6]. Whenever there is an error in the output, the feedback controller regulates the input to get desired output from a specific system. In automation systems there should be a sensing element and a controller element. This is the basic requirements for converting a normal system into an automatic system. There can be more than one sensing elements and more than one controllers. The sensor senses and monitors the output and the controller regulates the operation depending on some pre-defined logic.

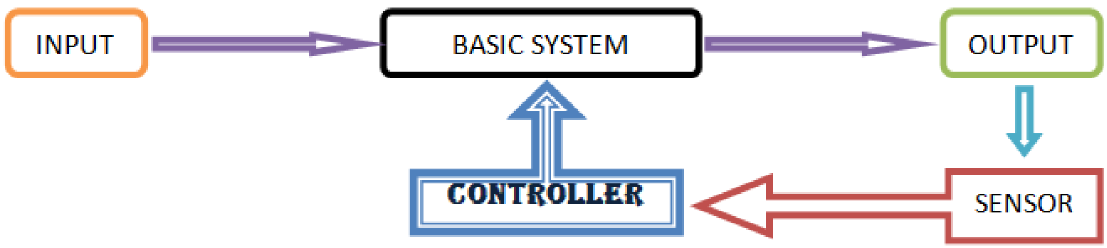


Figure 3.1. Basic Closed Loop Control

Every Automation system has two parts. The first one is the physical system or the hardware and the second one is the logic or programming part which is related with some specific software relevant to the controller. There must be some interface which can insert the logic in some form of coding into the controller. So the controller starts taking command from the sensing element and works according to the logic and the input data from the sensor.

3.1.2. CLASSIFICATIONS OF AUTOMATION SYSTEMS

Automation Systems can be classified according to different aspects. Automation systems can be divided into several categories according to the operation or application of the system. The system can also be sub divided into categories depending on the controlling unit used or the controller used. We are going to classify the system according to the field of application and then sub divide it into several categories depending on the controlling unit. These are—

3.1.2.1 . INDUSTRIAL AUTOMATION SYSTEMS

Automation systems are everywhere implemented in any industry. Starting from a simple conference room to any kind of assembly line automation system is employed. Now depending on the controlling unit these systems are sub classified as—

PLC BASED AUTOMATION SYSTEM

A programmable logic controller (PLC) or programmable controller is an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices, or any activity that requires high reliability, ease of programming and process fault diagnosis.

PLCs were first developed in the automobile manufacturing industry to provide flexible, rugged and easily programmable controllers to replace hard-wired relay logic systems. Since then, they have been widely adopted as high-reliability automation controllers suitable for harsh environments. A PLC is an example of a "hard" real-time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result.

DCS BASED AUTOMATION SYSTEM

Distributed Control Systems (DCS) is a computerized control system for a process or plant that consists of a large number of control loops, in which autonomous controllers are distributed throughout the system, but there is central operator supervisory control. DCS can be used to enhance reliability and reduce installation costs by localizing control functions near the process plant, with remote monitoring and supervision. These systems are used on large continuous process plants where high reliability and security is required.

AI BASED AUTOMATION SYSTEM

Artificial Intelligence (AI) is the newly developed technology which can handle a huge amount of data easily in an industry and Information Technology sector. It can easily trace out all the sensor data and sum them up easily in a single controlling unit. This system can automatically control the plant or industry assembly lines. This is a very reliable and précised system to be used as an automation system.

3.1.2.2. DOMESTIC AND COMMERCIAL AUTOMATION SYSTEMS

Now a day automation systems are implemented in domestic houses and commercial buildings. These types of automation systems are limited to a small extent. These systems are made of limited number of sensors and one or two controllers. These systems are relatively cheaper—

DEVELOPMENT BOARD BASED AUTOMATION SYSTEM

Some of the Automation Systems are implemented with some development board from Arduino Corporation, Raspberry and Texas Instruments etc. These are relatively cheaper and easy to interface with the sensors and rest of the system. These boards are having rugged construction and can be connected to system and supply easily. With some specific software these boards can be easily programmed and the programming is too easy to write in either embedded C or Python language.

Depending on the system requirement the controller is selected. Depending on the no of input and output devices the controller is selected. The controller is also selected depending on the requirement of sending data over cloud or Wifi connectivity. Sometimes the controller is also selected depending on whether the application is heavy or light. Sometimes it depends on the size of the RAM.

MICROCONTROLLER IC BASED AUTOMATION SYSTEM

For light applications this type of microcontrollers are used. For using these IC microcontrollers we need to develop an external circuit which will constitute the supply, peripheral devices and other connecting means. The microcontrollers will be described in later chapters.

3.1.3. ADVANTAGES & DISADVANTAGES OF AUTOMATION

The main advantages of automation are:

- Increased throughput or productivity.
- Improved quality or increased predictability of quality.
- Improved robustness (consistency), of processes or product.
- Reduced direct human labour costs and expenses.
- Can complete tasks where a high degree of accuracy is required.
- Replaces human operators in tasks that involve hard physical or monotonous work (e.g., using one forklift with a single driver instead of a team of multiple workers to lift a heavy object.)
- Reduces some occupational injuries (e.g., fewer strained backs from lifting heavy objects)

The main disadvantages of automation are:

- Possible security threats/vulnerability due to increased relative susceptibility for committing errors.
- Unpredictable or excessive development costs.
- High initial cost.
- Displaces workers due to job replacement.

3.1.4. AUTOMATION IMPLEMENTED IN OUR SYSTEM

Our system “Non Contact Water Level Monitoring for Rain Water Storage System Using Labview with Arduino & Ultrasonic Sensor” is mainly an automation system to be applied in a domestic or commercial building. The automation part is mainly focusing on the water circulation system of a building. There will be two tanks included in the automation part. The two tanks are Underground reservoir and Over head tank.

There is a control logic which is entered in the controller in form of programming. The main controller used in our case is Arduino UNO 3rd revolution. The sensors used here are Ultrasonic sensors. For two different tanks there are 2 different sensor modules. The Arduino UNO board is programmed with an embedded code compatible with the sensor modules and the board requirements. These programs are having an extension of .ino type.

The ultrasonic sensors are mounted on the top of the tanks facing on the top of the water level. The ultrasonic sensors will give a continuous reading of distance of water level from the top of the tank. According to the logic of the program the water levels of the tanks are calculated.

In our project work we are giving such logic that if the water level of the underground reservoir is more than 30% then only the automation system runs. Then rest of the system operation depends on the water level of the over head tank. Keeping the water level of the underground reservoir fixed if the water level in the over head tank becomes less than 20% the circuit starts operating.

The UNO board gives a high digital signal to the relay and the relay contacts switch from Normally open (NO) to Normally closed (NC). Then the pump is connected to the supply and starts operating. This pump is taking the water from the underground reservoir to the over head tank.

This process continues till the water level of the over head tank reaches a certain level. As per our design this level is set at 80%. When the level of 80% reaches the Uno board gives a digital signal to the relay and the relay contacts again switches from normally closed (NC) to normally open (NO). This causes the pump supply to be cut. The system stops working automatically.

We have attached an LED indication panel which is indicating the water level in the over head tank. In our system no manual intervention is needed. In our daily life it is not possible to check the tank water levels and operate the pump accordingly. In our system there is no chance of the pump being damaged due to dryness. This is because we have put such logic that the pump will never operate if the water level in the underground reservoir is less than 30%. So there is no chance of being dry.

This is the basic automation system implemented in our system. This system is cheaper as we are using Ultrasonic sensor modules and much cheaper Arduino UNO board. Further details of each of the component will be given in the later chapters.

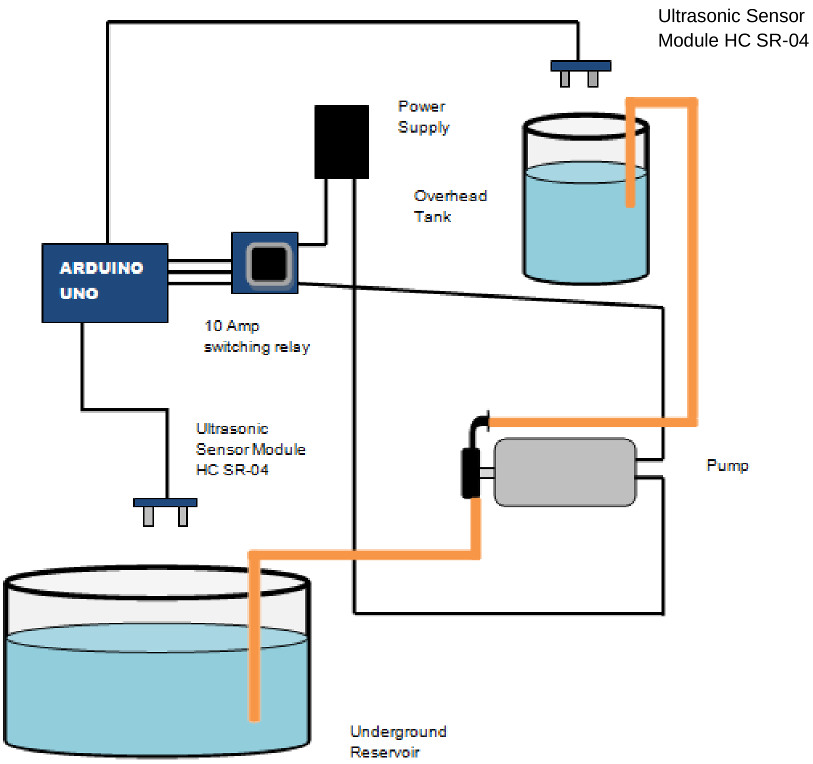


Figure 3.2. Automation System schematics

3.2. FLUID LEVEL MEASUREMENT METHODS

3.2.1. LIQUID LEVEL SENSORS [7]

Liquid level sensors are termed as the sensors used for detecting liquid levels or interfaces between liquids such as water and oil or solids and liquids. These sensors can also be defined as transducers or as integrated systems with instrumentation and control capabilities. This type of liquid level sensor is one of the most important sensors and plays a vital role in variety of industrial and consumer applications.

Industrial applications include liquid-level sensing in transport tanks, storage tanks and water treatment tanks, and also in the petrochemical industries for sensing liquids such as petrol, diesel and other fuels. Liquid level measurement is significant in household applications including electronic devices such as, water dispensers, water evaporators, steamers, monitoring system of boilers, heating systems, washing machines, steam irons, juice squeezers, automated-coffee machines, etc. Level sensors are designed for specific applications compared to general applications.

3.2.2 GENERAL CONSIDERATIONS FOR LIQUID LEVEL SENSOR SELECTION:

- Density and viscosity
- Vaporous mist and dust
- Chemical composition
- Interfaces and gradients
- Ambient temperature
- Humidity/moisture
- Process temperature
- Process pressure
- Regulated environment

For selection of liquid level sensors these parameters we need to consider. The sensors having problems with some of these factors are not compatible with those systems.

3.2.3. CLASSIFICATIONS OF LIQUID LEVEL SENSORS [8]

Liquid level sensors are of two types. These are—

3.2.3.1. POINT LEVEL MEASUREMENT

Point level measurement sensors are used for the purpose of marking a single liquid height or for presetting a level condition. Usually, this sensor works as a high alarm that measures the overflow conditions in tanks through liquid level sensors, or works as a marker to note down the low alarm conditions. The different types of sensors are given below:

- Float Sensor
- Capacitance Sensors
- Conductivity Probes
- Optical Sensors

FLOAT SENSOR

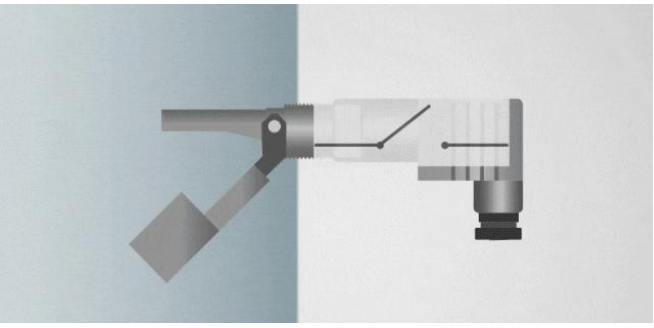


Figure 3.3. Float Sensor

Construction

A level measurement float system consists of a float, a sensor stem, a magnet, a reed switch and a weight suspended on the outside of the open tank. A scale is fixed on the outside of the tank, and the contents of the tank's level are indicated by the position of the weight along the scale.

Working Principle

Level detection of liquids is often done with a float-type liquid level switch. The float transfers on a mechanical arm or sliding pole and activates a switch when the level moves towards upward direction. Sometimes the float itself contains a small magnet that varies the state of a switch when the liquid level gets moving up and moves into the original position. This type of level sensor comes with many advantages like it is very simple, highly accurate, and best suitable for various products.

The Disadvantage of this sensor is that it requires various mechanical equipment especially the pressure vessels.

CAPACITANCE SENSOR

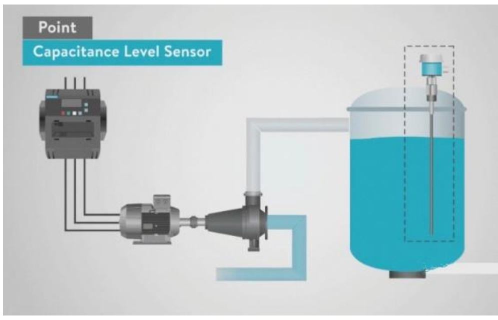


Figure 3.4. Capacitance Sensor

Principle of operation

The principle of capacitive level measurement is based on the change of capacitance. There are two plates in capacitive sensor: one plate acts as an insulated electrode and the other plate acts as a tank wall. The capacitance depends on the liquid level. An empty tank has low capacitance while a filled tank has higher capacitance. A simple capacitor consists of two electrode plates separated by a small thickness of an insulator such as solid, fluid, gas, or vacuum.

The Value of C depends on dielectric constant used, area of the plate and also on the distance between the plates.

$C=E\left(\frac{k \times A}{d}\right)$

Where: C = Capacitance in Pico farads (pF) , E = a constant known as the absolute permittivity of free space, K = Relative dielectric constant of the insulating material, A = Effective area of the conductors , d = Distance between the conductors

This change in capacitance can be measured by using an AC Bridge.

CONDUCTIVITY SENSOR

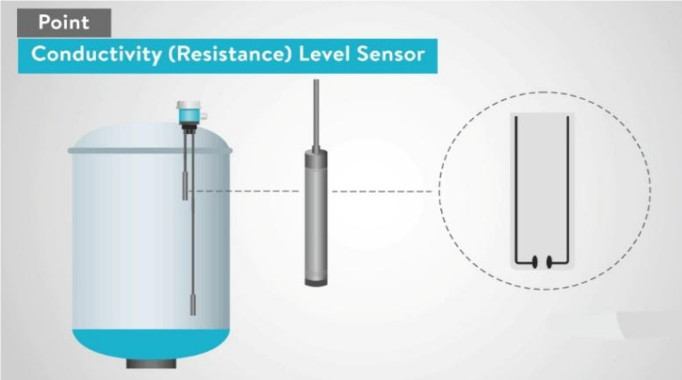


Figure 3.5. Conductivity Sensors

Construction and Working

This system is applicable for level measurement in conductive liquids. The conductivity of the insulated material can be varied if the probe is covered or not covered within the conductive product. There are two electrodes: one is used as a metal wall of the tank, and the other electrode is inserted into the tank. This principle can be explained with a practical application.

A Conductive probe is used as a liquid level indicator for measuring the level of electrically conductive products in a metal water tank, or other container, which can be obtained by means of a probe isolated from the container and a conductivity amplifier. When the product is not in connection with the probe, the electrical resistance is relatively high or infinite between the probe and the metal tank wall. If the level of the liquid rises completely between the probe and the tank wall, then the resistance gradually decreases.

This method is Advantageous as it is very simple, low cost and well suited for dual or multiple point control. The method is disadvantageous as the probe must not get contaminated with grease or any other deposits and has limited suitability for products of varying conductivity.

OPTICAL SENSORS

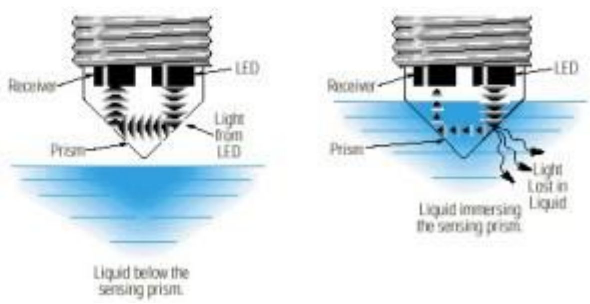


Figure 3.6. Optical Sensors

Level Detection Using Optical Sensors

The optical sensor consists of an infrared LED and a light receiver. The light emitted from the LED is directed towards a prism which forms the tip of the level sensor. If there is no liquid present in the tank, then the light from the LED is reflected within the prism and the receiver. When the liquid level raises and immerses the sensing prism, the light gets refracted out into the liquid, leaving little amount of light or no light to reach the receiver. Sensing this change, the receiver activates electronic switching within the level unit for operating external alarm or control circuit.

The advantages of this optical sensor are that they are not in contact with the process, and perform accurate measurements of small level movements. The disadvantages of these sensors include limited applicability and sometimes a high-cost of installation.

3.2.3.2. NON-CONTACT TYPE CONTINUOUS LEVL MEASUREMENT SENSORS

A continuous level sensor is most sophisticated and also provides liquid level monitoring of an entire system. This liquid level sensor is used to measure the fluid level within a specified range, moderately than at a one point, which produces an analog output and directly correlates to the level in the vessel. To create a liquid level management system, the output signal is interconnected to process a control loop and linked as a visual liquid level indicator. This measurement system consists of variety of sensors such as—

- Radar level sensor
- Ultrasonic Sensor

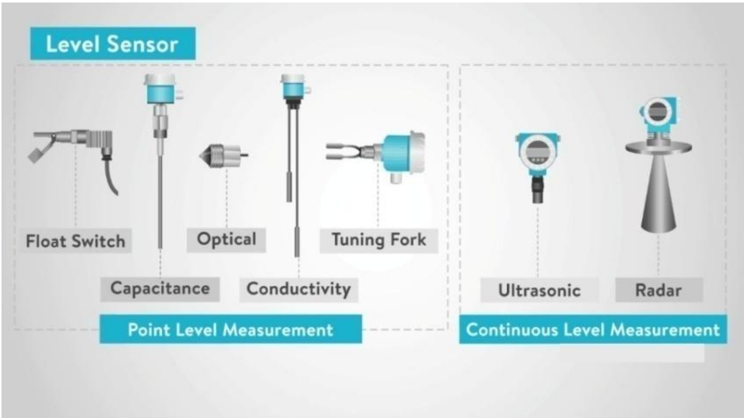


Figure 3.7. Fluid level Measuring Sensors

RADAR LEVEL SENSOR

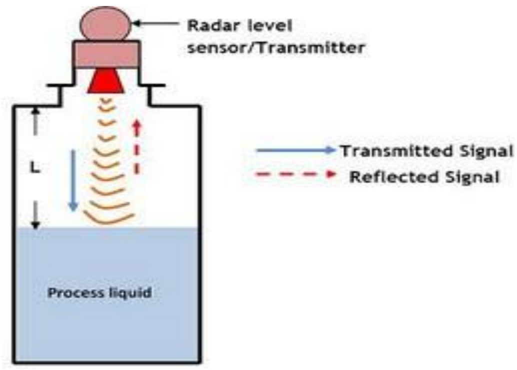


Figure 3.8. Radar Level Sensor

Construction and Working

The working of a radar level sensor is explained here to measure the level of liquid or solid. The radar signals are transmitted from the antenna placed at the top of the water tank or vessel as shown in the above figure. The radar signal gets reflected by the liquid surface and echo is carried out by the antenna.

By varying the signal, the frequency gets varied during the time of echo and the time of the signal transmission comparison. The difference of frequency is proportional to the distance of the liquid, and this statement is used to determine the accurate level of the liquid.

The advantages of this radar level sensor include high accuracy and least specificity as it can measure liquid levels in plastic tanks without establishing any contact with the liquid.

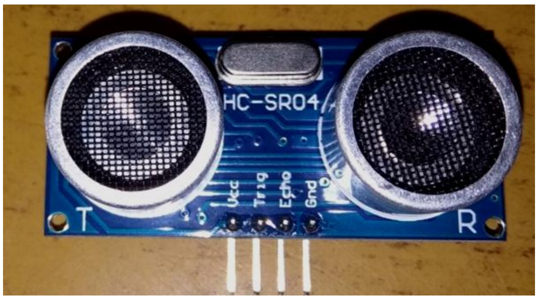
The disadvantages of this type of sensor include the cost, which is very high and the price increases with the increase in accuracy. Moreover, these sensors are very sensitive to the build up on the sensor surface.

Radar level sensors are widely used to measure the level of liquids as well as solids in storage tanks and tank terminals. These liquid level sensors operate at a wide range of temperature, pressure and various process conditions.

ULTRASONIC SENSOR (HC SR-04) MODULE

Description

The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package. It comes complete with ultrasonic transmitter and receiver modules.



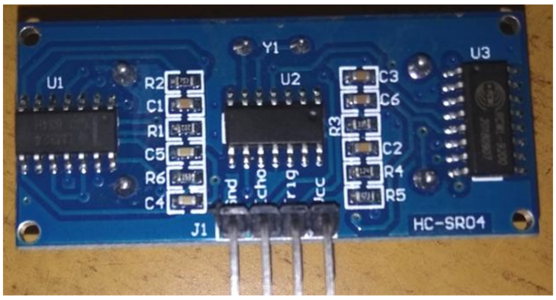


Figure 3.9. Ultrasonic Sensor Module HC SR-04

Features

Here's a list of some of the HC-SR04 ultrasonic sensor features and specs:

- Power Supply :+5V DC
- Quiescent Current : <2Ma
- Working Current: 15Ma
- Effectual Angle: <15°
- Ranging Distance : 2cm – 400 cm/1″ – 13ft
- Resolution : 0.3 cm
- Measuring Angle: 30 degree
- Trigger Input Pulse width: 10Us
- Dimension: 45mm x 20mm x 15mm

How does it Work?

The ultrasonic sensor uses sonar to determine the distance to an object. Here's what happens:

- The transmitter (trig pin) sends a signal: a high-frequency sound.
- When the signal finds an object, it is reflected.
- The transmitter (echo pin) receives it.

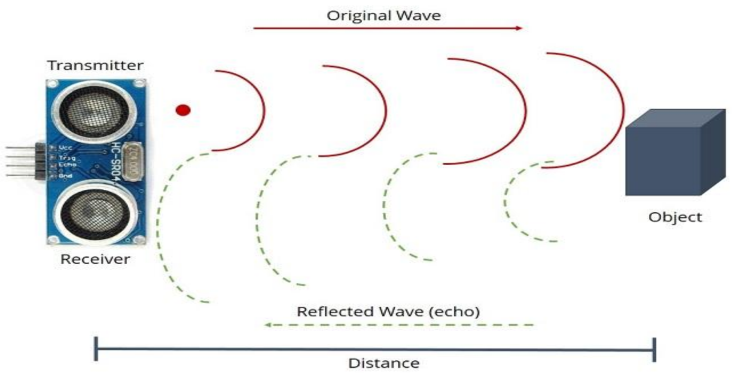


Figure 3.10. HC SR-04 Working Principle

The **HC-SR04 Ultrasonic (US) sensor** is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The sensor works with the simple high school formula that—

Distance = Speed × Time

The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module.

The time between the transmission and reception of the signal allows us to calculate the distance to an object. This is possible because we know the sound's velocity in the air.

HC-SR04 Ultrasonic Sensor Pin-out

Table-3.1. HC SR-04 Pin Description

Pin Number	Pin Name	Description
1	V_{cc}	The V_{cc} pin powers the sensor, typically with +5V
2	Trigger	Trigger pin is an Input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave.
3	Echo	Echo pin is an Output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor.
4	Ground	This pin is connected to the Ground of the system.

Calculation of distance

The speed at which sound travels is 340 meters per second.

This means sound takes 29.412 microseconds to travel 1 centimetre of distance.

So the total distance travelled is the multiplication of (Speed of sound) x (The time elapsed between the transmission of a wave and the receiving of the reflected wave).

The distance of the object is = the total distance travelled/2. [Because the wave travels twice the path]

So the distance in centimetres becomes = $\frac{\text{(Delay in microseconds/2)}}{29.412}$

How to use the HC-SR04 Ultrasonic Sensor

HC-SR04 sensor is commonly used with both microcontroller and microprocessor platforms like Arduino, ARM, PIC, Raspberry Pie etc. The following guide is universally since it has to be followed irrespective of the type of computational device used.

Power the Sensor using a regulated +5V through the Vcc ad Ground pins of the sensor. The current consumed by the sensor is less than 15mA and hence can be directly powered by the on board 5V pins (If available). The Trigger and the Echo pins are both I/O pins and hence they can be connected to I/O pins of the microcontroller. To start the measurement, the trigger pin has to be made high for 10uS and then turned off. This action will trigger an ultrasonic wave at frequency of 40Hz from the transmitter and the receiver will wait for the wave to return. Once the wave is returned after it getting reflected by any object the Echo pin goes high for a particular amount of time which will be equal to the time taken for the wave to return back to the sensor.

The amount of time during which the Echo pin stays high is measured by the MCU/MPU as it gives the information about the time taken for the wave to return back to the Sensor. Using this information the distance is measured as explained in the above heading.

Reasons for Selecting HC SR-04 Module for our purpose

Advantages of Ultrasonic sensor

- It has sensing capability to sense all the material types.
- This sensor is not affected due to atmospheric dust, rain, snow etc.
- It can work in any adverse conditions.
- It has higher sensing distance (in centimetres and inches) compare to conductive /capacitive sensor types.
- It provides good readings in sensing large sized objects with hard surfaces.

Disadvantages of Ultrasonic sensor

- It is very sensitive to variation in the temperature.
- It has more difficulties in reading reflections from soft, curved, thin and small objects.

These are the reasons why we have chosen Ultrasonic Sensor module HC SR-04 for our project.

Applications

- Used to avoid and detect obstacles with robots like biped robot, obstacle avoider robot, path finding robot etc.
- Used to measure the distance within a wide range of 2cm to 400cm.
- Can be used to map the objects surrounding the sensor by rotating it.
- Depth of certain places like wells, pits etc can be measured since the waves can penetrate through water.

3.3. CONTROL UNIT

3.3.1. WHAT IS CONTROL UNIT

In any kind of automatic system there must be a unit which will control every operation of the whole system. This unit always works as the brain of the system. It always takes input from some specific sensing elements and may be from some external & peripheral devices. This unit thinks and analyze the data according to some specific command set previously. This unit lastly give some commands based on the result of analysis and the actuating devices act accordingly. Without any kind of controlling unit any autonomous system cannot run.

In this project work Microcontroller based control unit has been utilized to implement the whole automatic control operation.

3.3.1.1. MICROCONTROLLER IC

There are a lot of microcontrollers those can be used for automation purpose. The most popular micro controller ICs are—

Atmel

- AT89 series (Intel 8051 architecture)
- AT90, ATtiny, ATmega, ATxmega series (AVR architecture) (Atmel Norway design)
- AT91SAM (ARM architecture)
- AVR32 (32-bit AVR architecture) (Atmel Norway design)
- MARC4

Intel

- 8-bit
  - MCS-48 8048 family – also incl. 8035, 8038, 8039, 8040, 8X42, 8X49, 8050; X=0 or 7
  - MCS-51 8051 family – also incl. 8X31, 8X32, 8X52; X=0, 3, 7 or 9
  - MCS-151 High performance 8051 instruction set/binary compatible family
- 8/16-bit/32-bit
  - MCS-251 32-bit ALU with 1/8/16/32-bit CISC instruction set and 24-bit external address space (16-bit wide segmented). Fully binary compatible to the 8051 8-bit family.

- 16-bit
    - MCS-96 (8096 family – also incl. 8061)
    - Intel MCS-296

3.3.1.2. RASPBERRY PI

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote teaching of basic computer science in schools and in developing countries. The original model became far more popular than anticipated, selling outside its target market for uses such as robotics. It now is widely used even in research projects, such as for weather monitoring because of its low cost and portability. It does not include peripherals (such as keyboards and mice) or cases. However, some accessories have been included in several official and unofficial bundles.

The organisation behind the Raspberry Pi consists of two arms. The first two models were developed by the Raspberry Pi Foundation. After the Pi Model B was released, the Foundation set up Raspberry Pi Trading, with Eben Upton as CEO, to develop the third model, the B+. Raspberry Pi Trading is responsible for developing the technology while the Foundation is an educational charity to promote the teaching of basic computer science in schools and in developing countries.

According to the Raspberry Pi Foundation, more than 5 million Raspberry Pis were sold by February 2015, making it the best-selling British computer. By November 2016 they had sold 11 million units, and 12.5 million by March 2017, making it the third best-selling "general purpose computer". In July 2017, sales reached nearly 15 million, climbing to 19 million in March 2018. By December 2019, a total of 30 million devices had been sold.

Most Pis are made in a Sony factory in Pencoed, Wales, while others are made in China and Japan.

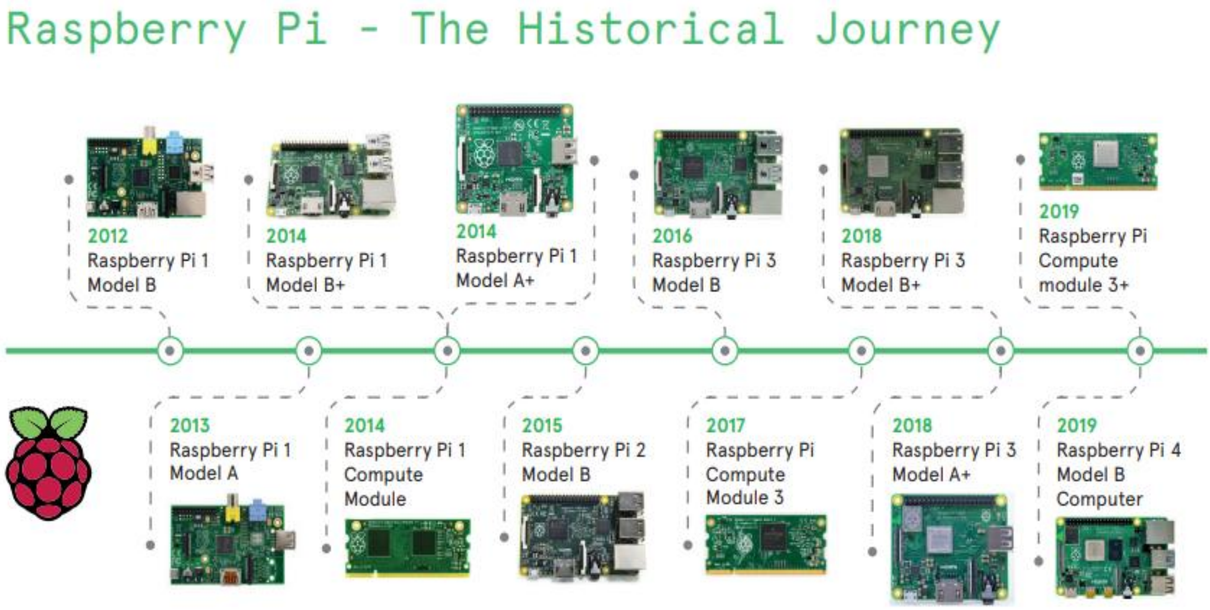


Figure 3.11. Hierarchy of Raspberry Pi

There are some more development boards from Texas Instruments, National Instrument etc.

3.3.1.3. ARDUINO UNO BOARD [9]

For our purpose we have chosen Arduino UNO as the control unit. Arduino UNO is chosen as because the system can be easily interfaced with the system without using any kind of peripheral device. This development board is much cheaper, easy to access, readily available in the market. This board is much simple in construction. The board is much stable and has an inbuilt code burner with it. The Integrated Development environment (IDE) is free and is easy to access. The code can be easily written and checked thoroughly in this software. For this reasons we have chosen Arduino UNO board for our purpose.

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

The word “uno” means “one” in Italian and was chosen to mark the initial release of Arduino Software. The Uno board is the first in a series of USB-based Arduino boards; it and version 1.0 of the Arduino IDE were the reference versions of Arduino, which have now evolved to newer releases. The Atmega328 on the board comes pre-programmed with a boot loader that allows uploading new code to it without the use of an external hardware programmer.

While the Uno communicates using the original STK500 protocol, it differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Technical specifications

- Microcontroller: Microchip Atmega328P
- Operating Voltage: 5 Volts
- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 can provide PWM output)

- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by boot loader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Length: 68.6 mm
- Width: 53.4 mm
- Weight: 25 g

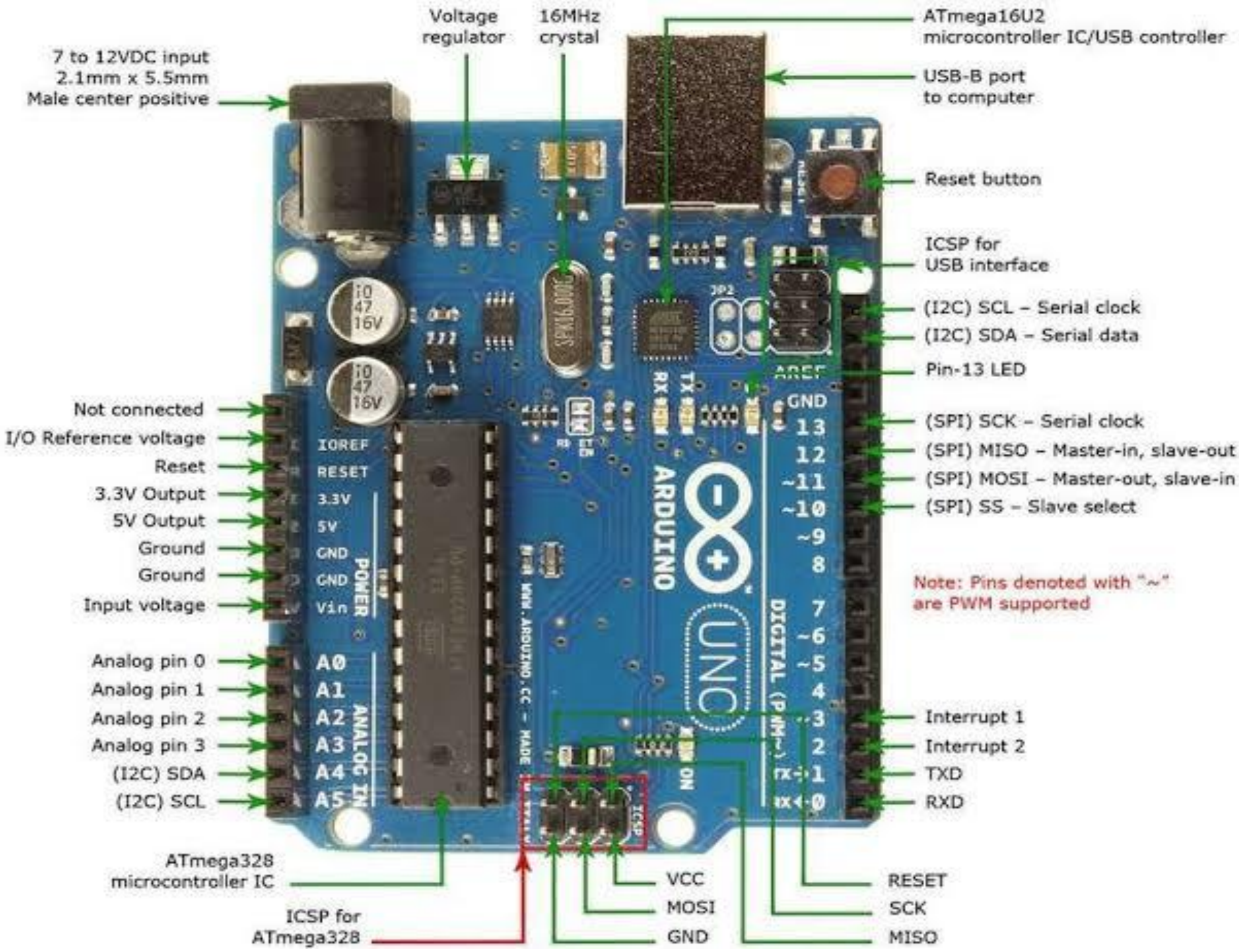


Figure 3.12. Arduino UNO Board with pins labelled

General pin functions

- **LED**: There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it is off.
- **V_{IN}**: The input voltage to the Arduino/Genuino board when it is using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You

can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

- **5V**: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- **3.3 V**: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND**: Ground pins.
- **IOREF**: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source, or enable voltage translators on the outputs to work with the 5V or 3.3V.
- **Reset**: Typically used to add a reset button to shields that block the one on the board.

Special pin functions

Each of the 14 digital pins and 6 analog pins on the Uno can be used as an input or output, under software control (using pinMode(), digitalWrite(), and digitalRead() functions). They operate at 5 volts. Each pin can provide or receive 20 mA as the recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50K ohm. A maximum of 40mA must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller. The Uno has 6 analog inputs, labeled A0 through A5; each provides 10 bits of resolution (i.e. 1024 different values). By default, they measure from ground to 5 volts, though it is possible to change the upper end of the range using the AREF pin and the analogReference() function.

In addition, some pins have specialized functions:

- **Serial** / UART: pins 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 ATmega8U2 USB-to-TTL serial chip.
- **External interrupts**: pins 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 (pulse-width modulation): pins 3, 5, 6, 9, 10, and 11. Can provide 8-bit PWM output with the analogWrite() function.
- SPI (Serial Peripheral Interface): pins 10 (SS), 11 (MOSI), 12 (MISO), and 13 (SCK). These pins support SPI communication using the SPI library.

- **TWI** (two-wire interface) / I²C: pin SDA (A4) and pin SCL (A5). Support TWI communication using the Wire library.
- **AREF** (analog reference): Reference voltage for the analog inputs.

Communication

The Arduino/Genuino Uno has a number of facilities for communicating with a computer, another Arduino/Genuino board, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The 16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows serial communication on any of the Uno's digital pins.

Automatic (software) reset

Rather than requiring a physical press of the reset button before an upload, the Arduino/Genuino Uno board is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nano farad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip.

This setup has other implications. When the Uno is connected to a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the boot loader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened.

Advantages and Disadvantages of Arduino UNO

It is very good for carrying out a specific project you may have in mind, especially if you can find the right shield but it doesn't teach you much about microcontrollers and the AVR in particular. For quick results, it is great but it won't help you learn microelectronics or programming.

Advantages

- Not much knowledge required to get started
- Fairly low cost, depending on shields you need

- Lots of sketches and shields available
- No external programmer or power supply needed

Disadvantages

- No understanding of the AVR microcontroller
- Sketches and shields can be difficult to modify
- No debugger included for checking scripts
- You get no experience of C or professional development tools

For these reasons we have chosen Arduino UNO board.

3.4. SWITCHING RELAY

3.4.1. WHAT IS SWITCHING RELAY

In electrical systems, a static relay is a type of relay, an electrically operated switch, which has no moving parts. Static relays are contrasted with electromechanical relays, which use moving parts to create a switching action. Both types of relay control electrical circuits through a switch that is open or closed depending upon an electrical input.

Static relays have been designed to perform similar functions with the use of electronic circuit control as an electromechanical relay performs with the use of moving parts or elements. For example, in an induction type electromechanical relay, the time delay for the switching action can be adjusted by adjusting the distance travelled by the disc, whereas in a static relay the delay can be set by adjusting the value of the resistance in an R-C time delay circuit.

Static relays may be based on analog solid state circuits, digital logic circuits, or microprocessor-based designs. Some authors use the term "static relay" to refer only to solid state relays.

3.4.2. STRUCTURE OF A STATIC RELAY

A static relay consists of—

- An input circuit that measures the value of desired property
- A comparator circuit that compares the measured value to a preset threshold
- An optional time delay circuit that controls the timing of the switch action after the input has reached the threshold
- A power supply for the static relay circuits

For example, an over current protective relay may have an AC to DC power supply for the input circuit, a level detector circuit and an RC time delay circuit. While early comparators used discrete transistor circuits, modern designs use operational amplifiers.

3.4.3. 5V SWITCHING STATIC RELAY

3.4.3.1. Features

The features of 1-Channel Relay module are as follow:

- Good in safety. In power system and high voltage system, the lower current can control the higher one.
- Single channel high voltage system output, meeting the needs of single channel control.
- Wide range of controllable voltage.
- Being able to control high load current, this can reach up to 250V, 10A.
- With a normally-open (NO) contact and a normally-closed (NC) contacts.

- Model Number: JQC-3FF-S-Z
- Manufacturer: Tongling

3.4.3.2. Interface specifications

- The output contacts of a relay (including NO, NC, and the common port) works as a SPDT – Single Pole Double Throw switch. Its operating principle is as follow: VCC----5V
- GND----for ground
- IN connects to the control valve which output 3V-5V
- Output contacts: connect to applications.

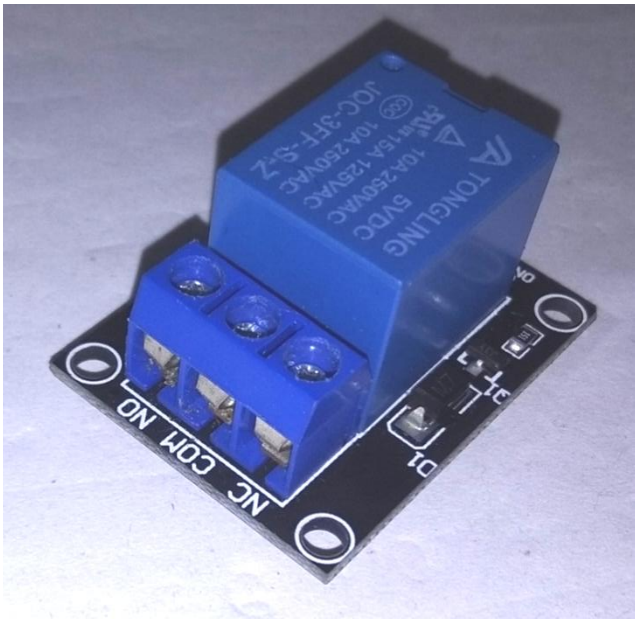


Figure 3.13. Switching Relay module JQC-3FF-S-Z

3.4.3.3 Advantages of Static Relay over other Switches

The advantages of a relay lie in its lower inertia of the moving, stability, long-term reliability and small volume. It is widely adopted in devices of power protection, automation technology, sport, remote control, reconnaissance and communication, as well as in devices of electro-mechanics and power electronics. Generally speaking, a relay contains an induction part which can reflect input variable like current, voltage, power, resistance, frequency, temperature, pressure, speed and light etc. It also contains an actuator module (output) which can energize or de-energize the connection of controlled circuit. There is an intermediary part between input part and output part that is used to coupling and isolate input current, as well as actuate the output. When the rated value of input (voltage, current and temperature etc.) is above the critical value, the controlled output circuit of relay will be energized or de-energized.

3.5. PUMP

3.5.1. WHAT IS PUMP?

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps.

Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, and come in many sizes, from microscopic for use in medical applications, to large industrial pumps.

Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers and other components of heating, ventilation and air conditioning systems. When a casing contains only one revolving impeller, it is called a single-stage pump. When a casing contains two or more revolving impellers, it is called a double- or multi-stage pump.

3.5.2. DESCRIPTION OF THE PUMP IN OUR PROJECT WORK

We have chosen a 12 Volt DC centrifugal pump for our purpose. Here we are considering a centrifugal pump as because our system design is suitable for using a centrifugal pump. A centrifugal pump is cheaper in cost and readily available in market. This pump is smaller in size and can be easily mounted on any system.

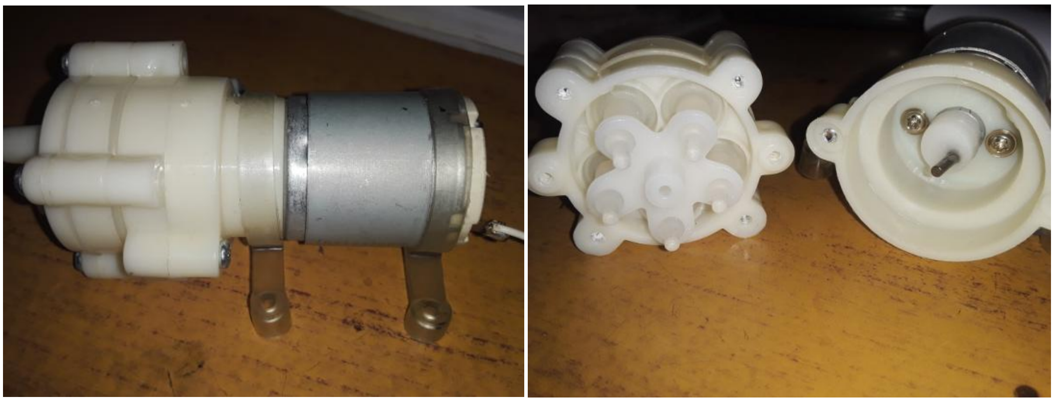


Figure 3.14. 12 Volt DC centrifugal pump for our purpose

Specifications

Input Voltage: 4.5-12V DC,

Permanent Magnet DC Motor

Power: 3W

Maximum Height: 0.4-2.0M

Maximum flow rate: 200L/H

Size: 38 x 34 x 27 mm

Working Principle

In this pump a 12 volt DC motor is used with a displaced shaft. This helps in incomplete rotation of the flower shaped structure which creates an intake pressure in 5 different water shackles. Thus the suction is completed. Then after on rotation the shackles get compressed and throw the water through the outlet.

Applications

- Miniature water supply models
- Water Vending Machines
- Mini water Fountain

CHAPTER-4

(SOFTWARES USED)

Hardwares and software are the main parts of a project work. Hardware is something that can be directly observed from outside. These components can be easily specified in the structure of the system. We need to use some of the software for programming of the controllers and for several interfaces. We have used several softwares for fulfilling our purpose.

4.1. PROGRAMMING SOFTWARE

For programming Arduino UNO board the compatible software used everywhere is Arduino IDE. We have used the Arduino IDE 1.8.11 for writing, compiling & burning the program [10]

4.1.1. INTEGRATED DEVELOPMENT ENVIRONMENT

An integrated development environment (IDE) is a software application that provides comprehensive facilities to computer programmers for software development. An IDE normally consists of at least a source code editor, build automation tools and a debugger. Some IDEs, such as NetBeans and Eclipse, contain the necessary compiler, interpreter, or both; others, such as SharpDevelop and Lazarus, do not.

4.1.2. ARDUINO IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, MacOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd 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, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU tool chain, 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.

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

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

Sketch Editing Tools

Arduino IDE is mainly used to sketch new files for programming Arduino UNO in a kind of embedded C language.

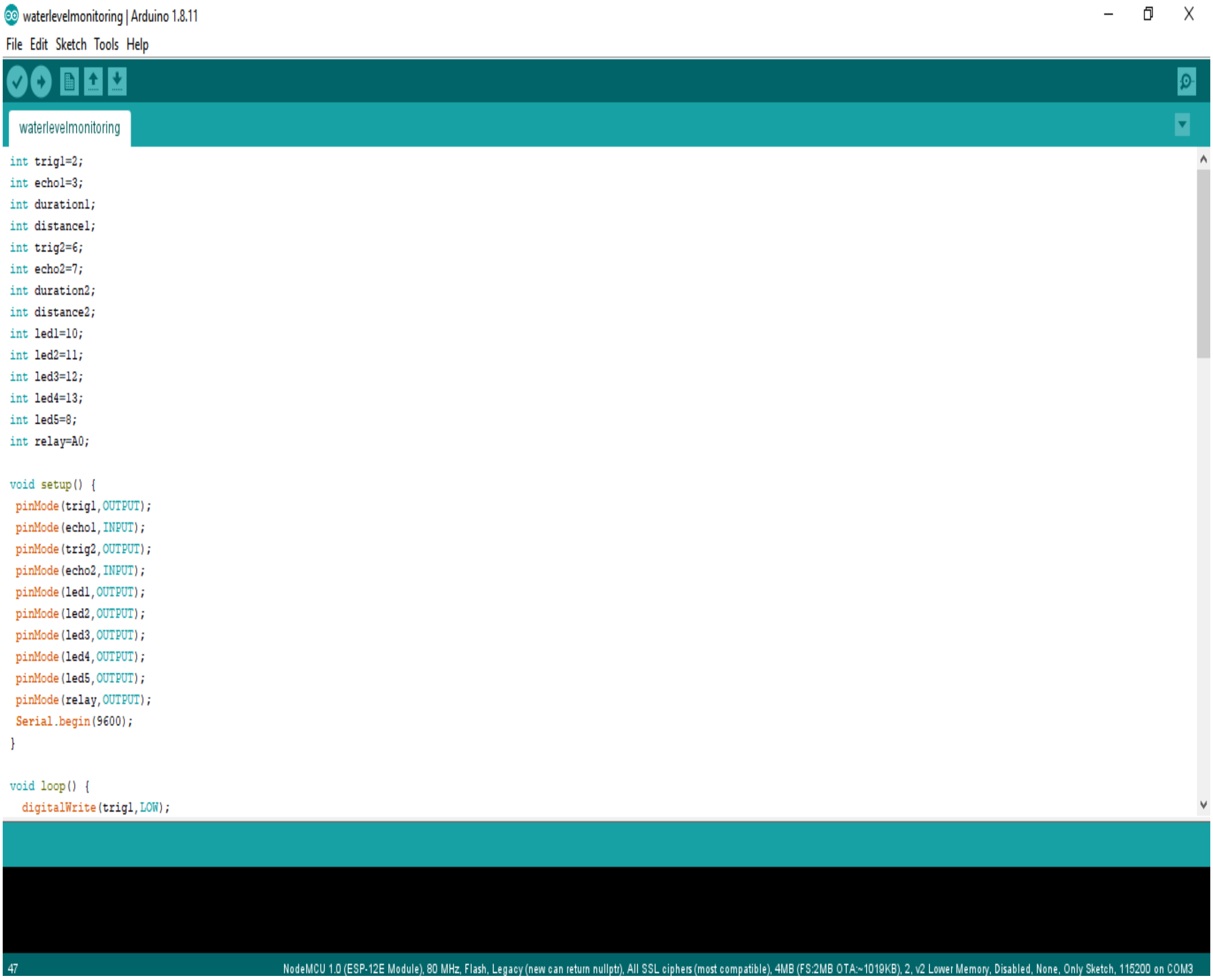


Figure 4.1. Arduino IDE 1.8.11 Interface

This one is the interface of the Arduino IDE software. Here in this interface we need to write the program.

Libraries

In this software we get different libraries to be used with different compatible boards and different sensors to be connected with the Arduino board. For different kind of development boards and shields there are different libraries. For Wifi module there are several different libraries, for servo motor there are several different libraries, for different Arduino Shields there are several different libraries.

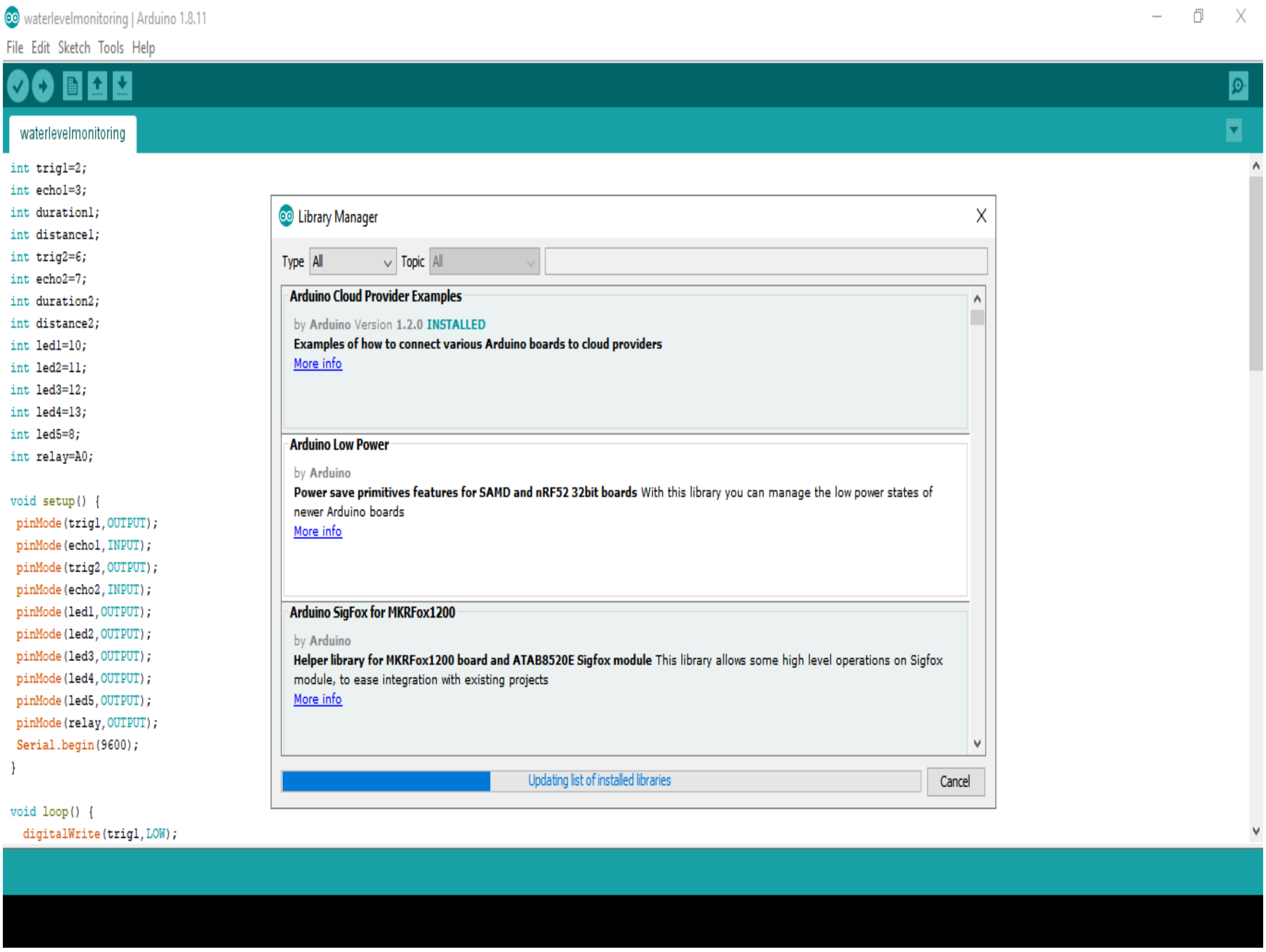


Figure 4.2. Libraries in Arduino IDE

Serial Monitor

Serial Monitor is a special feature which is used to show values or output variables back to the user in an understandable language. Sometimes it also returns some commands for Wifi modules where it shows the connections with the server. In our case it returns the value of the distance from the top of the tank to the tank water level. For any kind of Wifi connectivity serial monitor shows the connection with the DHCP. If required it may show the time stamps at which the values are retrieved.

Programmer Functions

This software is having such an algorithm that it works on two different functions void setup() and void loop(). This will be described later.

Burn Bootloader

Sometimes some of the boards and simulation softwares might not run with a normal function. Then we need to write the function with Bootloader directly from Arduino IDE. This tool is directly available in the menu bar of the software.

Sketches Management

For organization and storing of sketches this software makes separate folders for each of the sketches in the system. All these folders are placed in another folder named Arduino into a specific inbuilt library such as Documents. The separate folders of sketches are named the same as that of the sketches.

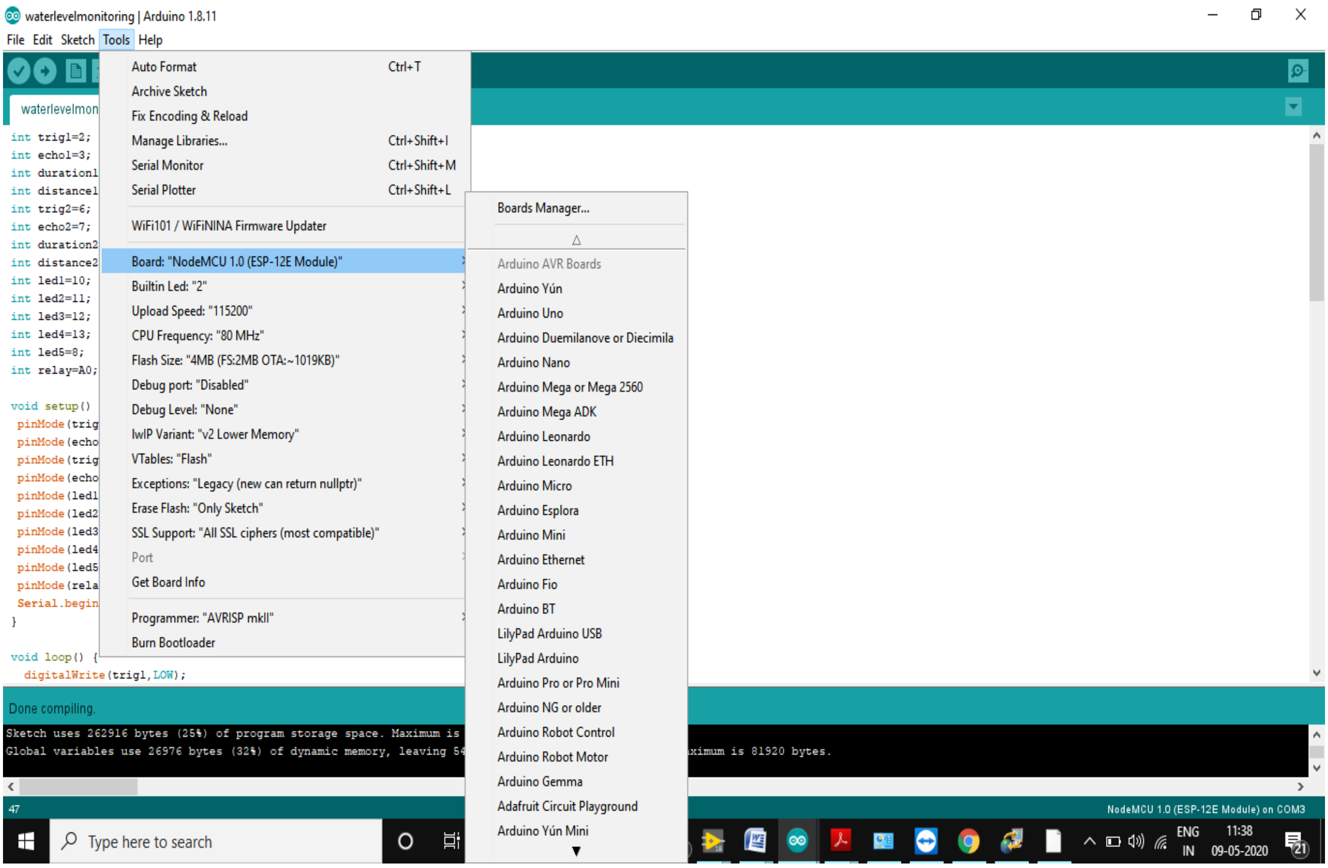


Figure 4.3. Boards Manager in Arduino IDE

Auto Format

This software can easily auto format a code and makes the code easily understandable for the programmer. This will show the punctuations required in the code. The parenthesis is indicated here which makes it more users friendly. The users need to scroll for finding out the ending or starting of a parenthesis. The auto format feature is a very useful feature of this software.

Fix Encoding & Reload

In this software we get an inbuilt compiler which will check every bit of the code and tells the user if there is any fault existing in the code or not. If there is any kind of fault in the code the compiler will show it in the lower part of the software. This will directly indicate the line of the code where the fault is done.

Board Selection & Management

For burning a code into a specific development board we need to select the board in the Boards manager. We need to set some of the band width, baud rate, upload speed, debugger, programmer, CPU frequency, flash size, debug port etc.

Port Menu

Port selection is one of the most important features in Arduino IDE. There can be more than one port connected to the system and we need to load different programs on different boards then we must have to select the correct port for loading the program into the correct board. If required we must identify which port is connected to which board from device manager in control panel.

4.1.3 ARDUINO UNO CODE FOR OUR PROJECT WORK

```
int trig1=2;
int echo1=3;
int duration1;
int distance1;
int trig2=6;
int echo2=7;
int duration2;
int distance2;
int led1=10;
int led2=11;
int led3=12;
int led4=13;
int led5=8;
int relay=A0;
```

Declaration Part

In this part all the variables of the code are assumed and defined. Here in our case all the variables give integer values. So for defining these variables we have used the datatype int. The corresponding Arduino pin numbers are written while declaring the variables. Here in our case 9 digital pins (2, 3, 6, 7, 8, 10, 11, 12, 13) and an Analog pin is used (A0).

```
void setup() {
 pinMode(trig1,OUTPUT);
 pinMode(echo1,INPUT);
 pinMode(trig2,OUTPUT);
 pinMode(echo2,INPUT);
 pinMode(led1,OUTPUT);
 pinMode(led2,OUTPUT);
 pinMode(led3,OUTPUT);
 pinMode(led4,OUTPUT);
 pinMode(led5,OUTPUT);
 pinMode(relay,OUTPUT);
 Serial.begin(9600);
}
```

Void Setup

In this section all the input variables and output variables are declared. The syntax for declaration of these variables is— **pinMode(variable, Mode).**

Here the mode can either be INPUT or OUTPUT. Here we have declared all the input and output variables.

Here we need to declare **Serial.begin(Baud rate)** if we need to show any kind of variable in the serial monitor then we should mention this command with the exact baud rate of the port used here.

```
void loop() {
  digitalWrite(trig1,LOW);
  delayMicroseconds(2);
  digitalWrite(trig1,HIGH);
  delayMicroseconds(10);
  digitalWrite(trig1,LOW);
  duration1 = pulseIn(echo1,HIGH);
  distance1 = (duration1/29.1)/2;
  Serial.print("DISTANCE1: ");
  Serial.println(distance1);

  digitalWrite(trig2,LOW);
  delayMicroseconds(2);
  digitalWrite(trig2,HIGH);
  delayMicroseconds(10);
  digitalWrite(trig2,LOW);
  duration2 = pulseIn(echo2,HIGH);
  distance2 = (duration2/29.1)/2;
  Serial.print("DISTANCE2: ");
  Serial.println(distance2);
```

Void Loop

In this section the main code is written. The main programming logic of the code is written in this section.

In our case we have calculated the distance from the data given by the ultrasonic sensor. At first the trigger pin of the HC SR-04 module is given a low pulse then after 2 microseconds it is triggered with a high value and the ultrasonic module transmitted an ultrasonic wave continuously for 10 microseconds. Then after some time the ultrasonic module receives the reflected wave and the echo pin is tested high with a special function pulseIn. In this case if the function value shows value high then the time duration of the transmission and reception of the ultrasonic sensor module.

Now to calculate the distance of the water level from the sensor module we used the formula as mentioned before. This distance is ultimately shown in the serial monitor with the function Serial.println(). The same procedure is followed here for the 2nd sensor module. Here the subscript 1 stands for the Underground reservoir and the subscript 2 stands for the over head tank in the system.

```
if(distance1<=17.4)   //underground reservoir

           {
            if(distance2>=16.3)
            {
              digitalWrite(led1,HIGH);
              digitalWrite(led2,LOW);
              digitalWrite(led3,LOW);
              digitalWrite(led4,LOW);
              digitalWrite(led5,LOW);
              digitalWrite(relay,HIGH);
            }
            if(distance2>=13.6 && distance2<16.3)
            {
              digitalWrite(led1,HIGH);
              digitalWrite(led2,HIGH);
              digitalWrite(led3,LOW);
              digitalWrite(led4,LOW);
              digitalWrite(led5,LOW);
              digitalWrite(relay,HIGH);
            }
            if(distance2>=10.9 && distance2<13.6)
            {
              digitalWrite(led1,HIGH);
              digitalWrite(led2,HIGH);
              digitalWrite(led3,HIGH);
              digitalWrite(led4,LOW);
              digitalWrite(led5,LOW);
              digitalWrite(relay,HIGH);
            }
            if(distance2>=8.2 && distance2<10.9)
            {
              digitalWrite(led1,HIGH);
              digitalWrite(led2,HIGH);
              digitalWrite(led3,HIGH);
              digitalWrite(led4,HIGH);
              digitalWrite(led5,LOW);
              digitalWrite(relay,HIGH);
            }
```

Here the condition part is written.

We have taken such a height of the underground reservoir and the distance of the sensor head from the top of the tank so this conditions will match correspondingly.

The height of the Underground reservoir we have used is 19.14 cm. The distance of the sensor from the top of the tank is 4 cm. As per our logic if the underground reservoir level is more than 30%, then the pump will operate according to the condition of sensor 2 in the over head tank. In such a condition the distance of the sensor form the water level is –

Distance1= 4 + 19.14*(100-30) % = 17.4 cm. So above 30% means the distance1 < 17.4 cm.

Now keeping this condition fixed if the distance2 is greater than 16.3 cm means over head tank level is less than 20% then the last LED glows and rest remains off. In this case the pump starts operating. Here the over head tank height is taken 13 cm.

As the level of the over head tank increases the corresponding LEDs of 40, 60, 80 and more than 80 % level glows. The pump keeps operating up to the level reaches more than 80% value.

```
        if(distance2<8.2)
        {
          digitalWrite(led1,HIGH);
          digitalWrite(led2,HIGH);
          digitalWrite(led3,HIGH);
          digitalWrite(led4,HIGH);
          digitalWrite(led5,HIGH);
          digitalWrite(relay,LOW);
        }
      }
      if(distance1>17.4)
      {
        digitalWrite(relay,LOW);
      }
    }
```

In this case as the tank level becomes more than 80% the pump is made of and all the LEDs are glowing.

The last part shows that if the underground reservoir level becomes less than 30% the pump is made off.

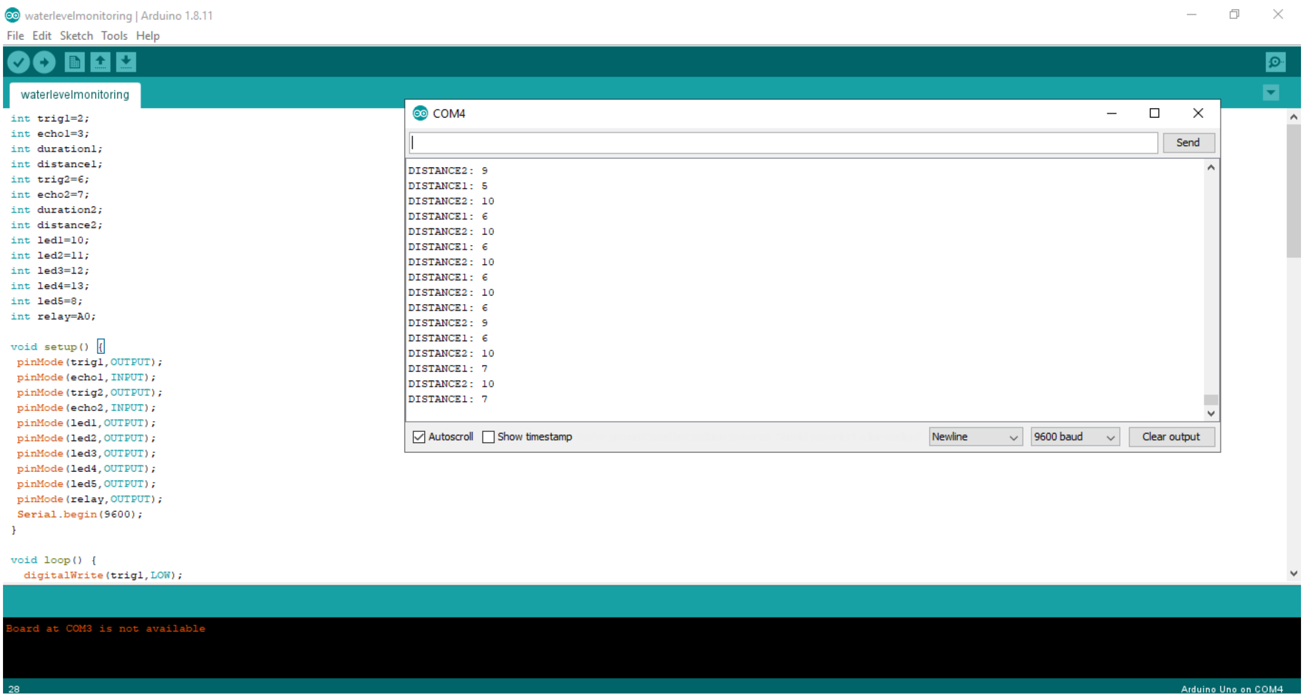


Figure 4.4. Serial Monitor in Arduino IDE

Here the distance values in our project are shown in the serial monitor. Rest of the operation will be explained and shown in the later chapters.

4.2. HUMAN MACHINE INTERFACE SOFTWARE (LabVIEW)

For Graphical representation and display of the Water levels in the tank we have used the version 5.0 of LabVIEW software. This is a Human Machine Interface Software [11-13].

4.2.1. LabVIEW

LabVIEW stands for Laboratory Virtual Instrument Engineering Workbench. It is a system-design platform and development environment for a visual programming language from National Instruments. LabVIEW is commonly used for data acquisition, instrument control, and industrial automation on a variety of operating systems (OSs), including Microsoft Windows, various versions of Unix, Linux, and macOS.

The latest versions of LabVIEW are LabVIEW 2019 SP1 and LabVIEW NXG 4.0, released in November 2019. NI released the free for non-commercial use LabVIEW and LabVIEW NXG Community editions on April 28th, 2020.

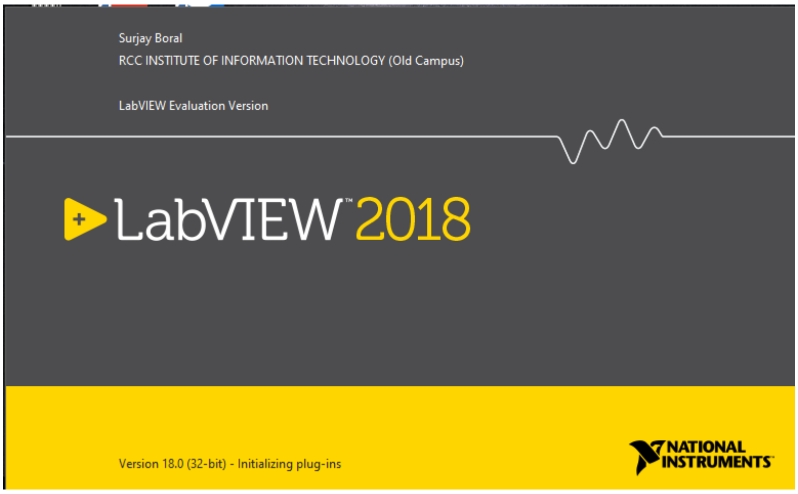


Figure 4.5. LabVIEW 2018

Dataflow Programming

The programming paradigm used in LabVIEW, sometimes called G, is based on data availability. If there is enough data available to a subVI or function, that subVI or function will execute. Execution flow is determined by the structure of a graphical block diagram (the LabVIEW-source code) on which the programmer connects different function-nodes by drawing wires. These wires propagate variables and any node can execute as soon as all its input data become available. Since this might be the case for multiple nodes simultaneously, LabVIEW can execute inherently in parallel. Multi-processing and multi-threading hardware is exploited automatically by the built-in scheduler, which multiplexes multiple OS threads over the nodes ready for execution.

Graphical Programming

LabVIEW integrates the creation of user interfaces (termed front panels) into the development cycle. LabVIEW programs-subroutines are termed virtual instruments (VI s). Each VI has three components: a block diagram, a front panel, and a connector pane. The last is used to represent the VI in the block diagrams of other, calling VI s. The front panel is built using controls and indicators. Controls are inputs: they allow a user to supply information to the VI. Indicators are outputs: they indicate, or display, the results based on the inputs given to the VI. The back panel, which is a block diagram, contains the graphical source code. All of the objects placed on the front panel will appear on the back panel as terminals. The back panel also contains structures and functions which perform operations on controls and supply data to indicators. The structures and functions are found on the Functions palette and can be placed on the back panel. Collectively controls, indicators, structures, and functions are referred to as nodes. Nodes are connected to one another using wires, e.g., two controls and an indicator can be wired to the addition function so that the indicator displays the sum of the two controls. Thus a virtual instrument can be run as either a program, with the front panel serving as a user interface, or, when dropped as a node onto the block diagram, the front panel defines the inputs and outputs for the node through the connector pane. This implies each VI can be easily tested before being embedded as a subroutine into a larger program.

The graphical approach also allows nonprogrammers to build programs by dragging and dropping virtual representations of lab equipment with which they are already familiar. The LabVIEW programming environment, with the included examples and documentation, makes it simple to create small applications. This is a benefit on one side, but there is also a certain danger of underestimating the expertise needed for high-quality G programming. For complex algorithms or large-scale code, it is important that a programmer possess an extensive knowledge of the special LabVIEW syntax and the topology of its memory management. The most advanced LabVIEW development systems offer the ability to build stand-alone applications. Furthermore, it is possible to create distributed applications, which communicate by a client–server model, and are thus easier to implement due to the inherently parallel nature of G.

Design Patterns

Applications in LabVIEW are usually designed using well-known architectures, known as design patterns. The most common design patterns for graphical LabVIEW applications are listed in the table below.

Table 4.1. **Common design patterns for LabVIEW applications**

Design pattern	Purpose	Implementation details	Use cases	Limitations
Functional Global Variable	Exchange information without using global variables	A shift register of a while loop is used to store the data and the while loop runs only one iteration in a "non-reentrant" VI	• Exchange information with less wiring	• All owning VIs are kept in memory
State machine	Controlled execution that depends on past events	Case structure inside a while loop pass an enumerated variable to a shift register, representing the next state; complex state machines can be designed using the State chart module	• User interfaces • Complex logic • Communication protocols	• All possible states must be known in advance
Event-driven user interface	Lossless processing of user actions	GUI events are captured by an event structure queue, inside a while loop; the while loop is suspended by the event structure and resumes only when the desired events are captured	• Graphical user interface	• Only one event structure in a loop
Master-slave	Run independent processes simultaneously	Several parallel while loops, out of which one functions as the "master", controlling the "slave" loops	• Simple GUI for data acquisition and visualization	• Attention to and prevention of race conditions is required
Producer-consumer	Asynchronous of multithreaded execution of loops	A master loop controls the execution of two slave loops, that communicate using notifiers, queues and semaphores; data-independent loops are automatically executed in separate threads	• Data sampling and visualization	• Order of execution is not obvious to control
Queued state machine with event-driven producer-consumer	Highly responsive user-interface for multithreaded applications	An event-driven user interface is placed inside the producer loop and a state machine is placed inside the consumer loop, communicating using queues between themselves and other parallel VIs	• Complex applications	

4.2.2. LabVIEW IN OUR PROJECT

LabVIEW is used as a Graphical User Interface in our project work. Here we are using LabVIEW ver. 5 for virtual representation of the Tanks and the LED indication panel. This will directly show the continuously changing water levels in the Underground Reservoir and the Overhead Tank. accordingly the LED indication panel is also shown.

For interfacing LabVIEW with the system the Arduino UNO output signal is connected to the Analog Input card of LabVIEW. The input card is inserted into the system card slot.

The Input card of LabVIEW has several Digital Input and Analog Input pins where the Arduino data pins has to be connected which will send the distance data of the sensors.

Figure 4.6. NI 9203 Analog Input Card of LabVIEW

The Arduino UNO Board will give measured signal of the corresponding tank level value which will be calibrated into tank level value in the LabVIEW display.

We have created a new Virtual Instrument (VI) in a separate project file. We then found out all the things we need to show in the VI from the controls. We have taken the tanks from— Controls→ Modern→ Numeric→ Tank. Then we have taken all the LEDs for Making the LED indication panel. The LEDs are selected from the path— Controls→ Modern→ Boolean→ Round LED. This are configured accordingly in the Hardware card.

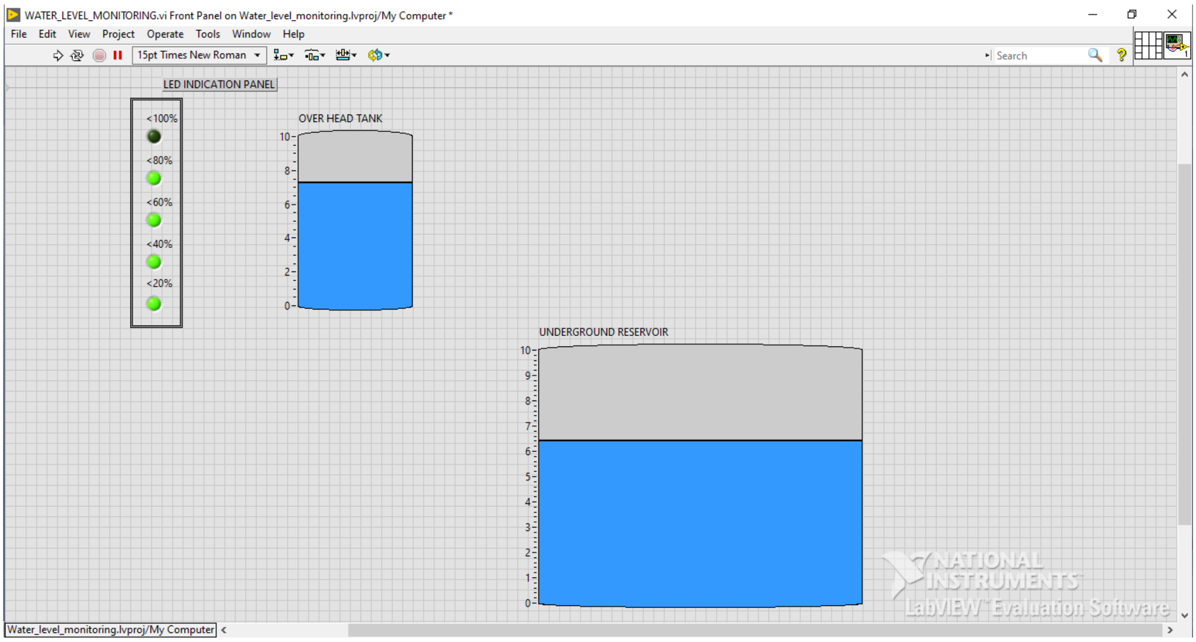


Figure 4.7. Virtual Instrument in LabVIEW

Here we can see that the Over head tank level is lower than 80% and the LED indication panel is also showing the same. With the changing water level the changes in LabVIEW software has been observed.

There is a separate Block Diagram View for the system—

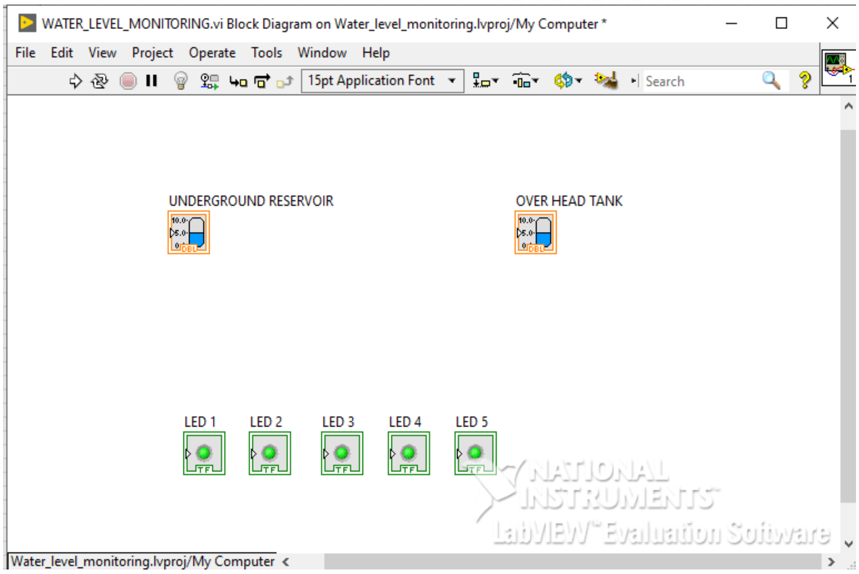


Figure 4.8. Equivalent Block Diagram in LabVIEW

LabVIEW can also be used as a control unit. We can also write simple logic program in the LabVIEW software to operate the system directly without any Arduino UNO board.

4.3. SIMULATION SOFTWARE

We have used Proteus 8.0 Professional design suite for doing the preliminary simulations of our system. We have inserted Arduino library and Ultrasonic Sensor library in the library folder of the software for inserting Arduino Module and the HC SR-04 module in the Schematic of our project. Here we have taken a separate virtual serial monitor.

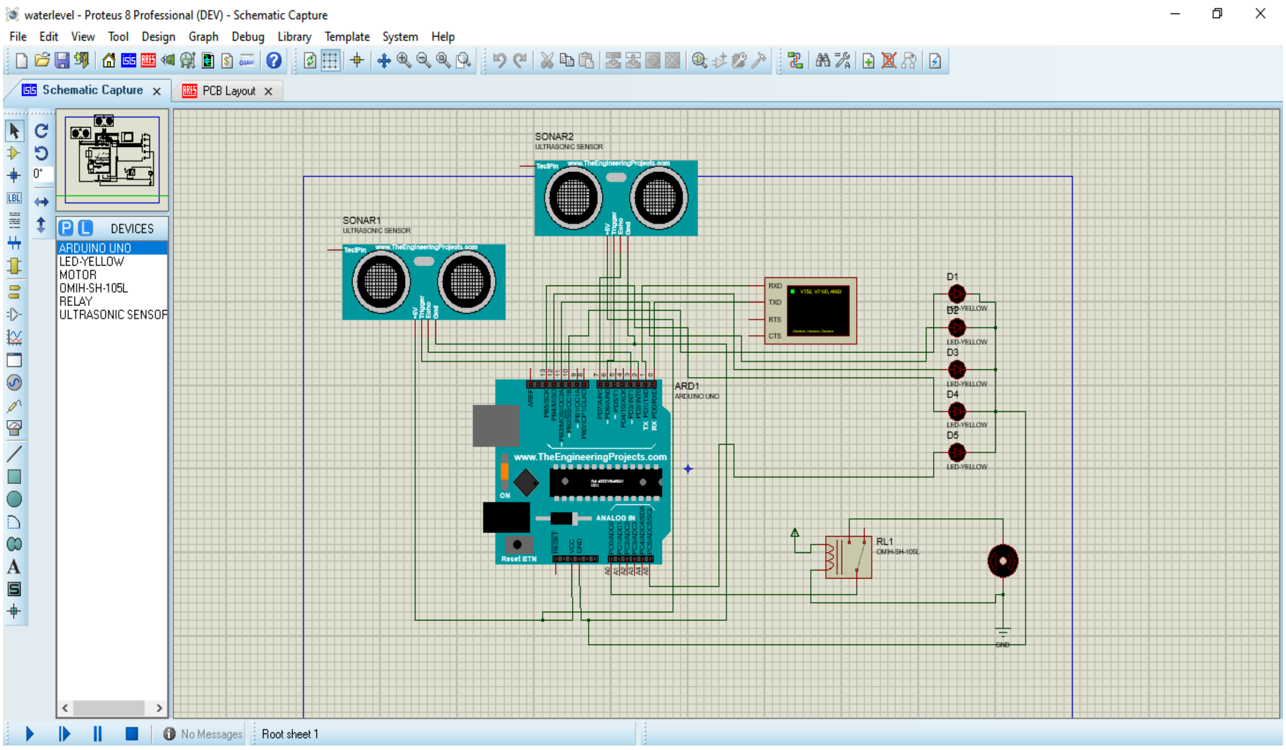


Figure 4.9 Proteus 8 Professional Design Suite

4.4. DESIGN SOFTWARES

4.4.1. FRITZING [14]

Fritzing 8.7 is used for design of the circuit. Here all the modules, controllers and actuators are connected together with several wires of different colours. Standard colours of wires are used for easy identification of data and power circuit wires. The circuit diagram is shown in the next chapter.

4.4.2. EPLAN [15]

EPLAN Electric P8 is an electrical engineering design software program that offers unlimited possibilities for project planning, documentation, and management of automation projects. The automatic production of detailed reports based on wiring diagrams is an integral part of a comprehensive documentation system and provides subsequent phases of the project, such as production, assembly, commissioning and service with the data required. Engineering data from other project areas, such as fluid and pneumatic engineering, can be exchanged via interfaces within our CAE software. This therefore guarantees consistency and integration throughout the entire product development process.

Benefits of EPLAN over traditional CAD packages:

EPLAN develop solutions for greater efficiency, putting integration and automation at everything it does by providing end-users with all the core functions required of an electrical design package, and easily-integrated additional tools that can be adapted for industry-specific processes; from fluid and pneumatic engineering to enclosure design.

CHAPTER-5

(LOGIC & OPERATIONS)

5.1. LOGIC OF OPERATION OF OUR SYSTEM

The automation part in our system is implemented according to certain conditions —

The Underground reservoir should always have water level more than 30% for the pump to be operated based on the tank level in the over head tank. Keeping this condition constant if the water level in the tank is less than 20% the pump starts operating. The pump keeps operating in the same way until the water level in the Over head tank reaches 80%. After 80% value the pump is stopped. It will again operate when the tank level goes down 80% value.

Table 5.1 Logic of our system

Underground reservoir water level measured by ultrasonic sensor 1	**Over head tank Water level measured by ultrasonic sensor 2**	**Pump status**
>30%	<20%	ON
>30%	>80%	OFF
<30%	-----	OFF

Here it is clearly shown that the Underground Reservoir level should have to be more than 30%. Then only the system operates. This is done because after a certain water level the pump may face dryness due to lack of water head.

With more than 30% water level in the underground reservoir if the water level in Over head tank is less than 20% the pump starts and continues until the level reaches 80% value.

5.2. IMPLEMENTATION STEPS FOR THE PROJECT WORK

5.2.1. Planning and Designing

The first step in our project work is to make the plan. We have planned to harvest rain water and to implement automation in the water supply system of a domestic building. First we have planned to store the rain water in the roof of the building. Then through a pipe we will be taking it to a tank where it will be filtered and cleaned. This tank is named The Filtration Tank.

The Filtration tank consists of three stages of filtration. These are—

- Activated Carbon Filter: Carbon filtering is a method of filtering that uses a bed of activated carbon to remove impurities from a fluid using adsorption. Carbon filtering works by absorption, in which pollutants in the fluid to be treated are trapped inside the pore structure of a carbon substrate. The substrate is made of many carbon granules, each of which is itself highly porous. As a result, the substrate has a large surface area within which contaminants can be trapped. Activated carbon is typically used in filters, as it has been treated to have a much higher surface area than non treated carbon. One gram of activated carbon has a surface area in excess of 3,000 m^2 (32,000 sq ft).

- Mixed Acid Filtration: In this system Several Anion resins are present in the filtration tank. This will neutralize all the basic components or cations present in the Filtration tank. There may be strong anions like SO_4^{2-}, NO_3^- etc.
- Mixed Base Filtration: In this system Several Cation resins are present in the filtration tank. This will neutralize all the basic components or Anions present in the Filtration tank. There may be strong Cations like Na^+, K^+ etc.

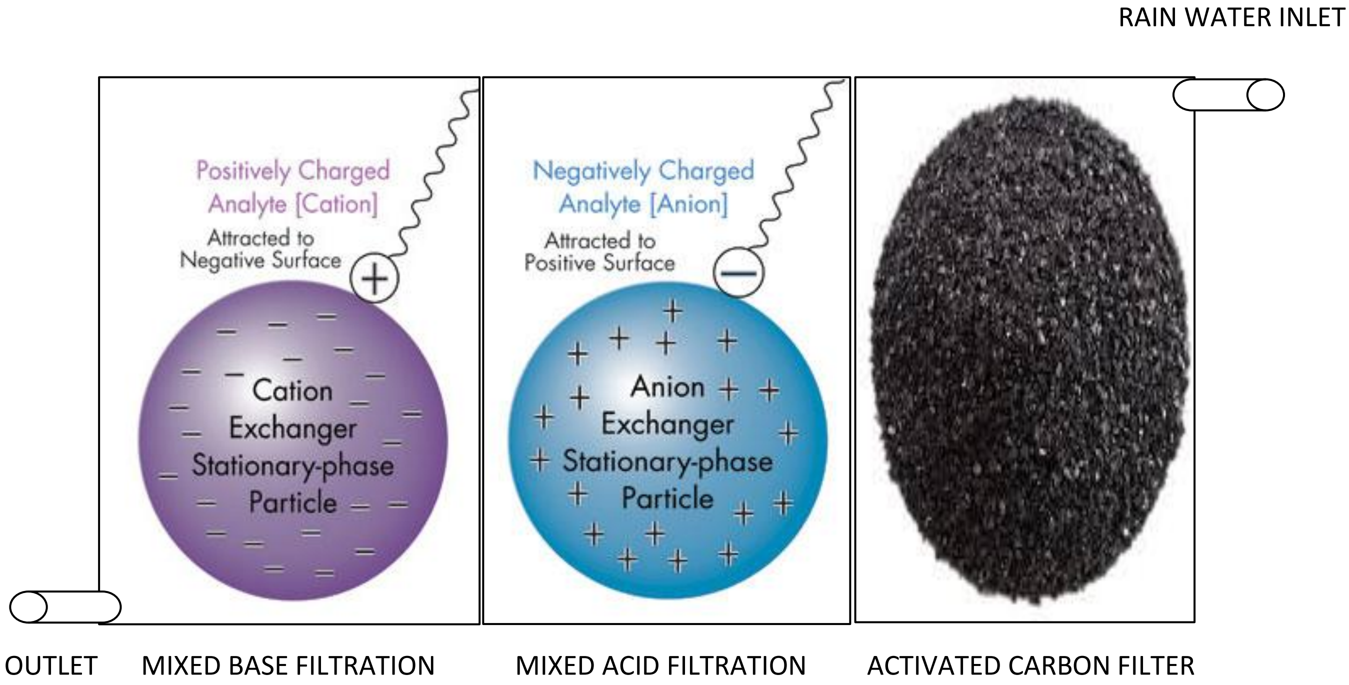


Figure 5.1. Filtration Tank

After filtration the comparatively purified rain water is sent to the Underground Reservoir for storage. The underground reservoir is the largest tank in the system. The tank we have considered here is having the depth of 19.14 cm, having a diameter of 18 cm. The tank we considered here is of 4 litres. Another pipeline from municipal water supply also comes in the Underground Reservoir.
Then comes the last tank- The Over Head tank. We have taken a tank of 10 cm diameter and 13 cm depth. This tank is connected with the Underground reservoir through a pump.

Then comes the automation part which will operate the pump automatically, depending on the water levels of the Underground Reservoir and the Over head tank.

The complete Piping and wiring diagram is drawn. This is shown as follows—

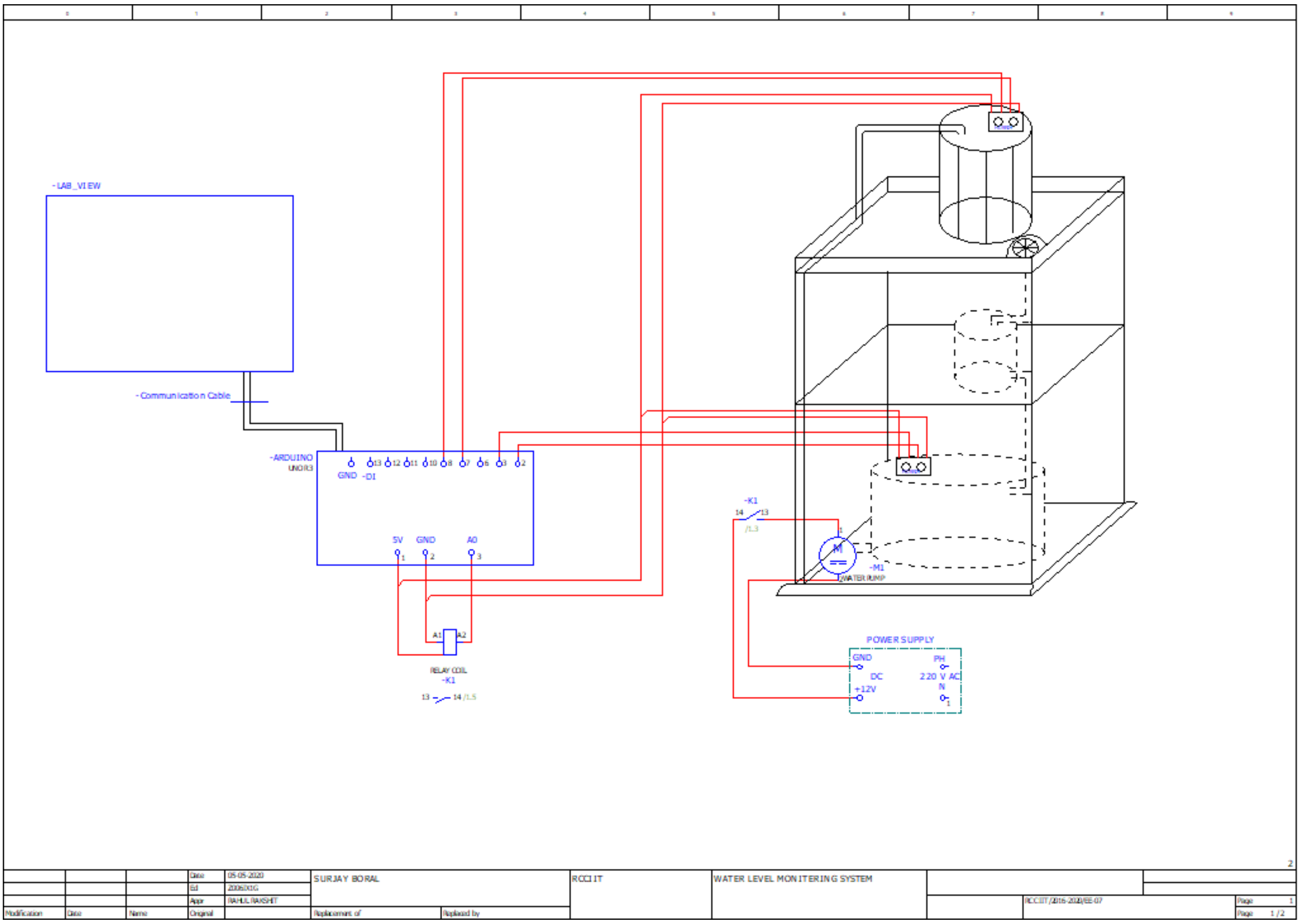


Figure 5.2. Piping and Wiring diagram

This Diagram is drawn in Eplan Electric P8 software. The building shaped structure is shown where we have shown the tanks placed accordingly. It can be clearly identified that the cycle starts from the roof and then comes to the Filtration tank in the middle floor. Then the pipe is coming from the filtration tank to the Underground reservoir which is placed on the lower most floor of the structure.

From the underground reservoir a pipe is connected to the over head tank which is placed on the roof again, through a pump which is also placed on the most floor of the structure. The Arduino UNO is schematically drawn here and the corresponding pins of it are directly connected to the Ultrasonic sensors mounted on the top of the tanks. The pump is operated by a relay whose coil is getting energised from the Arduino UNO is shown here. The power supply is also shown here, which is connected to the pump through the contactor of the relay. The System having LabVIEW connected with the Arduino UNO board is shown here.

All the components of the system placed outside the structure is mounted on the middle floor of the structure in the real system. The wirings are shown by red lines in the diagram.

5.2.2. Circuit Designing

For our purpose we designed the circuit in the Fritzing software. The circuit diagram is shown as follows—

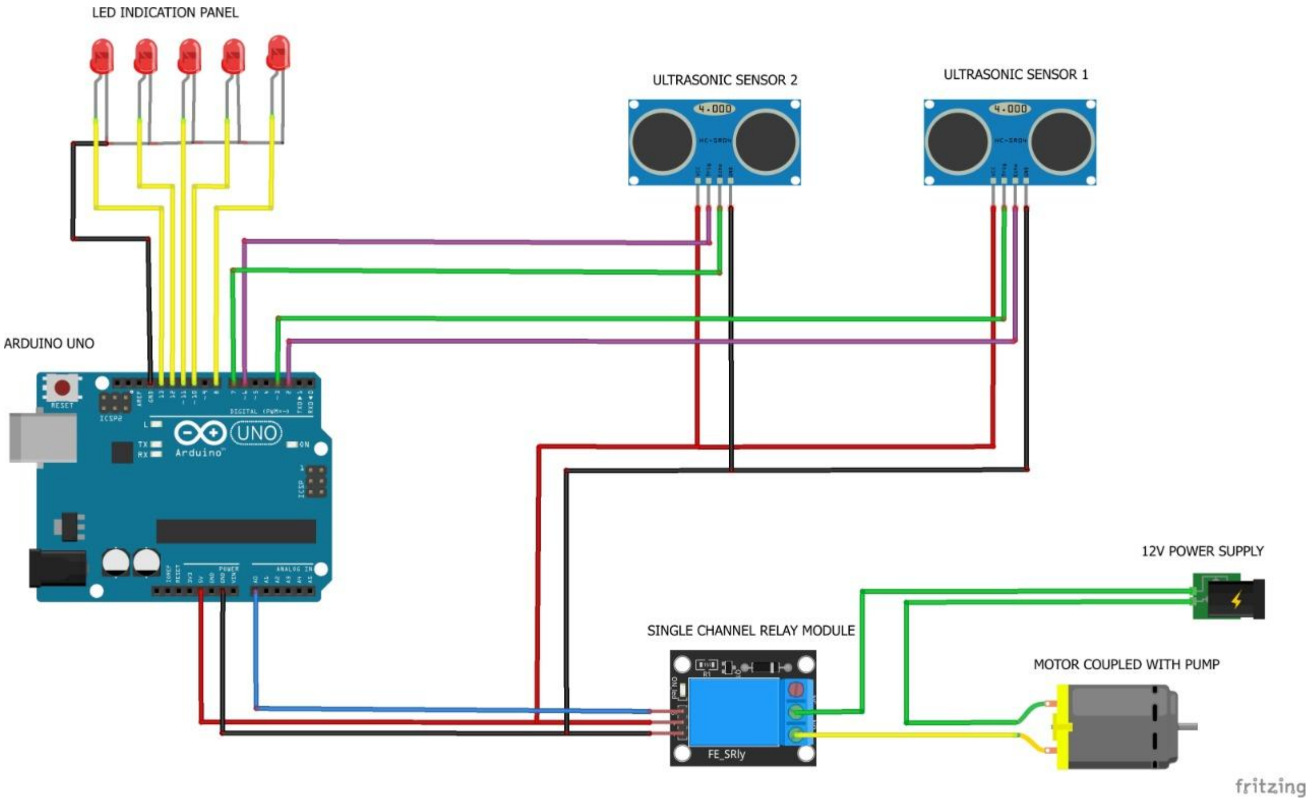


Figure 5.3. Circuit Diagram

The connection of the Ultrasonic sensor modules are described as follows—

The V_{cc} pins of both the sensors are connected to the 5V pin of the Arduino UNO board. The Gnd pins of the sensors are shorted with the Gnd pins of the Arduino UNO board. The Trigger and Echo pins of the Ultrasonic Sensor of the underground Reservoir are connected to 2, 3 no digital pins of Arduino UNO. The Trigger and Echo pins of the Ultrasonic Sensor mounted on the top of the Over Head tank are connected with the 6^{th} and 7^{th} digital pins of the Arduino UNO. In this diagram we have shown the V_{cc} connection through red coloured wire, Gnd as black, Trigger as green and Echo as Violet coloured wire.

The LED indication Panel is shown here whose LEDs are connected to the 8^{th}, 10^{th}, 11^{th}, 12^{th} and 13^{th} pin of the Arduino UNO board. The motor of the pump is connected to the power supply through a switching relay of 5V which is operated through the A0 analog pin of the UNO board.

5.2.3. Simulation of circuit

As mentioned previously we have simulated the circuit in the Proteus 8 Professional Design Suite. We have made a schematic view in the Proteus ISIS software. Where we have taken a virtual serial monitor where the distance of the water level from the sensor is shown. The simulation diagram was already given in the previous chapter. The simulation results were positive so we moved to the next step.

5.2.4. Hardware Model Implementation and Testing

After completing all these previous stages we have started working on the Hardware Model. At first all the components are bought from the market at reasonable prices. Then the Electrical components are connected according to the circuit diagram. The wire colours are also matched according to the diagram. The components here used are 2 different Ultrasonic Sensor Module HC SR-04. These sensor modules give continuous digital data through the trigger and echo pin. The other components used here are an Arduino UNO board, a 5V static relay module, a 12V DC pump. The power to the pump is supplied using a 12 Volts 2 Amps DC adapter.
The circuit connection is done and the LED indication panel is made on a Vero board. High intensity Green LEDs are used for this purpose.

The circuit connection is shown in the picture given below—

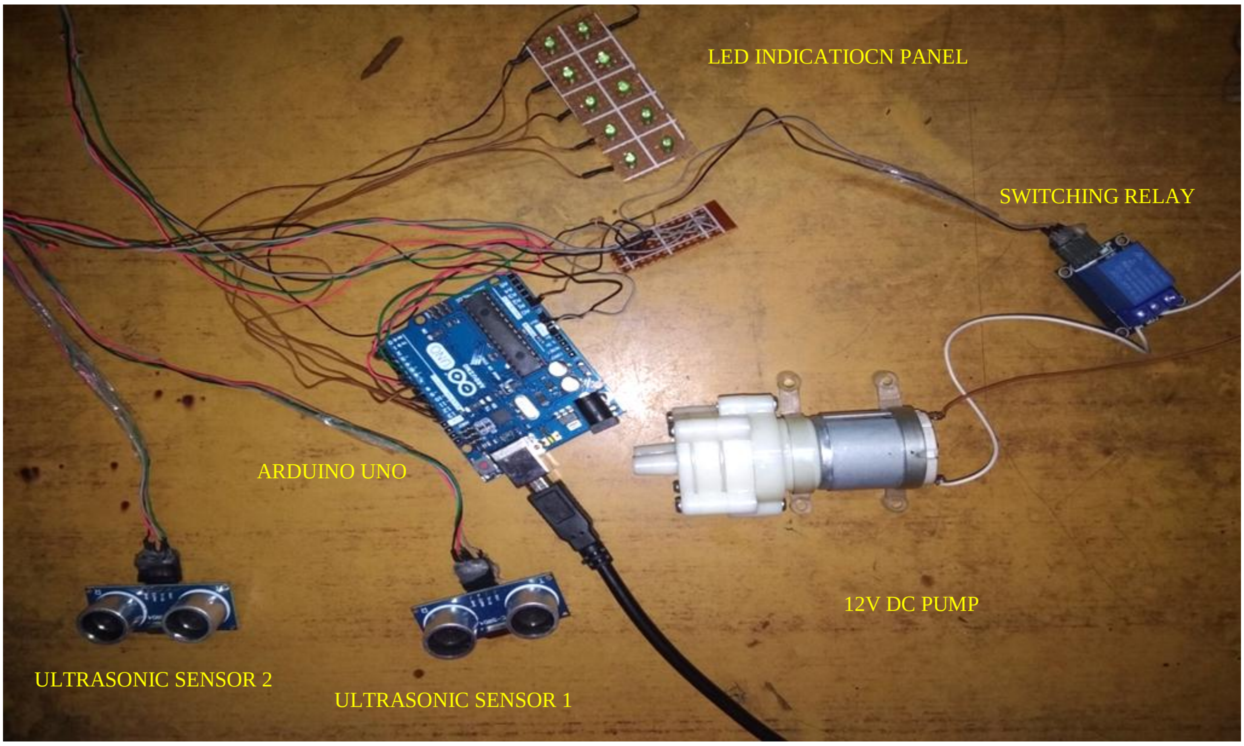


Figure 5.4. Hardware Circuit Connection

Here all the components are marked already. As seen from the picture the wires of different colours are also shown here. After giving 5V power supply to the circuit through the USB cable to the Arduino UNO the working circuit is also shown in the pictures given below—

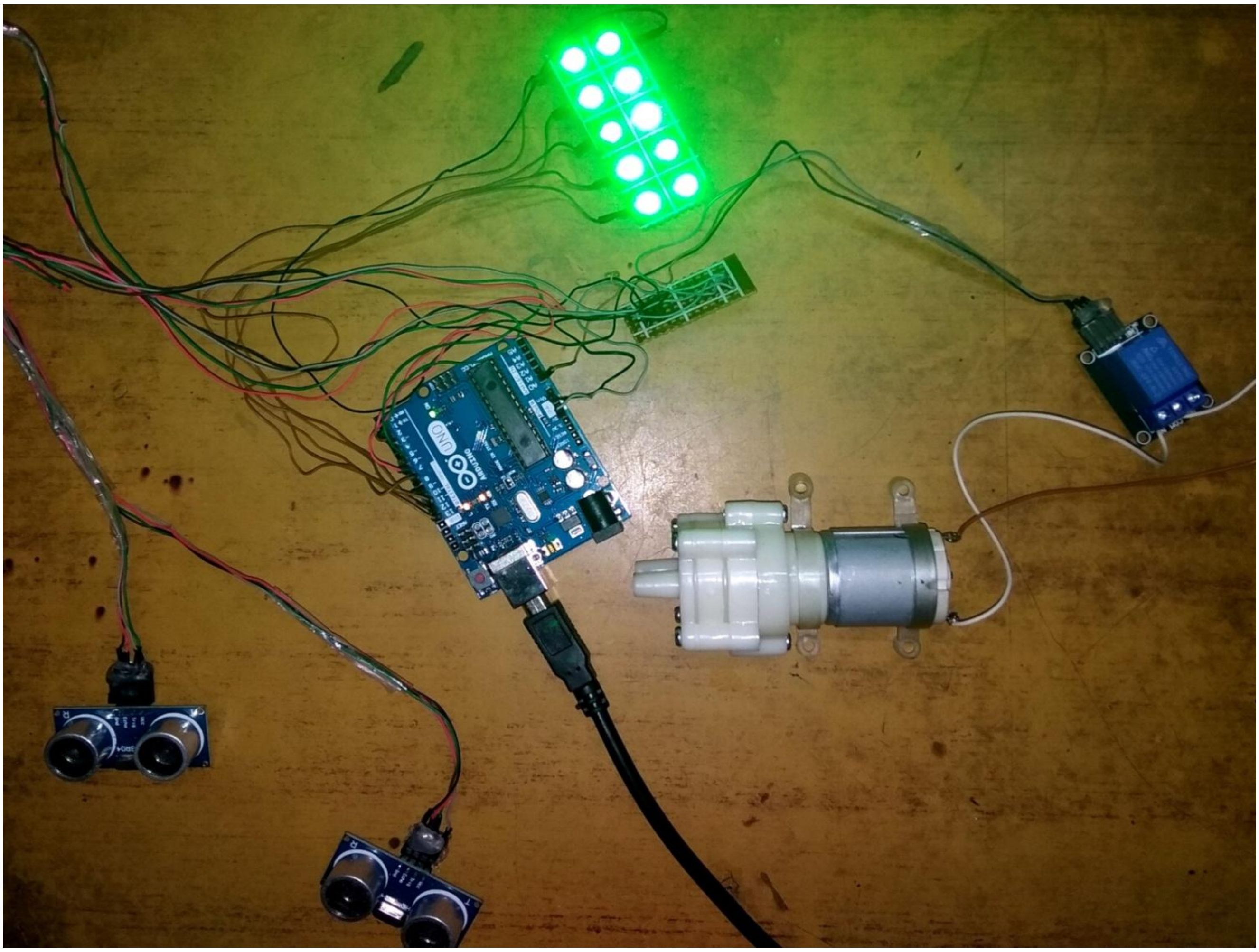


Figure 5.5. Working Circuit

Now the circuit operations are shown by different pictures taken at different distances measured by the sensor modules.

Figure 5.6. Working circuit at 20% water level in Overhead tank

From this picture it is depicted that the Over head tank level is less than 20% and the water level in the underground reservoir is more than 30%. So the red LED in the relay is glowing and indicating that the pump is operating.

Now with the increasing water level in the over tank the LED indication panel shows different data.

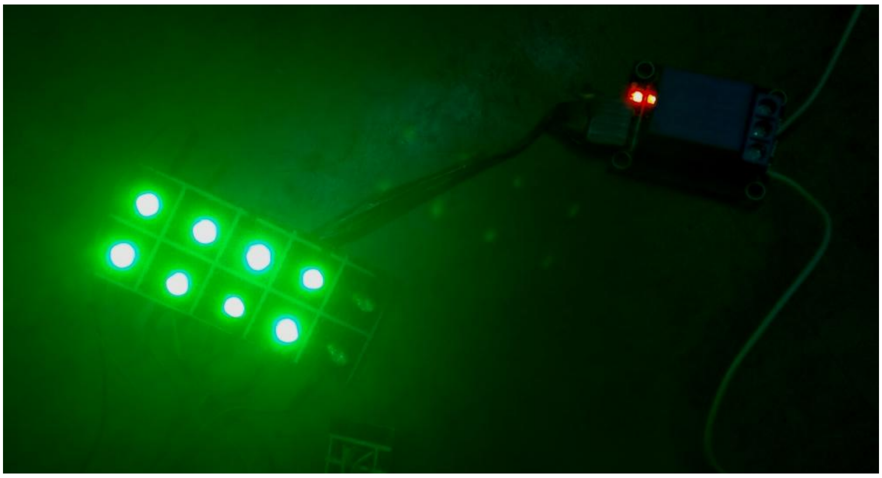


Figure 5.7. Working circuit at 80% water level in Overhead tank

This picture is depicting that the over head tank level has reached more than 60% and less than 80% value. Still the pump is working as previously set in the logic of our project.

The first working diagram of our project already showed that when the tank level reaches more than 80% all the LEDs are glowing and the Relay LED is not glowing means the pump is not working.

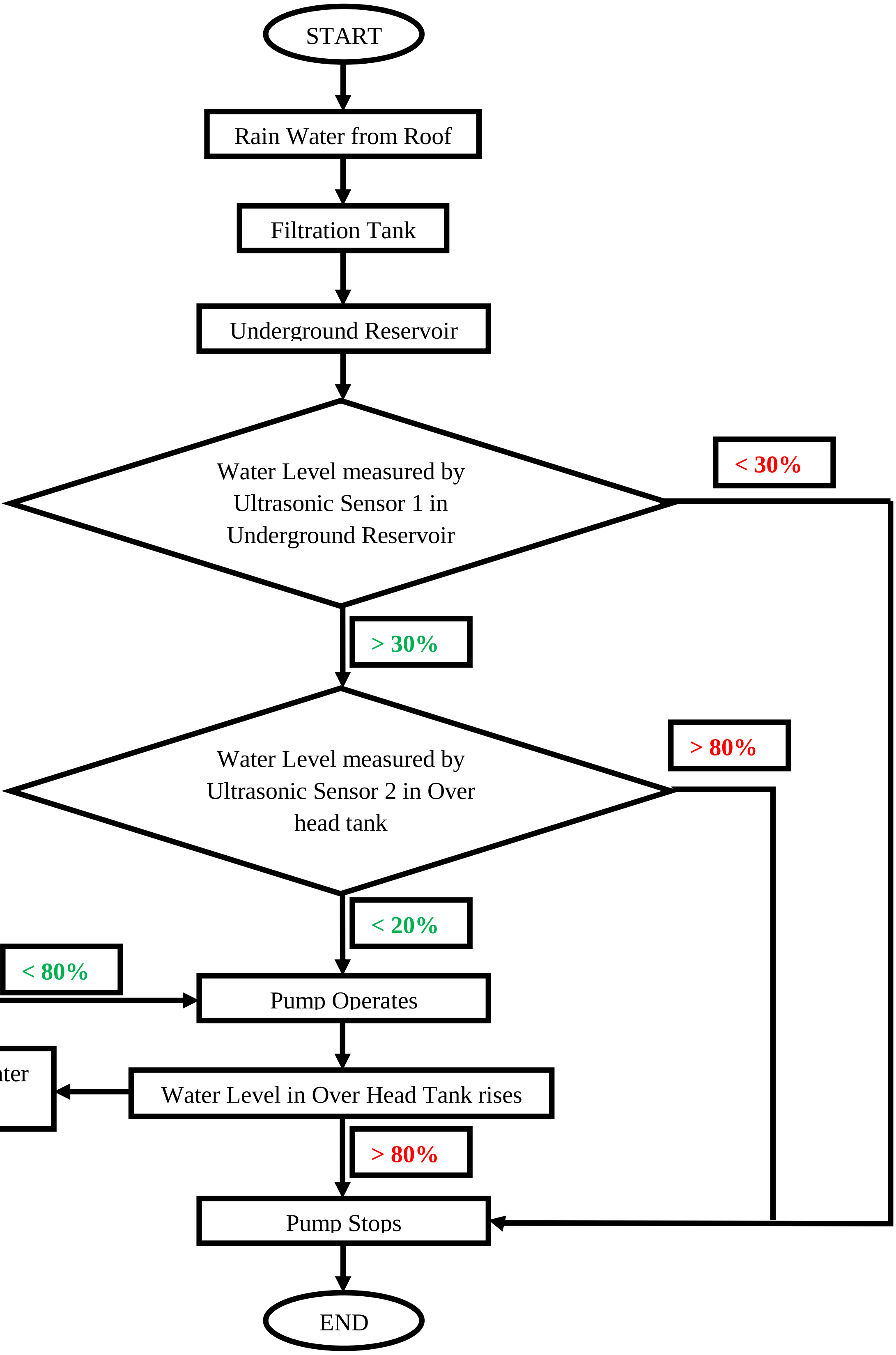
Then we have started working on the structure. For the structure we have used 2 mm thick hollow square bars made of Galvanized Iron of 2.5 cm x 2.5 cm cross sectional area. The whole structure is made of this material. The roof section is made of 6mm thick ply board.

Figure 5.8. Structure under construction

5.2.5. Interfacing with LabVIEW

Then we have started working on the LabVIEW software. The Arduino pins are connected with the Input card of the LabVIEW software. The Virtual Instrument as mentioned earlier was made in the software. Then the circuit was run for several times.

5.3. FLOWCHART OF OPERATION OF THE SYSTEM



CHAPTER-6

(COST ESTIMATION, FUTURE SCOPES & CONCLUSION)

6.1. COST ESTIMATION

The total cost of this project can be estimated after the making the bill of materials—

Table 6.1. Bill of Materials

Component or Materials	Quantity (No.)	Rate (Rs.)	Total Price (Rs.)
Arduino UNO Board	1	310	310
USB A-B Cable	1	40	40
HC SR-04 Module	2	60	120
5V Switching Relay module	1	60	60
12V DC Pump	1	300	300
12V 2Amp DC Adapter	1	200	200
Green LED	10	2	20
Vero Board	1	40	40
Single Stranded Wire	5 meters	12	60
Multi Stranded Wire	1 meters	10	10
Male Pin header	2	5	10
Female Pin header	1	10	10
DC Jack	1	5	5
DC Socket	1	5	5
1 L plastic bucket	1	100	100
5 L plastic bucket	1	250	250
0.5 L plastic container	1	50	50
10 mm galvanized rubber pipe	8 ft	4	32
Miscellaneous	-	-	200
Grand Total			**1822**

6.2. FUTURE SCOPES

- **IoT Implementation:** The whole system may be modified using Internet of Things. The Tank level data may be uploaded to certain cloud storage or some free or paid websites. This data will give provide some relevant information while we need to use it once again. This type of IoT system may not be so much worthy while implementing this into a domestic or commercial building. It will be very much helpful if the water level monitoring system is implemented in an Industry.
- **Implementation in Industries:** This system can be implemented in industries such as Chemical plants, Power plants, paper mills where the water requirement is too high. This system need to be implemented there with multiple tanks and industrial controllers and sensors.
- **Improvement in Purification Level:** Rain water from roof may be purified through several more stages. The water will be much cleaner and will be free of micro organisms.

- **Display the water level:** The LED indication panel may be replaced by a LCD or OLED display. We just need to interface the displays with the Arduino UNO Board. It would be much more attractive and will use less amount of power.

6.3. CONCLUSION

This project can be applied to any where in a society and our current scenario says that we should opt for Rain Water Storage. It is simple to implement with a bit high but affordable implementation cost. No manual operation is required as automatic control is employed. Automatic operation of the system is of great advantage in a human’s busy schedule. In case of manual operation sometimes fault in the pump may arise due to less water storage in the reservoir. In this case this risk of fault is overcome. As we have tested the system already and it was running perfectly. So it can be considered to be a useful project. The major drawback of this system is that although less but a constant power is lost for continuous run of all the sensors, relay and Arduino Uno and major power is lost in the pump operation also the Activated Carbon filter and Mixed Base filter needs to be changed after a specific time. That includes a cost.

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