"In Pursuit of Global Competitiveness"

DISSERTATION

REPORT

ON

Arduino-Based Smart Irrigation Using Sensors and ESP8266 Wi-Fi Module

Submitted by

SUJIT DEVANAND THAKARE

For the Degree of

Master of Engineering

(Electronics Engineering)

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(An Autonomous Institute of Government of Maharashtra)

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Guided By

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(An Autonomous Institute of Government of Maharashtra

(2017 - 2018)

CERTIFICATE

This is to certify that, the Dissertation Report entitled **"Arduino-Based Smart Irrigation Using Sensors and ESP8266 Wi-Fi Module"** submitted by **Sujit D. Thakare** is a bonafide work completed under my supervision and guidance in partial fulfillment for award of Master of Engineering (Electronics), Degree of Government College of Engineering (An Autonomous Institute of Government of Maharashtra), affiliated to Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (M.S., INDIA).

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Place: Government College of Engineering, Aurangabad

Date:

DECLARATION

I hereby declare that I have formed, completed and written the dissertation entitled **“Arduino-Based Smart Irrigation Using Sensors and ESP8266 Wi-Fi Module”**. It has not previously submitted for the basis of the award for any degree or diploma or other similar title of this for any other diploma/ examining body or university.

Place: Aurangabad — Sujit D. Thakare

Date: — (ME16F13F010)

CONTENTS

ABSTRACT

This paper presents a smart irrigation system which is economical and gives the automation in the farm. The aim of this paper is to design an Arduino based controlled irrigation system using Wi-Fi module. The proposed system detects the moisture content in soil, PH level of Soil and temperature using moisture sensor, PH sensor and the temperature sensor. The moisture level of soil is sensed and according to that irrigation can be done. If the level of moisture is below the threshold level the moisture sensor sends the signal to the Arduino board and notification is send through IoT platform. As Compared with the other systems, this system gives better efficiency and it is also less expensive. Arduino collect the data from all the sensors and link that data with the cloud. The main advantage of the system is that the owner of the farm can remotely monitor their farm on IoT. The main aim of the project is to make agriculture smart using automation and IoT technology.

Keywords—Arduino, Sensors, Wi-Fi Module

List of Abbreviations

Abbreviations	Illustrations
CCTV	Close Circuit Television
GSM	Global System for Mobile
Wi-Fi	Wireless Fidelity
IDE	Integrated Development Environment
SOC	System on Chip
TCP	Transmission Control Protocol
IoT	Internet of Things
LCD	Liquid Crystal Display
GPIO	General Purpose Input/output
WSN	Wireless Sensor Node
GPRS	Ground Positioning Radar System
GPS	Global Positioning System
ADC	Analog to Digital Converter
USB	Universal Serial Bus
PWM	Pulse Width Modulation
MISO	Multiple Input Single Output
ASCII	American Standard Code for Information Interchange
RAM	Random Access Memory
LED	Light Emitting Diode

List of Figure

1. INTRODUCTION

1.1 General

Nowadays, water scarcity and water logging has become an unpreventable issue to tackle with. Water plays an important role in the day to day life of a human being. In India lot of agricultural land and industries are already facing the drought problems, so with the help of current technology this issue can be sorted out to some extent. In today's smart and fast lifestyle, smart irrigation became prevalent due to clemency, malleable means of observing and controlling an agricultural land as respect to user’s indulgence and requirements. The investigation of a land or fertile areas through sensors devices and the anticipation of snags through extrapolation are of essential prominence for the scrutiny of these regions. The most challenging part is the ease and budget of mounting them in the field and the cost of it differs with rising number of facilities to be scrutinized and control. Protection of the irrigated land from becoming underwater, overwater, dry, more basic and more acidic are the essential necessities of the smart irrigation system. Due to the encroachment of wireless technology, there are numerous networks are familiarized like Global system for mobile, Wireless fidelity, and Bluetooth. Every network has their own exclusive specifications and uses. CCTV camera is available for inspection purpose of the growth of crops which are there in the land but one can’t understand the nature of environment and soil parameter through it and it is very expensive which also requires manpower for surveillance purpose. In these categories of scrutiny systems, human intervention is required to observe that specific region and only he can observe what is going on at that place. Today’s technology requires a user-friendly device which is economical in cost as well as most effective which is provided by Arduino board. In today’s generation, it is very convenient to send the notification to IoT platform because of widespread use of smartphones and PC. This project implements a system which is used for smart irrigation system using Arduino Board and Wi-Fi module ESP 8266. Compared with the other systems, Arduino Board with Wi-Fi module and Cloud platform system gives the better efficiency and it is also less expensive. This new version Wi-Fi module is integrated with TCP/IP protocol and has self-contained SOC (System on Chip). In brief, Arduino Board is used to record data from PH sensor, Moisture sensor and Temperature sensor which provides the data to the ESP 8266 which then push notifications from the server to an Android device or PC. In addition to that motors are used to control the agricultural parameters sense by the various sensors. The issue of observation and controlling of an irrigation system when the owner is not at the place becomes very important because incidents like underwatering and overwatering are increasing day by day. There are some inspection techniques were computerized systems had been established which notifies the user in a distant locality about invasion or effort to encroach in the farm. The proposed system uses an IoT platform to sense the data and send this data to an android phone or PC of the user and to notify the remote area and generates the alerts of the probable scenario. This system is also useful for the handicapped people which provides facilities like monitoring of environment and irrigation automation. The need for a microcontroller and wireless transceiver is eradicated by the IOT module, thus it made the system compressed, economical and convenient to use. The key benefit of the method is that the owner can monitor their land or system anywhere from the world and can act according to the situation. To get a notification for monitoring purpose any cellular device or PC is required. Nowadays, the knowledge of the parameters required for yielding the good quality of crop in the land has become an unpreventable necessity. It performs a significant part in the surveillance and governing the system. On that account system uses PH, temperature and moisture sensors to analyze the three essential parameters of the soil. The ability of the device should be of such a nature that the cost of the item seems to be always a smaller amount. The attractiveness of smart irrigation system has been rising impressively in recent years due to considerable cost effective and easiness of system through android device and tablet connectivity. The one side of that is the price tag and the second aspect are the user-friendly nature of the system. As we know that in India not everyone is a technically fulfilled. To overcome this problem this system is made such that everyone can easily operate it. In today’s generation, it is very convenient to send the notification to the cloud because of the widespread use of smartphones. The whole system is distributed into two parts. The first part comprises setting up the Arduino Board and interfacing it with the several sensors. The second part consists of developing the IoT platform and connecting it to the server. Arduino Board does not have inbuilt Wi-Fi module on it. So in order to counter that disadvantage Wi-Fi module ESP 8266 is used because of that the transmission becomes simpler and faster. It also helps the owner to monitor the system globally throughout the world. This system is simple to implement. Arduino Board is also connected to the two motors which are interface with the relay driving circuit and power supply. Motors are connected to the water tank and fertilizer tank respectively when one can trigger the motor from remote place it gets turn on and off and according to necessity supplies the fertilizers or water to the field. It gives alert instantaneously and also it is economical for personal use and becomes very convenient because of the smartphone. This System is designed to improve the security, flexibility and to remove the flaws of the existing system. It raises the usage of Android phones to offer the innovative approach towards the agriculture. Cloud computing allows persons to monitor, achieve, and regulate their delicate information through the Internet. This project implements the smart irrigation system using open cloud server to notify the user about the existing parameters of the field. People want to identify one additional thing about their smart irrigation system is that, they have the capability to connect to the internet for observing distantly or not. Previously smart irrigation system contains only the moisture, temperature sensors and PIC controller that also with LCD display only means if one has to get on-field information user have to go to the field or within the range of bluetooth and ZigBee module. Information is not available to the user remotely because of the inability of the transmission of the data. The Arduino Board and Wi-Fi module fulfilled both conditions in that it is an inexpensive, effective controller. To recognize systems with enormous functionality it can be interfaced with other modules. Arduino Board is very effective controller with ATMega 328 controller immersed on it also it has the I/O pins through which external peripherals and devices can be coupled. This system is easy to operate, user-friendly interface so it will be easily handled by user even though he/she does not have any experience of operating an android phone.

1.2 Necessity

People are frequently migrating from place to place, for their daily schedule and workload. In some situation if they fail to visit the land then they are in big trouble by considering the moisture and PH level of the filed. This worry can be eliminated by Smart agriculture scrutiny system, there is no need to get panic about the temperature, moisture and mainly PH level of the soil etc. Watering the crops single handedly is a hectic task nowadays because of the availability of the man power. Because of this system, we can remotely monitor the agricultural field, briefly we can say we can save the valuable time and money also.

1.3 Objective

Thus, the objectives of this system can be specified as:

- To distantly monitor the agricultural field and control it.
- To save valuable time and consume the energy proficiently.
- To minimize human efforts.
- To develop an intelligent irrigation system this can be scrutinized by user distantly throughout the world via cloud server.

- The aim of this development is to implement a less expensive, consistent and accessible smart irrigation system that can be used to distantly monitor and control the various parameters of the soil by means of an Arduino Board to attain hardware simplicity.

1.4 Theme

This system is centered on Arduino Board and ESP module 8266 with sensors like temperature sensor, moisture sensor and PH sensor etc. To control the parameters two motors are used and this are very less expensive, this make the system cost efficient and easy to implement. The theme of the proposed system is to monitor and control the farm field remotely from anywhere through the cloud server by the user. It will save the time and energy efficiently.

1.5 System Requirement

1.5.1 Hardware Requirements

1. Arduino Board is use as the controller here for controlling and processing purpose.
2. Sensors like PH Sensor, Moisture Sensor and Temperature Sensor
3. Relays are used to permit low voltage devices to be turned on/off in response to an event going in or out of a comfort zone of the field condition.
4. GPIO pins to interface with external peripherals.
5. Wi-Fi module ESP 8266 is used for uploading the data to the server.
6. Android phone, PC etc.
7. Motors to provide water and fertilizers.

1.5.2 Software Requirements

1. Integrated Development Environment (IDE)
2. Arduino programming
3. Arduino library
4. IoT platform Thinger
5. Cloud Server

1.6 Organization

This text is a presentation of the work carried out which is aimed at putting forward the schemes of the seminar. The report included a comparative study of major components used to design and development of the system, performance analysis and concluding remark. The organization of the text is as mentioned below.

Chapter 1 is Introduction in which necessity, objectives and principle of a smart irrigation system using Arduino Board and wi-fi module ESP 8266. It gives a complete introduction of the system with the explanation of the theme of making the system.

Chapter 2 is a Literature survey which gives a survey of different systems available for the same purpose, their advantages and limitations as well as their applications. It also gives detailed information about various components used in the presented system and the reason for selecting them.

Chapter 3 is System development consists of complete information about the development of the system right from its concept to manufacturing. It provides system architecture and hardware as well as software details. Various software used for development, programming and operation of the system have also been provided.

Chapter 4 gives a performance analysis of the system based on statistical and practical methods. System’s performance analysis by considering the various factors affecting the system has been presented in this chapter.

Chapter 5 provides decisions centered on the study of result, advantages of the system and possible future scope for it.

2. LITERATURE SURVEY

There are several techniques available for smart irrigation. Among them, the techniques including moisture sensor, temperature sensor, water flow sensor and humidity sensor are most commonly used one with different types of microcontroller and connecting techniques like Bluetooth, GSM, GPRS and Wi-Fi. But it has its own snags. Wireless Sensor Networks (WSN) technique also has been used for scrutiny and irrigation purpose.

2.1 IoT Based System for Remote Monitoring

This method increases wireless sensor node (WSN) methods by involving novel scheme methods and upgraded to inexpensive irrigation and scrutiny systems. In this system temperature, humidity sensors, humidity sensor and water flow sensors were utilized. The controller used in this system is the STM32L152RE which is a Microcontroller unit (MCU) of the STM32 series of development boards. Microcontroller uses to sense the data from temperature, moisture and water flow sensor. The key motive of sensor systems is the observing of basic data and provides elementary data and conclusion for the base situation.

Three important section of sensor network as shown below:

- Antimony electrode is used for water flow measurement.
- Inverse relation between soil resistance and soil moisture is used for soil moisture measurement.
- DS18B20 sensor working on the Dallas one wire protocol has been used for the temperature measurement.

STM32Nucleo is the platform on which entire system has been developed. The system is comprises of three main blocks amongs which the microcontroller unit is at the heart of the system to which different sensors and bluetooth module is connected. The microcontroller performs the main action to receive the real time sensor informatioin from the sensor link to it. After doing manupulation it sends the on field data to the bluetooth module. Bluetooth module is used here to accessthe system information remotely within the bluetooth range using smartphone.The Microcontroller used here has an additional features of low power consumption. It is operated in the two power saving modes like sleep mode and stand by mode. Freeware version of IAR is used to developed and debugging of firmware of Microcontroller unit.

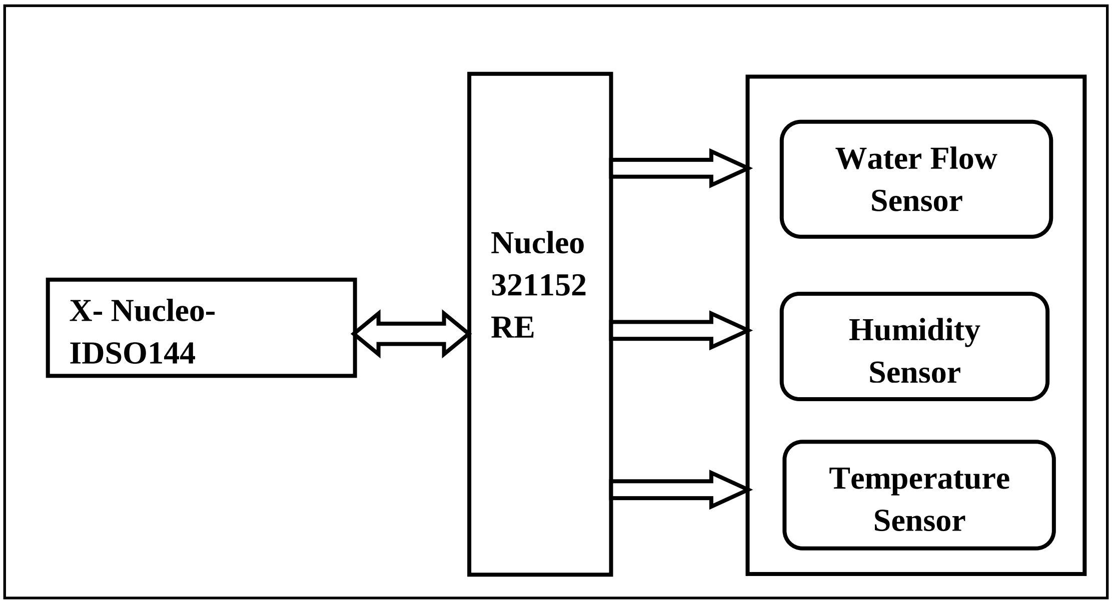


Figure 2.1: Block diagram of the monitoring node

But the disadvantage of this system is that the system is that it cannot establish the communication outside the Bluetooth range and hence only used within the specific range.

2.2 Irrigation System Using a Wireless Sensor Network and GPRS Module

Considering water logging and water scarcity issue in the back of the mind this system was designed in order to control the water used for the crops in the agriculture field. The system uses microcontroller-based gateway unit in order to access the distributed wireless network. This WSN comprises of soil temperature and moisture sensors. The moisture and temperature sensors are placed at the root of the crops in order to get the proper readings or on field information about the existing crop. In addition to this gateway unit is also used to precipitate the actuators and linking up the data to web application. All the scrutiny of the data and scheduling is programmed through the web page. It is triggered by photovoltaic panel and has cellular interface with the user.

The wireless sensor network is a mixture of huge device nodes which can detect and converse to work systematized in a supportive way. A WSN comprises of several number of sensors that accumulate information and transfer it to a numeral of sink nodes. WSN is an assembly of sensors which are used in the communication or physical phenomenon given such as temperature, moisture etc. and then transfer the data wirelessly to the information handling station to take effectiveness of them without humanoid involvement in the locality of the physical atmosphere. This system has a duplex communication model which based on the cellular internet interface with help of which one can do irrigation scheduling and data inspection through the web page. The main drawback of the system is it does not provide the real time field information to the user within the range.

2.3 Remote Sensing and Control of an Irrigation System Using a Distributed Wireless Sensor Network

The proposed system uses several distributed wireless sensors in order to receive proper on field information through Bluetooth and GPRS unit. Arid and semiarid area already facing the water drought problem. This system provides the potential solution for the efficient water management which is the major concern in the many cropping system in those areas. This helped to maximize the productivity with minimum uses of water. This system contains six sensors including temperature sensor, moisture sensor, water flow sensor, air pressure and temperature sensor, solar plate sensor and humidity sensor to investigate the on-field parameters. The wireless sensor network is distributed across the field from which the data is calculated based on the soil property map and all the data which is calibrated is transmitted wirelessly to the base station. The sprinklers location is georeferenced by the Global Positioning System (GPS) and it receives the signal wirelessly form the computerize base station. Programming logic controller is used to electronically controlled the irrigation machine contains sprinkler assembly under it. Low cost Bluetooth wireless radio communication is used to trigger the communication in between irrigation controller to the base station and the sensor network. Graphic user interface-based software developed in this paper offered stable remote access to field conditions and real-time control and monitoring of the variable-rate irrigation controller. The farmer gets all the information about the field through GSM and wireless communication but the system is incapable of storing the previous values.

2.4 Arduino Based Smart Drip Irrigation System Using Internet of Things

Water logging is a big problem farmer faced nowadays. For that the Smart drip irrigation technique is proposed in this project is divided in to three important parts Senssing unit, controlling unit and last the distributed unit. This project is a blend of automatic and semi automatic irrigation system. Circuit uses sensor like Humidity sensor, Temperature sensor and PH sensor to sens the on field data. ATMega 328 is the microcontroller used here in order to control and manupulated the data. Distributed network compraises of Pump and Solenoid vaalve with the help of which smart irrigation has been done. The web format is design to analyse the sens parameter remotely and to take specific action to counter that. Basically microcontroller retrive all the information from temperature, PH and humidity sensor. Microcontroller did some mathematical calculation in order to calliberate the sensor with the on field value. LCD display is connected to the microcontroller in order yo view on field parameters. Web page format has been design with help of JAVA platform in order to acces the distributed network and analyse the parameter from remote area. Microcontroller sends all the on field inforamtion to web portal through serial communication via MAX 232 serial port which is connected to PC wirelessely. Motor pump and solenoid valve are connected to microcontroller with driver circuit and by anlysing the field parameters the motor can turn on and off remotely. PH . temperature and moisture of the field is control by the proposed system. This system continuosly transmitt the data from field to the web portal so ine can analyse and study the real time information about the field. According to sens parameter microcontroller also hlps the famer for selecting the specific crop. This system provides an innovative approch towards the farming and can yeild more production rather than the conventional strategies.

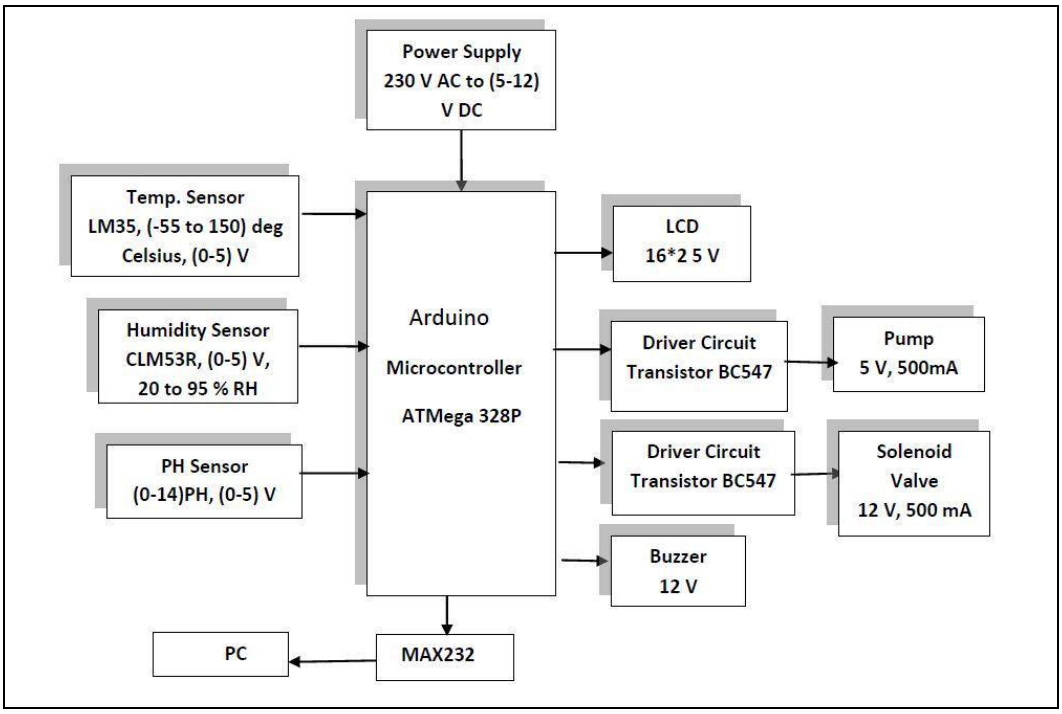


Figure 2.2: Block diagram of smart drip irrigation system

Figure 2.2 shows the block diagram of drip irrigation system with all sensing, controlling and distributed unit. This system gives all the information in most innovative way the main drawback of this system is that it is helpless of storing the previous reckonings and also impotent to give information about the moisture contained in the soil.

2.5 Soil Parameters Monitoring with Automatic Irrigation System

The population of India is increasing day by day and it demands high yield of crop from the farmers. But with climate change and with the availability of workers is very hectic task nowadays. India already facing a drought problem in so many states taking all the consideration in account this system gives smart irrigation models which contain various sensors, microcontroller, relay driving circuit and motor. It also uses LCD to view the parameters sense by the sensors. This system comprises of four sensor PH sensor, Temperature Sensor, Humidity sensor and Moisture Sensor. ATMega microcontroller used to access and transmission of data which has been send by field sensor. Microcontroller transmits all the information to LCD where one can view the data.

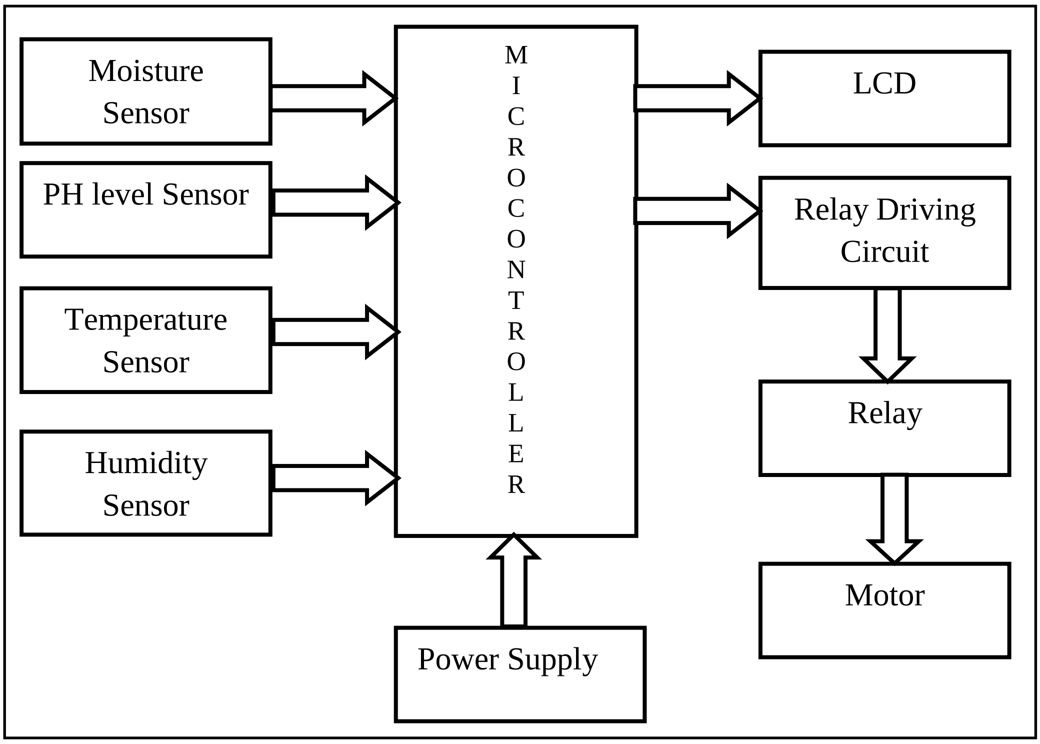


Figure 2.3: Overview of the irrigation system

When the various sensors sense the data, they deliver all the information to the microcontroller. After receiving the data microcontroller performs some manipulation. Considering the field parameters, it activates the relay driving circuit which triggers the relay. Relay performs ON\OFF operation of the motor which is connected to the water pump.

Relay performs the operation by the threshold values given to it by user according to moisture contain and temperature of the soil. PH sensor gives the information about the basic and acidic nature of the soil and with the help of which farmer can use the fertilizers in the farm. To cure the water problem, it can turn off and, on the motor, automatically. System has to look at temperature of the soil also for taking the threshold values to turn on and off the motors because as temperature increases evaporation of the water also increases. Figure 2.3 shows the block diagram of the existing system. The system senses all the information and can perform all the automated operation but it is unable to deliver remote access to the system.

2.6 GSM Based Automated Irrigation Using Sensors

In this system PIC Microcontroller is used for controlling the sensors and for driving the circuit and GSM module. Temperature sensor, Moisture Sensor and Humidity Sensor are the sensors used to take information from the field and deliver it to the GSM module and driver circuit. LCD is also used here to observe the field information provided by the PIC controller.

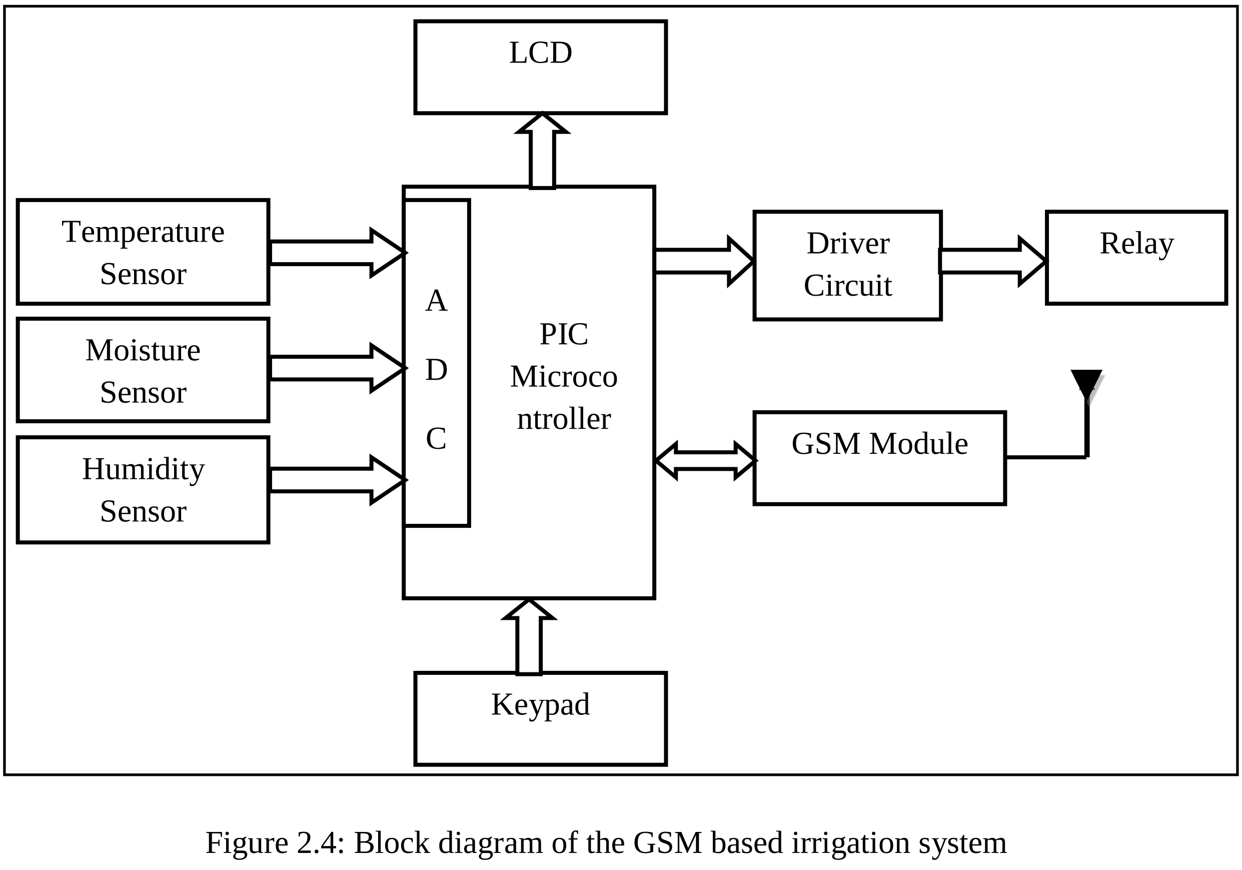


Figure 2.4: Block diagram of the GSM based irrigation system

Figure 2.4 show the block diagram of the system, the evaluation indicated that the importance of the networking for smart irrigation will increase for the purpose of not only remote control but also for adding flexible services and sophisticated UIs. In this system moisture sensor, temperature sensor and humidity sensor sense all the on-field parameters and provide the data to the ADC pins of PLC microcontroller. Microcontroller performs all necessary action and release the data towards driver circuit, GSM module and LCD display. Display can give the real time data to farmer whereas the when the data values of temperature sensor, moisture sensor and humidity sensor exceeds beyond the threshold values it sends the text message via GSM module to the user in order to give the data information. The main drawback of the system is it fails to give real time information about the field to the user and it only delivered the message when data exceeds beyond the threshold values otherwise not.

2.7 Design and Implementation of Automatic Plant Watering System

This system uses the ATMega 328P microcontroller as a controller in this system. This system also has a servo motor in order to drive the pump whenever necessary input is given to it. LCD display is used to observe the moisture sensor readings which is connected to the microcontroller on other side. Depletion of water level is a dangerous threat to the irrigation process. Efficient and optimum use of water can also yield the better crop as proposed by the system.

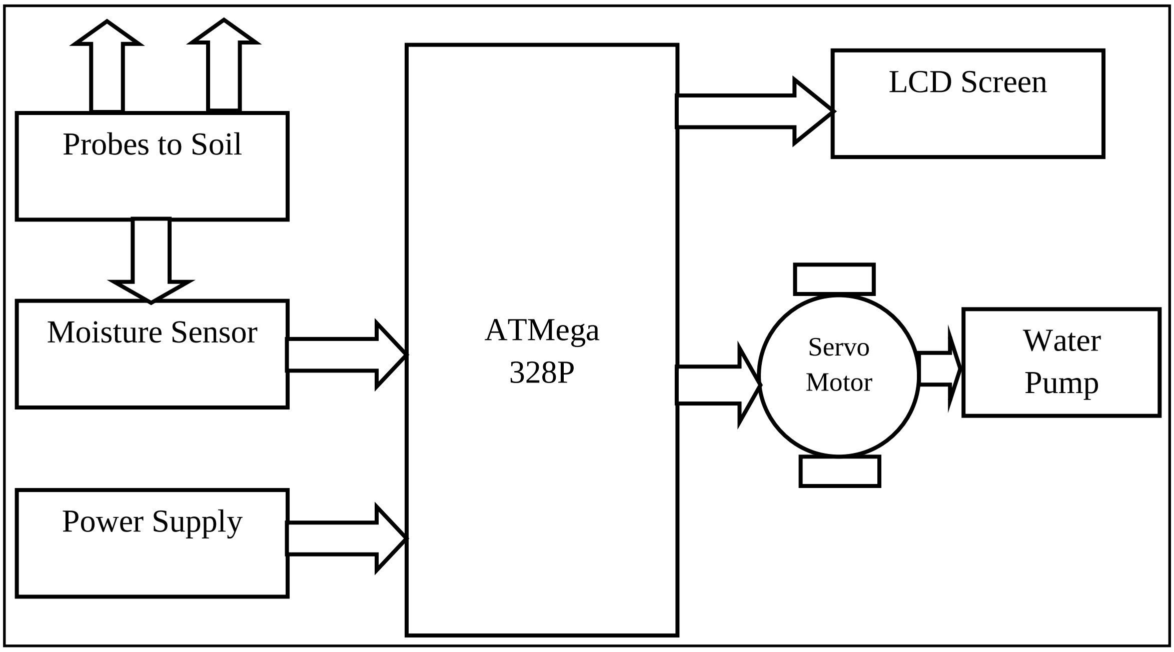


Figure 2.5: Block diagram of the automatic watering system

Figure 2.5 shows the block diagram of Automatic Watering System in which the probes of the soil moisture sensor are immersed in the soil. Moisture sensor gives the reading on the basis of amount of water contain in the soil. ATMega 328P microcontroller is used here to conceptualize the data and deliver the field data to the user through the LCD screen which is also connected to the Microcontroller. When there is requirement of water means the moisture, sensor gives minimum reading servo motor is get turn ON by the microcontroller which is again connected to the water pump and when moisture sensor gives maximum output microcontroller turns OFF the servo motor so as the water pump to optimize or reduce the use of water. In this way water can be used in minimum amount and with crop yielding is maximize. The main snag of the system is it only provide information about moisture level of the soil and also does not give the real time data. This system also fails to give remote access to the user as it does not contain some type of wired or wireless communication between user and the microcontroller.

2.8 Smart Water Dripping System for Agriculture/ Farming

The system proposed here is the most innovative process among others. The main triggering to build this system is occurs from the water scarcity issue the world faces nowadays. It gives the innovative way to yield maximum crop with in limited use of fertilizers and water. This system embraces with the ATMega 328 microcontroller which is connected with on field sensors and driving circuitry. This system also gives the information about the weather forecast and crops to be taken in the field for agriculture purpose. All the data sends to the android application through database server. Smart irrigation system is as shown in the figure it contains the temperature sensor, Moisture sensor and PH sensor to sense the on-field soil parameter. Microcontroller fetched all the sensing information from the sensors and according to that operates the functionary connected to it. This system also uses the Web-Scrapper which gives the prediction about the weather forecasting. It extracts the predicted rain information from the various web sites and application available on the cloud. It again uses data mining techniques called Naïve Bayes which gives prediction about the crops to be taken in the field according to the field information given by the sensor. To avoid the soil from becoming more acidic and basic it uses PH sensor and also gives information about which fertilizers has been used to control that through android app. Android application is design with help of SQL and JAVA programming.

Microcontroller runs the driver circuitry on the basis of information given by the sensors which contain servo motor which regulates the pipe direction by 180 degrees after some interval of time with motor driver circuit which is used to evacuate the water from the tank or reservoir.

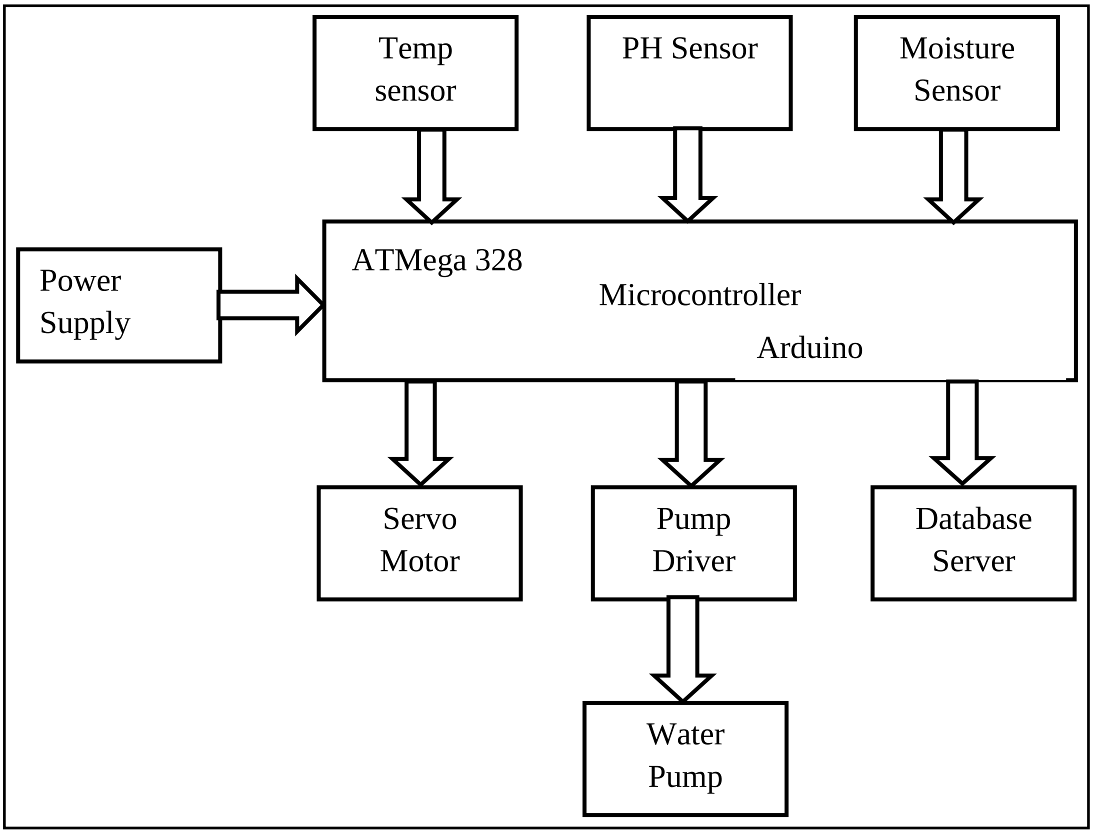


Figure 2.6: The assembly of the smart water dripping system

Database server uploads all the available information to the cloud or on an android application. The main disadvantage of such useful system is it cannot afford by the common man because it is highly expensive.

2.9 Automated Irrigation System Using Artificial Neural Network

This a system which is based on Artificial Neural Network. This system used neural network toolbox from MATLAB to implement it for proper and balanced use of water. This system is hard to understand and it fails to deliver real time data to the user. As shown in the figure above system uses Neural Network in order to optimize the water use in the farming. It uses MTLAB to simulate all the related activities required for the designing purpose of Smart Farm Irrigation System which helps to face the problem of overwatering and underwatering in indoor farming.

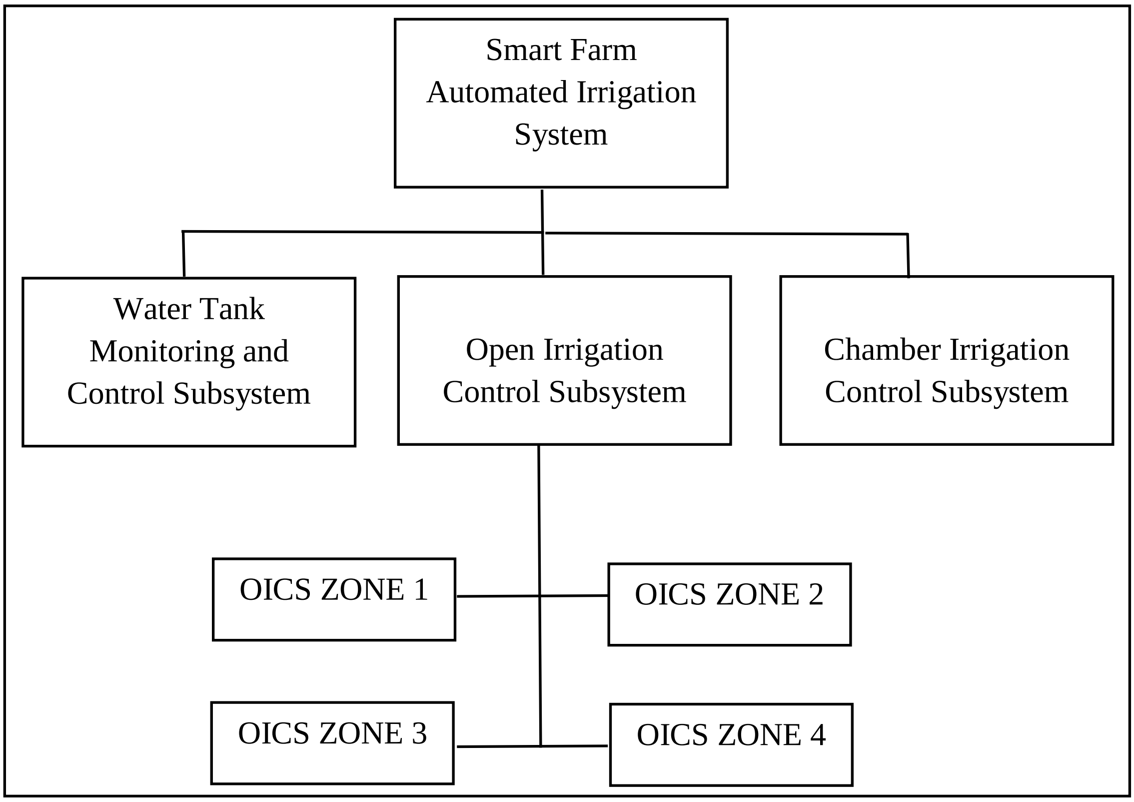


Figure2.7: System block diagram

The most important factor of the smart irrigation is the power available at the station or the motor board. By using power distribution subsystem ANN solves this major problem for that it has to lot of alteration and algorithms. WTMSC, OICS and CICS are the subsystems which are simulated under the MATLAB under the Artificial Neural Network block. Constructing the subsystems is actually a very hectic task it has to consider all the water flow in the farm and also the water flow parameter of the tank used in the system. The main drawback of the system is it is very hard to understand to the normal human being.

2.10 Arduino-Based Smart Irrigation Using Water Flow Sensor, Soil Moisture Sensor, Temperature Sensor

In this research paper, various sensors like temperature sensor, moisture sensor and water flow sensor are used to tackle with various environmental issue like temperature, moisture and water contain in the soil. This system provides an innovative way to approach the agricultural data through ESP module 8266. Arduino Board is used here to control the sensors, ESP module and sprinklers and pump which is connected to the separate power supply. ESP module separately has its own TCP/IP protocol and on chip SOC and also has separated program language coding. Figure 2.8 shows the block diagram of Arduino based smart irrigation system which comprises of sensors, controlling unit and distributed network. Temperature sensor sense the temperature of the soil and release the output in terms of voltage to the Arduino board which analyze the information and sends the proper information to the ESP module. This procedure follows for the moisture sensor which senses the moisture of the soil and water flow sensor which contains the information about the running water present in the agriculture field. ESP module sends the information to the IoT platform which is design or freely available for analyzing the results from the various sensors. Basically, what ESP module done is it can convert the information sends by the sensors in the form which is understood by normal human being. User can access the data from one simple login ID and password. Information also travels from router to router before reaching the base station. Sprinklers assembly and pump system is connected to the Arduino board. ESP module gives the user interface so from that one can turn off the motor or turn on the motor depends on the output or readings given by the sensors. Separate IP address is provided to the user for benefiting them to reach the IoT platform easily through any browsing network

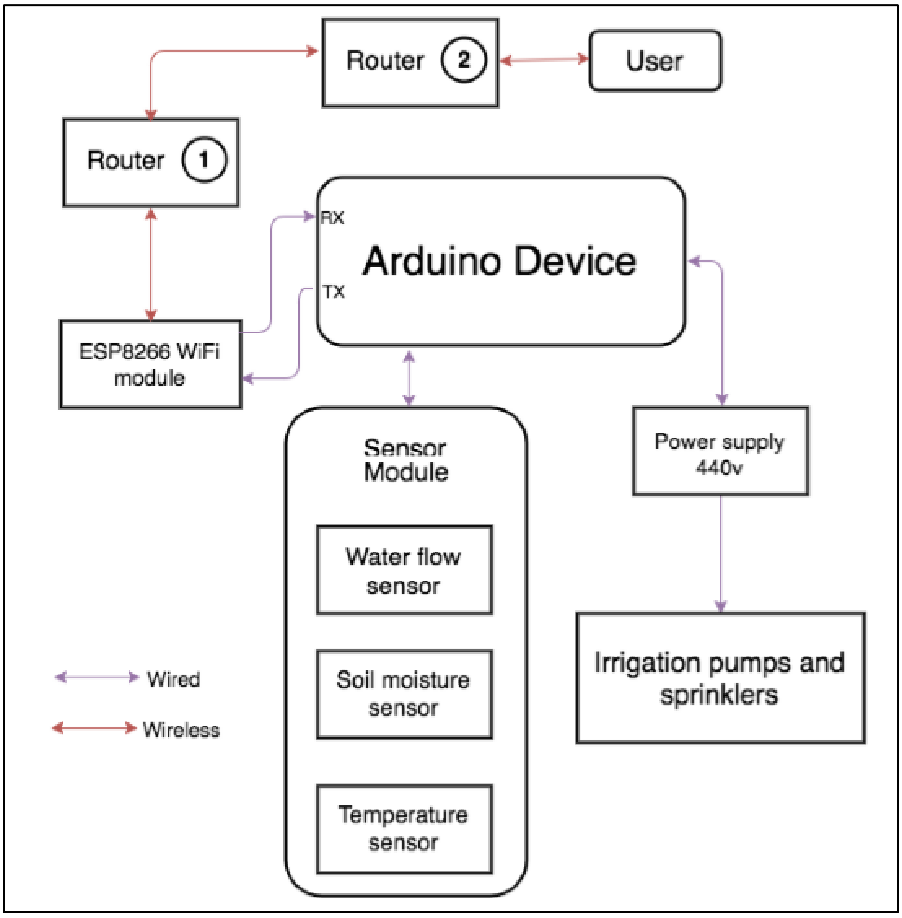
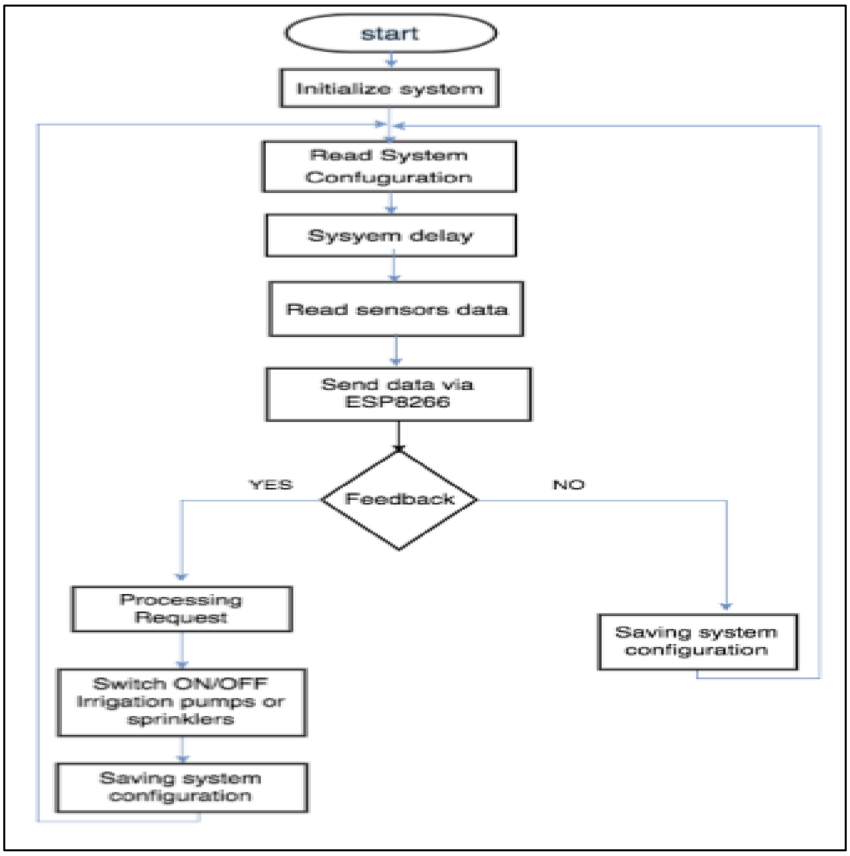


Figure 2.8: Block diagram of smart irrigation system

The main disadvantage of this system is it cannot give the proper information about the basic and acidic nature of the soil.



Figures 2.9: Flowchart for smart irrigation system

Above figure 2.9 shows a flow chart for the Smart irrigation system using ESP module 8266.

2.11 Online Farming Based on Embedded Systems and Wireless Sensor Networks

This system implements Embedded system with help of wireless sensors in order to take huge leap in the world of wireless network. This project use ZigBee network in order to upload the data. The main aim of this system is to design a system in such a way that anyone can access it from the outside of the area or from the remote area. This project implements for dealing with environmental parameters like weather, soil fertility, weed monitoring, moisture of the soil, temperature of the soil, water contain in the field with help of embedded systems. Wireless cameras are also used for the recording purpose of the growth of the crops in the field. This footage is continuously uploaded to the web server so one can understand the effect of fertilizers and water supplied to the crops. Embedded system compares the moisture and temperature level of the soil with provided temperature and moisture level. According to that the motors which are connected to the system are turn off and on automatically.

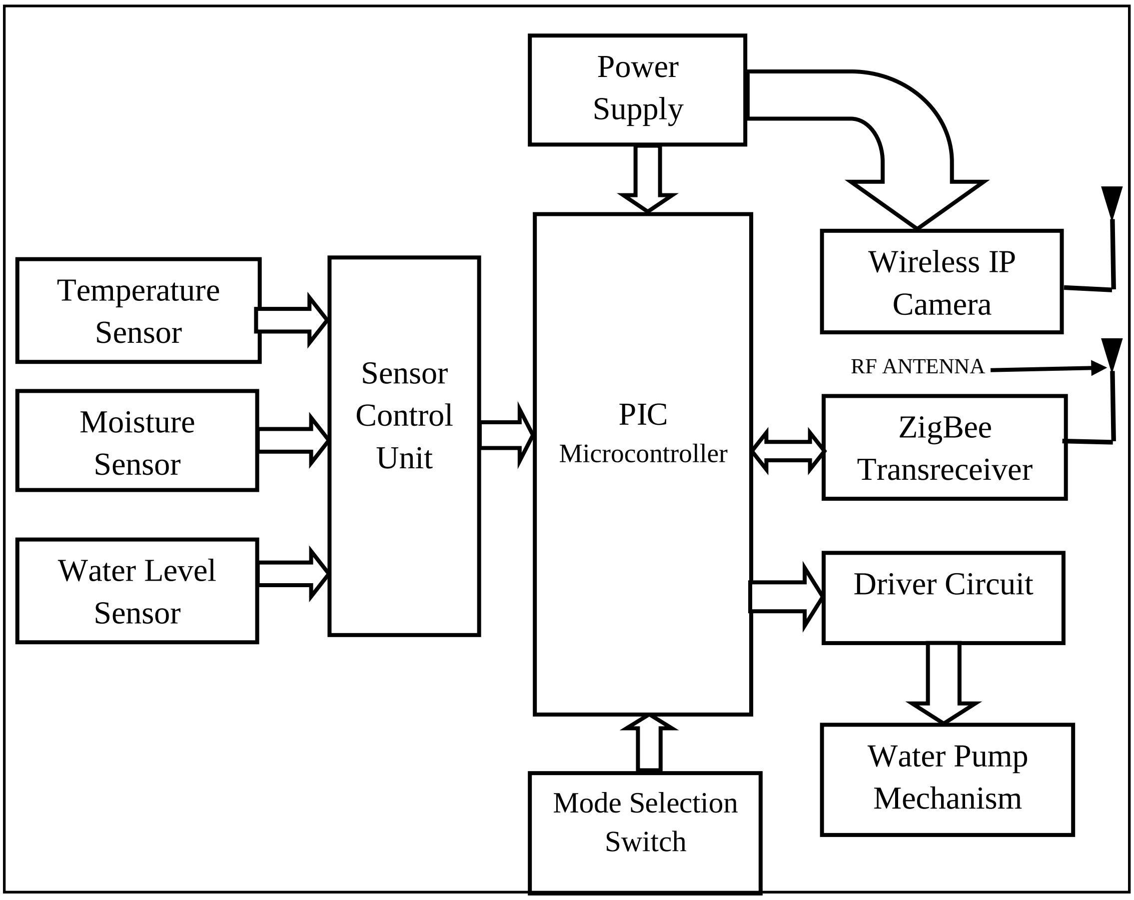


Figure 2.10: Block diagram of embedded system design

The Embedded system contains temperature sensor, moisture sensor, water level sensor with sensor control unit. PIC microcontroller is used here in order to control the whole parameters of the soil and assembly connected to it. Wireless camera, driver circuit, water pump is connected to the other half of the controller. ZigBee Transreceiver is used here in order to upload the information to the server. The main downside of the project is it can’t give actual information about the PH level of the soil.

3. SYSTEM DEVELOPMENT

3.1 Proposed System Block Diagram

The main objective of the system is to develop on intelligent irrigation system which can be scrutinized by user distantly throughout the world via IoT platform. This system is connected to cloud so it can be accessible through the PC or any other smartphone. It also gives the current status about the moisture, temperature and PH level of the field through moisture sensor (FC28), temperature sensor (LM35) and PH sensor (L10530) respectively which are connected to the Arduino. It can be access by the destined user remotely through PC or smartphone. Smartphone has the feature of continuous monitoring with alarm alert and also, we can get the notification and has Wi-Fi access. With the avail of these potent smartphone applications, the system becomes more astute, more expeditious and more perspicacious.

This scrutiny method comprises mainly two sections:

1. The first part consists of setting up the Arduino Board, Wi-Fi module ESP 8266 and interfacing it with the sensors.
2. The second part consists of developing the cloud platform and linking it to the server for notification.

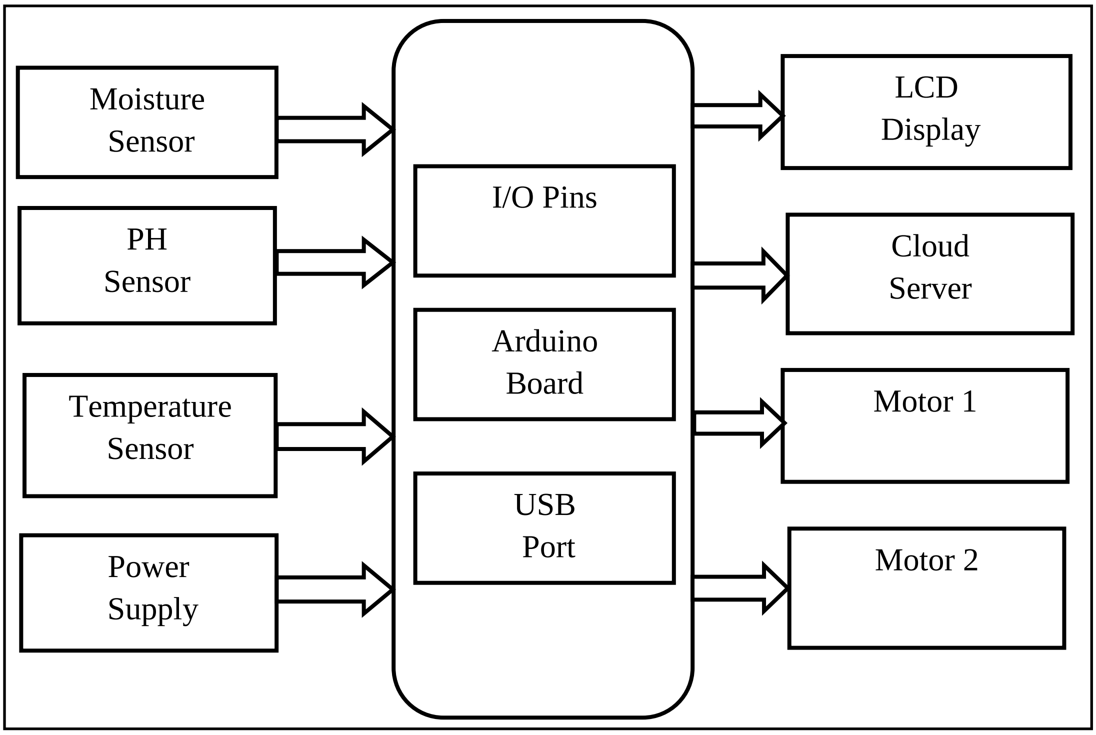


Figure 3.1: Basic block diagram of system

The system proposed diagram is distributed in two sections. First part consists of Arduino Board for monitoring activities which also contains different sensors for security. It is controlled by Android Phone remotely if there is network connectivity. The system consists of a Wi-Fi module ESP 8266 which used to give the notification to the cloud platform.

The figure 3.1 shows, Temperature Sensor, PH Sensor and Moisture sensor is interface with Arduino Board and Wi-Fi module ESP 8266. The Arduino Board collects the data from the sensors and provide the results to the ESP module then it sends the data through the cloud on a smartphone. The user can also monitor the values remotely through the android phone and PC.

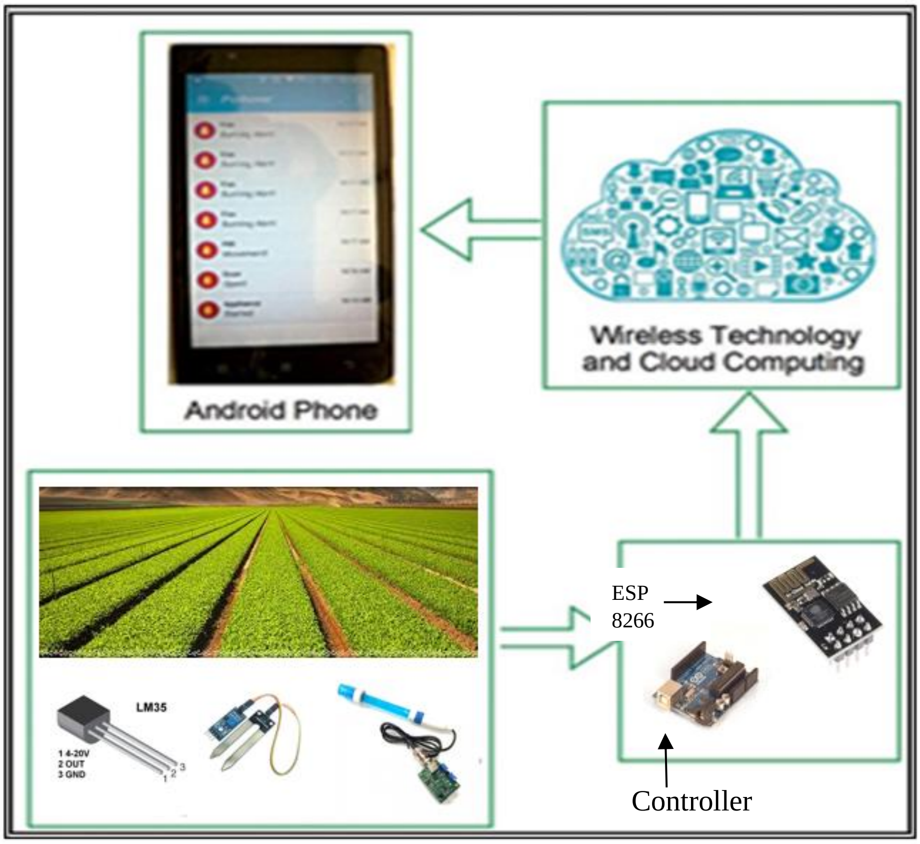


Figure 3.2: Diagram of the smart irrigation system using the arduino board

The system is divided into four sections as shown in figure 3.2. The first section is the Sensor section. Those sensors send the data to the controller that is Arduino Board and ESP module 8266 which is second section of system. Third and fourth sections comprise cloud server and smartphone. The smart irrigation system is becoming extra dominant. Internet of Things based smart irrigation system utilizes sensors to assemble and share data from numerous superiority devices.

3.2 Proposed System Components

The System components are as explained below:

3.2.1 Arduino Board

The Arduino Board is tiny and inexpensive controllers. It required a power jack to get triggered. The Arduino Board don’t have an inbuilt Wi-Fi module. Arduino Board can interface with various wireless modules like Bluetooth module, ZigBee module and Wi-Fi module to transmit the signal wirelessly to the cloud, smartphone or any operating system. Arduino Uno Board is work on ATMega 328 controller IC. It has a crystal oscillator of frequency 16 MHz, supply port, USB connection, a reset button, ceramic resonator, an ICSP header and the power jack. The Uno contrasts from all previous boards in that they are not able to use the FTDI USB-to-serial driver chip. Instead, it topographies the Atmega16U2 (Atmega8U2 up to version R2) involuntary as a USB-to-serial converter.
IO Pins: It is the important feature of the Arduino Board. Using input/output(I/O) pins of Arduino Board we can connect external devices with Arduino Board. It can verbally express as an interfacebetween the Arduino Board and the external devices.

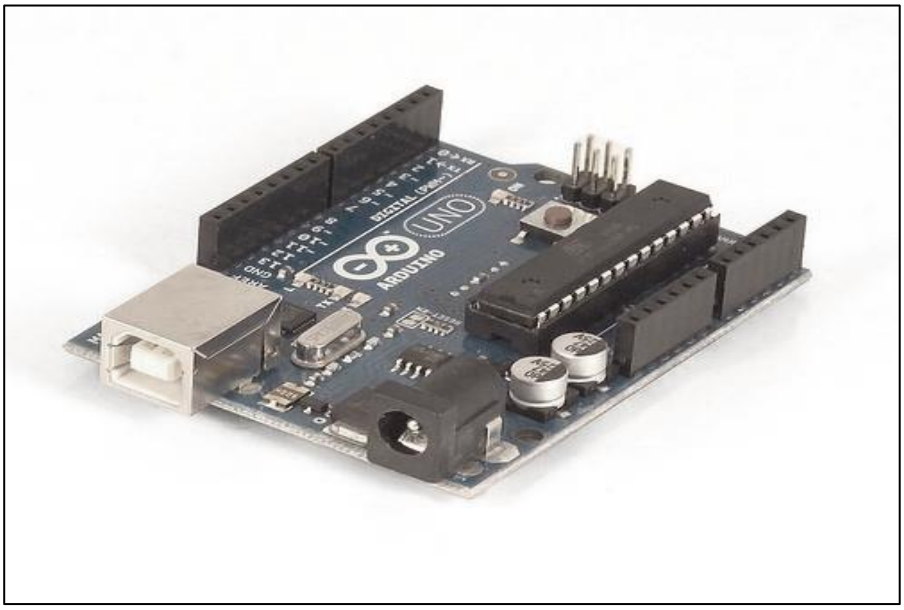


Figure 3.3: Arduino Board model

The Arduino Board model which comprises of ATMega 328 microcontroller in it has 14digital I/O pins for the external peripherals which works on the digital platform amongst which 6 pins are used to deliver the pulse width modulation (PWM)and 6 pins are reserved for the various analog input, others are power, ground pins and some are special purpose pins.

The prevalent modification takes place with the Arduino Board is that it is improved to a subsequent group of core controller and its networking gets upgraded. Furthermore, the Arduino Uno Board has enhanced in power managing, also to give provision to more influential peripheral USB devices, new Arduino Board also has dignified switched power source which is 50 mAmp. External power supply or USB connection is used in order to power the Arduino Uno Board. If external power supply is not provided by the USB connection, then the power source can be selected inevitably and it is either in the form of battery or AC to DC adapter. Board has the power jack mounted on its body with the help of 2.1 mm banana socket type of center positive plug has been connected to the adapter assembly whose one pin is connected to Vin pin and one pin is connected to the ground (GND) pin of the power circuit board. The board works on the peripheral supply of 6 to 20 volts. The board become unstable only when supplied power falls below the 7V range and 5V supply power less than five volts and if it is operated with higher amount of power in the range of 13V-15V it results in the overheating effect of the voltage regulator and damage the board. The indorsed range is 7 to 12 volts. The Arduino Board has inbuilt USB ports and it provides adequate connectivity for external devices that are needed by Arduino Board. Using USB port, we can connect external USB devices with the Arduino Board. It is better to use powered hub so that all the pressure should not come on board voltage regulator. There is no Power switch is available on an Arduino Board, to switch it off remove the supply is the only option that available to the user.

VIN: This pin is used when the Arduino Board gets supply from external power circuitry. If USB connection is used to power the Arduino Board then it can be access only through this pin.

5V: 5V supply is required to trigger the Arduino Board. When supply is applying within the range of 5-12 V then it is strictly provided through the Vin pin else if it is provided from the 5V pin the controller may get damage.

3V3: This pin is used to apply the voltage in the range of 0-3.3V or it is generated by on board voltage regulator assembly. It provides 50 mA of current.

GND.: This pin is used to ground the Board.

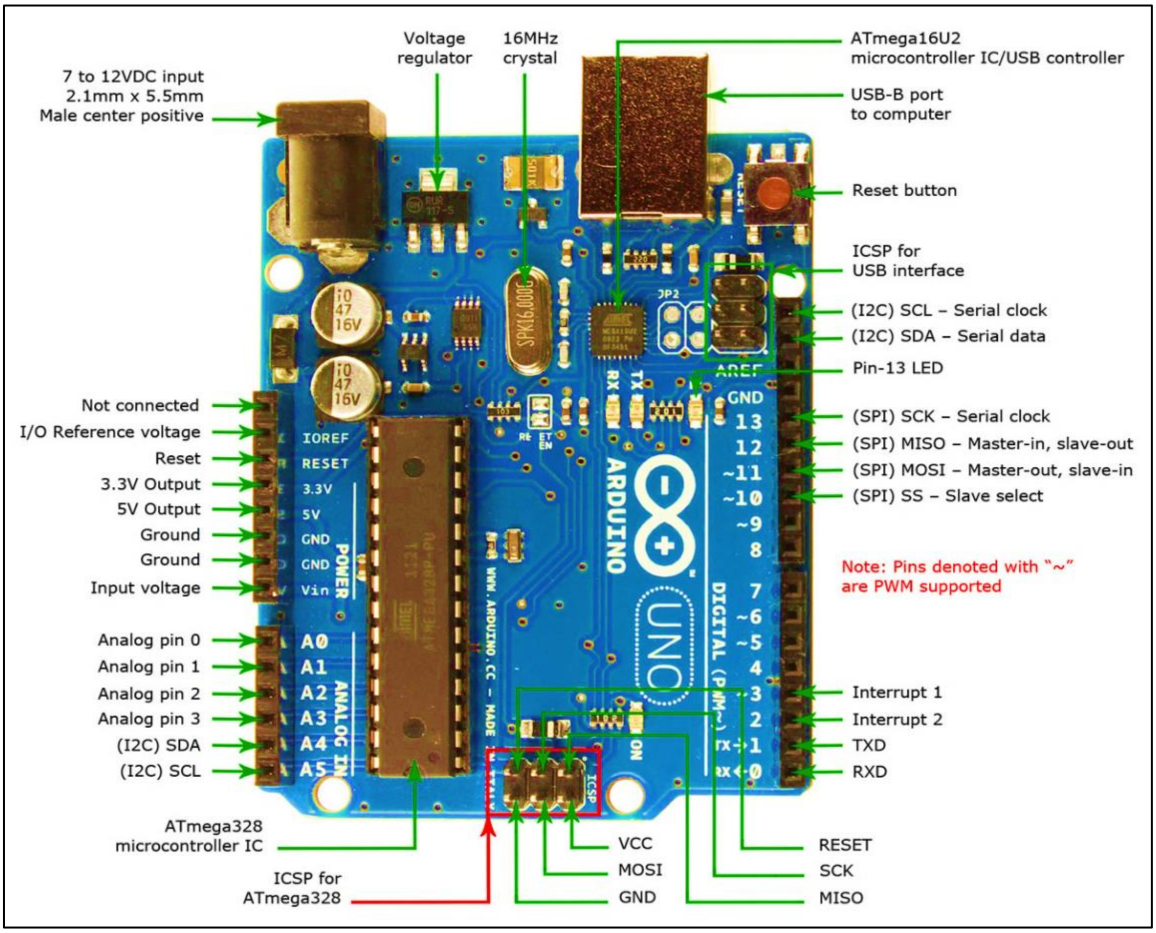


Figure 3.4: Arduino Board pin configuration

Memory: Arduino Board has 32 KB of flash memory, 2 KB Static RAM (SRAM) and 1 KB of EEPROM.

I/O Pins: Arduino Uno has 14 analog input- output pins amongst which 6 pins gives the PWM output and 6 digital I/O pins. 6 pins named A0, A1, A2, A3, A4 and A5 are provided analog input and 3, 5, 6, 9, 10 ,11 gives the PWM output.

Serial 0 (RX) and 1 (TX): These two pins are responsible for the serial communication between an Arduino Board and external peripherals.

Reset: Reset button is provided on the board in order to remove temporary glitch appears in the hardware. Pressing this button initiates the program which is dumped in the controller from starting point.

USB protection: If current more than the capability of Arduino is provided to the Arduino Uno Board i.e. 500 mA then the fuse inevitably interrupts the assembly and shelter the circuitry.

3.2.2Sensors

Generally, there are two types of sensor for sensing the environmental parameters one is Passive Sensors and another one is the Active sensors. Measurement of soil parameters is very hectic task because it requires various chemicals and mainly water in proper count. The only reason why there is very few sensors available which measures the soil parameters is only because of its water requirement, without water it is unable to read or analyze lots of parameter like porosity, salinity etc. Passive sensors are used to measure the earth parameters. In this case moisture, temperature and PH of the on-field soil are measured and analyze via Soil Moisture Sensor, Temperature Sensor and PH Sensor.

1. Moisture sensor

Soil Moisture Sensor is the passive sensor which is used to measure amount of water contain in the soil. It is very easy to use and manufacture. Soil moisture sensor comprises of two electrode or probe which are made up from various moisture sensing material. Working of moisture sensor is usually based upon two principles one is by measuring the resistance of the soil and other one is by measuring the capacitance of the soil. When two electrodes are immersed in the soil and voltage is applied to the Vin terminal of the moisture sensor then the current tries to complete the closed loop. Earth is the treasure of minerals and when current tries to flow through the soil it gets assisted by the minerals. During the measurement of moisture of dry soil resistance of the closed loop or current driving path is on the higher side and so as the value of the sensor. In case of wet soil resistance is on lower side because of water as it is also the good conductor of electricity and favors the flow of current through it that’s why the resistance of the circuit is on lower side so as the output. Another principle is of the measurement of water contain of the soil via frequency dependent capacitor phenomenon. Soil act as the dielectric constant and the two probes acts as two conducting plate. Frequency and Voltage is directly proportional to the dielectric constant between the plates. When the power gets turn ON charges induced on the one plate and soil act as a dielectric constant, as mention dry soil has a dielectric constant on higher side and wet soil has a dielectric soil on the lower side. Dielectric constant directly proportional to the moisture contain in the soil. Moisture sensor ranges from 0 to 100 % depending upon the moisture content in the soil. +5 V power supply is sufficient to give analog output to the Arduino board. When the soil is completely dry it shows moisture level of 0% and 100% when the soil is completely wet.

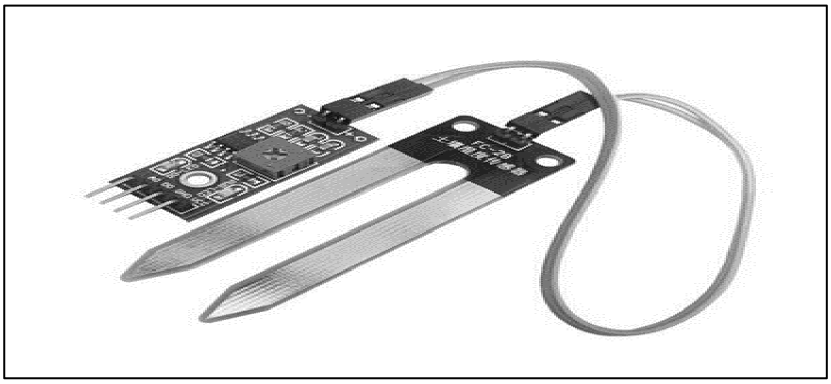


Figure 3.5: Soil Moisture sensor

Soil Moisture Sensor has two Input pin one is for input and the one is for ground. Moisture sensor works on the 5V DC power supply and provides the analog output in the range of 0.52V to 5V. The main advantage of this type of moisture sensor is it can connect with Arduino with minimal efforts. In this system the output of moisture sensor is given to the A5 pin of the Arduino Board. The values provided by the sensor is then manipulate by the formula

Moisture= Moisture*100;

Moisture= Moisture /255;

According to this formula moisture sensor's output varies in between 0% to 100%. On the basis of readings given by the sensor watering has been done in the farm. Dimension of the moisture sensor is 60x20x5 mm. It is very tiny, easy to use and most importantly it is less expensive, can afforded by the normal human being.

2. Temperature sensor (LM35)

Temperature sensor LM35 is used to measure the temperature of the soil. The LM35 is a precision integrated-circuit temperature device. It is design in such a way that it increases its output voltage with respect to increase in temperature and vice a versa means it means temperature is directly proportional to the output voltage. One main advantage of LM35 is its output delivering capability, it shows result in degree centigrade (°C), so the requirement of subtracting the given result from the estimated value is totally vanished. The most of the temperature sensors has given the measurements in terms of degree Kelvin so to obtain desired output from the given value one has to subtract 273(0°C is equivalent to 273°K). In simple words the calibration from degree Kelvin to degree Centigrade is unnecessary here. The temperature sensor LM35 is not necessitate any exterior standardization or pruning to provide characteristic. The precisions of ±¼°C at room temperature and ±¾°Coveroccupied −55°C to 150°C temperature range. LM35 is calibrated with the low-cost triggering assembly. This temperature is manufactured with the less expensive wafer level. LM35 is an integrated circuit which makes connections with the external peripherals easier than other temperature measuring sensors because of its low output and low input impedance, linear transformation of output and most important accurate inbuilt capabilities. The sensor works in temperature range between −55°C to 150°C. The sensor is also advantageous in terms of the power drawn phenomenon as it only has the power consumption of 60 μA from available power supply and also in terms of self-heating capabilities i.e. it has very less near about 0.1°C self-heating in still air. Temperature sensor is advantageous in one more account as it has very accurate in terms of the measuring values of the existing component or material. Temperature sensor operates on +5 V DC supply.

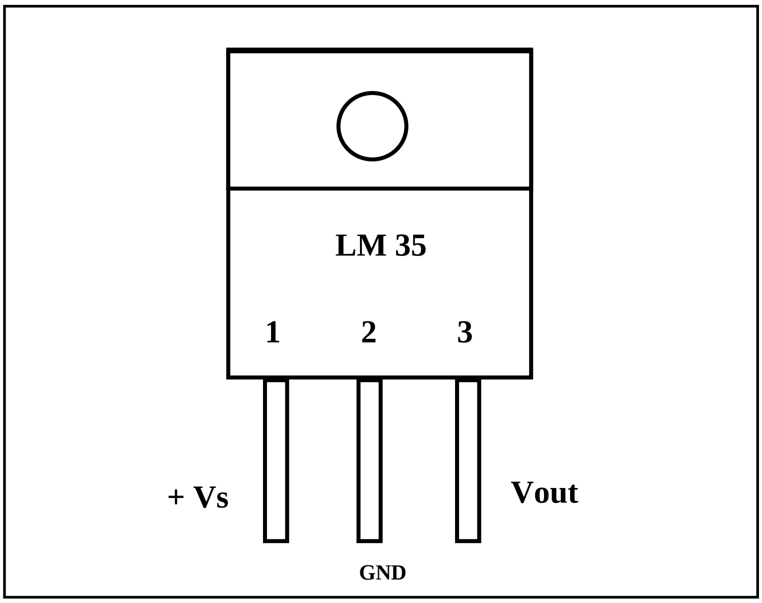


Figure 3.6: Soil Temperature sensor

Figure 3.6 shows the LM35 temperature sensor which is used in this system in order to minimize the efforts of interfacing with an Arduino board. The sensor has 3 pins in which first pin(+Vs) is used for applying power supply of +5 V, the second pin (GND) is used for the earthing purpose while third pin(Vout) is used for obtaining the output voltage or on field reding in terms of voltage. Temperature sensor operates in the range of 4V to 30V, the input may vary with respect to application in which it has been used. Basically, temperature sensor is of two types depends on the range of use

1. Basic Centigrade Temperature Sensor (2 °C to 150°C)
2. Full- Range Centigrade Temperature Sensor

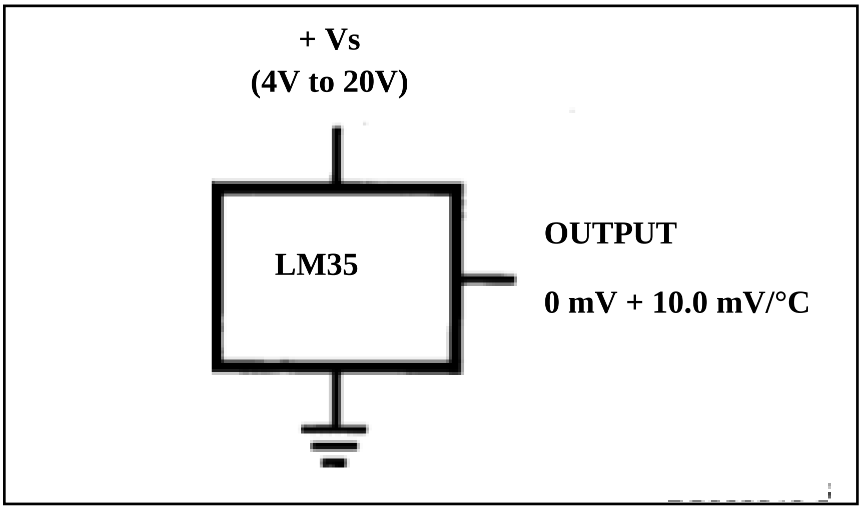


Figure 3.7: Basic Centigrade Temperature Sensor

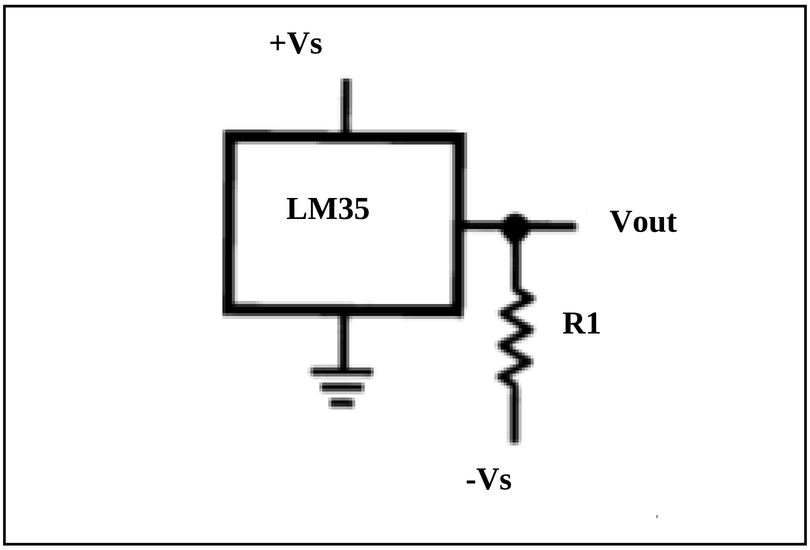


Figure 3.8: Full- Range Centigrade Temperature Sensor

Basic centigrade temperature sensor has an output in terms of 0 mV + 10.0 mV/°C when provided with the input in the range of 4V to 20V. In comparison with the basic centigrade temperature sensor full range centigrade temperature sensor is available with wide range of input voltage and it provides the output in relation with the temperature of the material or the environment. For 150°C it gives the reading of 1500mV, for 25°C it gives the reading of 250mV and for -55°C it provides the output of -550mV. LM35 temperature sensor is linearly varies with the increase or decrease in temperature by the factor of 10mV/°C which is also called as linearity factor. In this system LM35 sensor is used to measure the temperature of soil in which cultivation of the crops should been happened. The normal temperature range of the soil in most part of the India is in between 7°C to 52°C so in this range temperature sensor can work properly. Basically, what temperature sensor do in this project is to measure the on-field temperature of the soil and pass the given information to Arduino board which is connected to it. Temperature sensor delivers analog output so it is connected to the A1 pin of the Arduino board. The values provided by the sensor is then manipulate by the formula

temp=temp*500;

temp=temp/1023;

According to this formula temperature sensor's output varies in between room temperature to its maximum capability. On the basis of readings given by the sensor watering has been done in the farm. It is very tiny, easy to use and most importantly it is less expensive, can afforded by the normal human being.

3. PH Sensor

PH sensor is used to measure the particular PH value of the field. What is the PH of the soil? Basically, it is a hydrogen ion concentration present in per moles of the soil. This sensor helps in terms of measuring the acidic and basic nature of any solution or the material. If soil contains hydrogen atom in more proportion then it makes soil acidic and vice a versa. The more acidic or basic nature of soil may affect the growth of the plant in the field. The proper nutrition's are required for the crops in order to grow in good manner. In other case if farmer has provided the extra basic or extra acidic fertilizers to the crops then also it can affect the crop while growing and which ultimate result come in the form of dead crop or can affected by some of the uncurable disease. So, in order to prevent the agriculture land from being more acidic and basic the PH sensor is used. If in case farmers provide the fertilizer which is more acidic and crops does not require that much amount of acidic nutrients then in this condition PH sensor performs the vital role, with the reading given by PH sensor the more basic solution or fertilizer can spread in the field in order to cure it from disease or becoming more acidic.PH sensor is of the rod shape in which one bubble of the particular solution is there at the top to measure the particular value. The rod is comprising of glass membrane and silver wire which is dipped in potassium chloride solution (KCL) and silver wire is coated with silicon chloride membrane. Activity of hydrogen ions in the water leads to the measurement of PH level of the material or solution by the PH probe. When hydrogen ions come out of the solution and immersed on the glass causes the diffusion of ions on the glass membrane while most of the hydrogen ions are still in to the solution. Potential difference is generated in between the hydrogen ions and which aggravated the small current flows through the solution. The hydrogen ions contain in the solution is directly proportional to the small amount of current flows through the solution. This phenomenon causes the measurement of the PH level of the any solution or material.

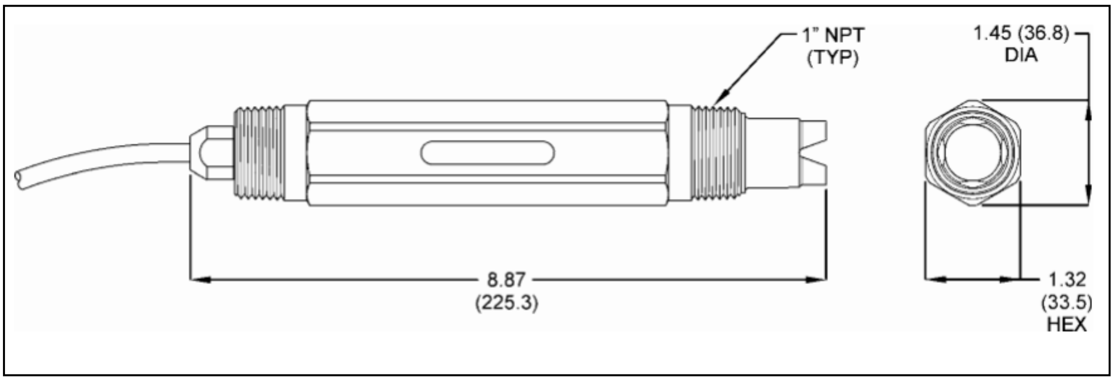


Figure 3.9: Dimension of soil PH sensor

Figure 3.9 shows the dimension of soil PH sensor. Normal water or groundwater has a PH value of 7. If the solution having PH value less than 7 then it is acidic and if it is greater than 7 then called as basic solution. PH sensor measures the PH value of the material with-in the range of 0-14. This sensor works in the temperature range of 1°C to 99°C. PH sensor requires the power supply in the range of -5V to +5V.

Figure 3.10 shows the PH sensor which is use in this circuit. Soaker bottle is at the front panel of the sensor. This solution in the bottle PH sensor is connected with an Arduino Board which delivers the reading to the user after performing certain manipulation. PH sensor delivers the output in terms of the voltage to the board.

It also provides the analog result and connected to the one of the analog pins of the Arduino i.e. A0. According to the readings provided by the PH sensor farmer has to be decide to turn on and off the fertilizer pump. The output current produce by the diffusion of hydrogen ions is very weak which is unable to drive the circuit and multimeter is not able to measure the current because of which analog to digital circuitry is used here. This analog to digital circuit is called as Gain Control Board.

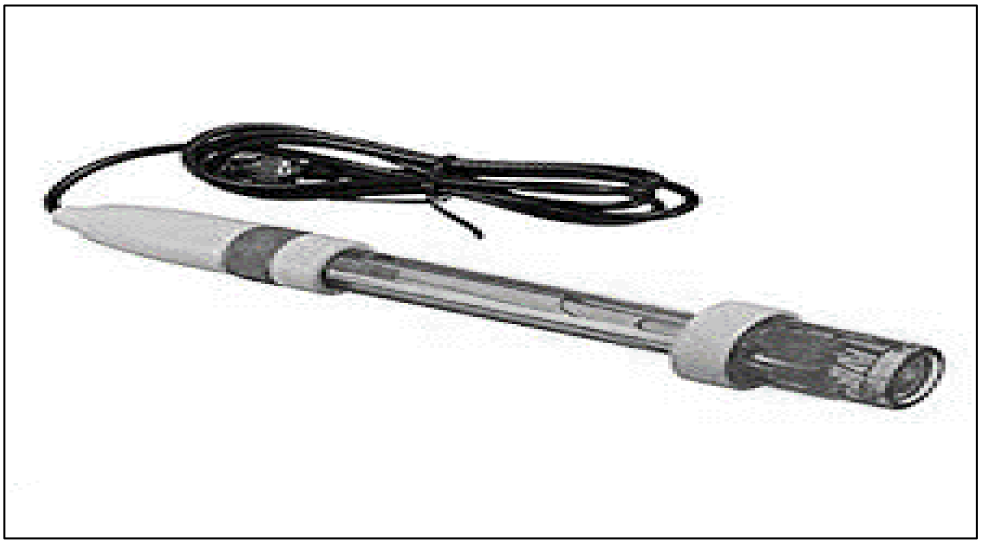


Figure 3.10: Soil PH sensor

3.2.3: Gain Circuit Board

PH sensor which is used in this system is very hard to interface with the Arduino Board. The sensor provides less amount of output current to the Arduino Board and digital multimeter or analog multimeter can't able to read the values, due to this Arduino board is unable to perform the certain manipulation and it has been restricted from doing certain operation which has to execute after receiving the on-field information from the sensor. Also, the output voltage of PH sensor is inversely proportional to the PH reading, if solution or material having less PH value then it gives less amount of voltage at the output terminal and vice versa. In order to interface this tricky PH sensor to the Arduino Board one separate analog to digital converter is used and it is called as gain circuit board.

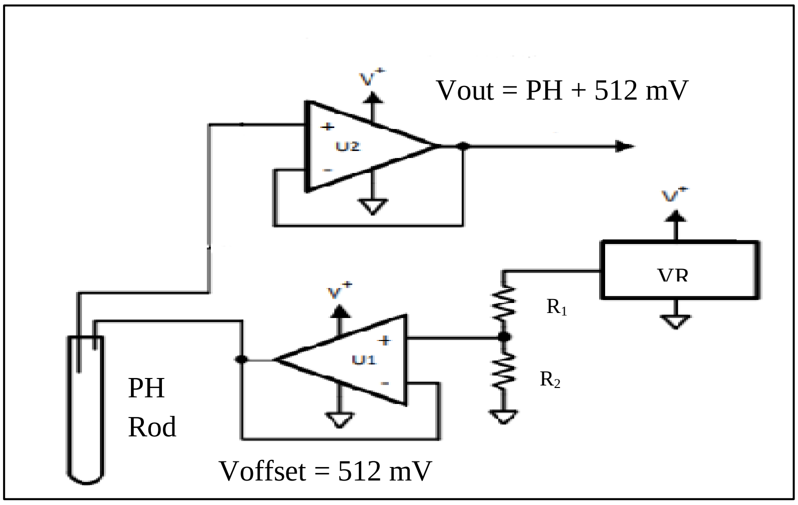


Figure 3.11: Gain Circuit Board

The important aspect behind the design of any kind of sensor is, it should be calibrated with any of the microcontroller or peripherals to fulfill the outcomes. Sensors requirement varies with the application to be used. Sensors compatibility with all the devices is the main parameter to design or constructed any kind of circuitry. PH sensor gives the output in the range of -5V to +5V i.e. bias output or bipolar output. But most of the application or circuits are work on the unipolar signal. It has been quite a problem to interface PH sensor with board or controller. There are the two-problem statement one is the level of the signal and other one is high impedance. It means as all the appliances works on singular power supply, the signal should be level shifted to trigger the peripherals connected to it and buffer is used to vanishes the second condition as the electrode has high impedance it must be given to the buffer of high input impedance. Figure shows the gain circuit board which compensate the two drawbacks of the sensor. Sensor uses voltage reference circuit which gives the exact output of 1.024V. This supply is applied to the 10 kΩ resistor divider assembly which bias the voltage in equal count of 512 mV. The amplifier is set in the unity gain configuration which biases the output electrode of PH electrode in 512mv, which results in to producing the output which is 512mv exceeds than normal reading and nullifies the condition of bipolar power supply and the PH electrode gives the value of PH + 512 mv. This shifts the power supply in to the range where external peripherals can handle the output of PH sensor. Normally PH sensor delivers the output which is able to drive the external circuitry which is connected to it but in some condition, it has been given to the amplifier to drive the peripherals. Amplifier act as high input impedance buffer which strengthens the weak output of PH sensor. If PH sensor has to connect with high input driven circuits then the high input impedance buffer circuit act as a bridge or interlink in between the input circuitry and the output of PH electrode. Amplifier U1 is use in the most of the cases such as the devices which required unipolar power supply and can drive on the low power supply and U2 is used where both unipolar and high amount of power supply is required.

Figure 3.12 shows the Gain circuit board which is used to increase the strength of the output of PH sensor and shifts the output in the range where Arduino Board gets trigger or get the proper input values in order to carry out further operation. Gain Circuit Board consists of Operational Amplifier, Voltage Regulator several capacitors, resistors and simple P-N junction diode. This circuit requires to pre-amplify the PH output with high input impedance and PH to voltage conversion.

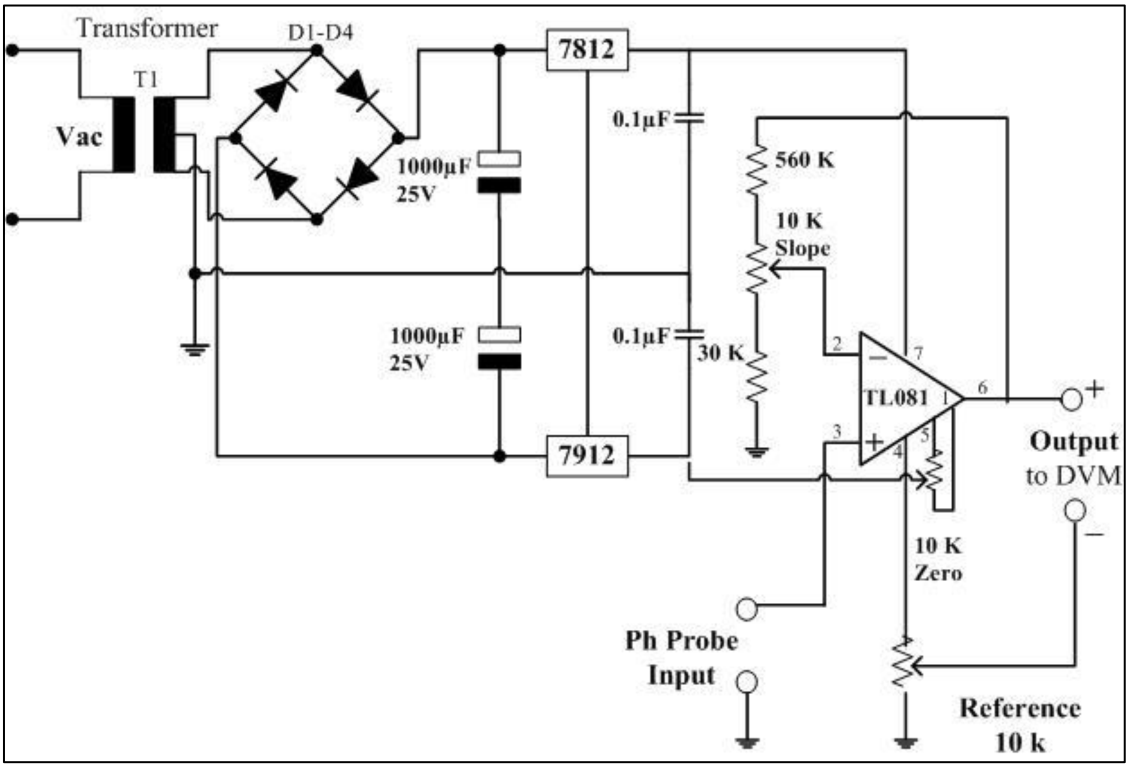


Figure 3.12: Proposed Gain Circuit Board

Operational amplifier provides 16.7 gain and gives output of 1mV for every increase in PH. PH electrode gives less amount of current so to support it two voltage regulators are used. Resistor assembly is used for the biasing purpose. This circuit is like a simple archetype of a circuit which is required to interface PH sensor to the Arduino Board. This board constructed on the basis of one simple phenomenon that the voltage produce by the PH sensor is directly proportional to the hydrogen ion concentration of the solution. PH probe is highly resistive in nature with high input impedance. The basics of connecting the PH probe requires two operational amplifiers with stable offset and output voltage in proper count, high input impedance with biasing input on lower side. It also requires error straining circuitry with decoupling caps. Mainly, the circuit has to response for bipolar input values. Operational amplifiers are chosen on the basis of high input impedance and stable offset. In order to select operational amplifier, it has to fulfill above requirement but has to stand in the terms of accuracy and cost. Because most of the amplifiers have the characteristics that can interface with PH probe so, select it wisely. This circuit based on the comparative analysis in between ideal PH probe and the probe which is used in this system.

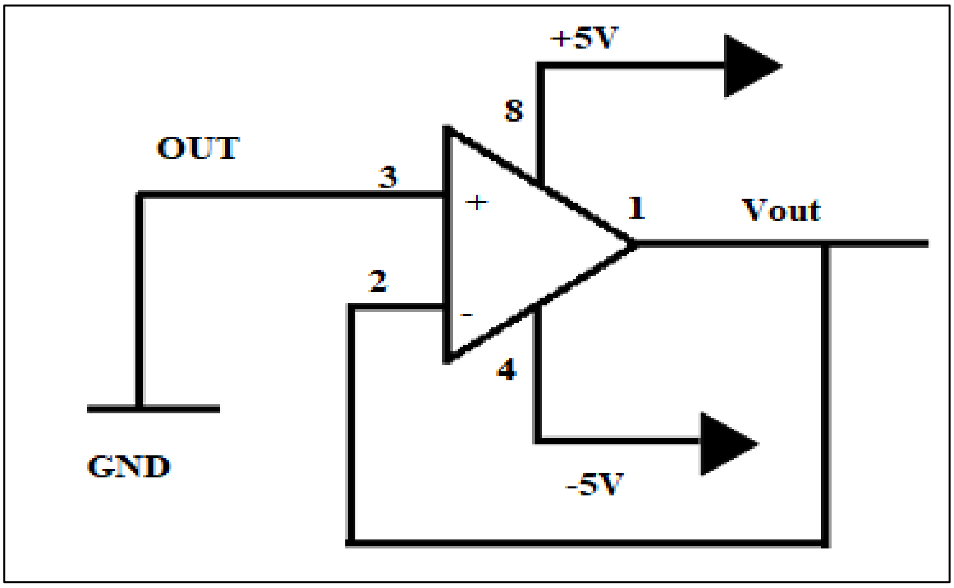


Figure 3.13: Operational amplifier circuit

Ideal PH probe gives the output of 0V for the 7 PH value. Due to its bipolar property it gives the positive and negative values at the output. 0.414V output is given for the 0 PH value and 0.414V for the 14PH value. The PH probe used in this system gives the output values of -0.4V for the PH value of 7, at 5 PH value it gives -0.150V output. This gives the sufficient reading in order to obtain the range for the PH scale i.e. 0.190V/3.

Output voltage is calculated on the basis of the two types of formula,

$$V_{out} = V_{in} + V_{offset}; \text{ (for 5V)}$$

$$V_{out} = -V_{in} + V_{offset}; \text{ (for 0V)}$$

Here the system requires the two operational amplifier one is for the amplifying purpose and one is for providing offset voltage. It also requires the negative verge as operational amplifier uses the negative voltage for swing. The circuit uses basic configuration of the non-inverting amplifier merge with the differential amplifier circuit. Stability is the main parameter of the any circuit, capacitor is used here in order to provide the stability to the design.

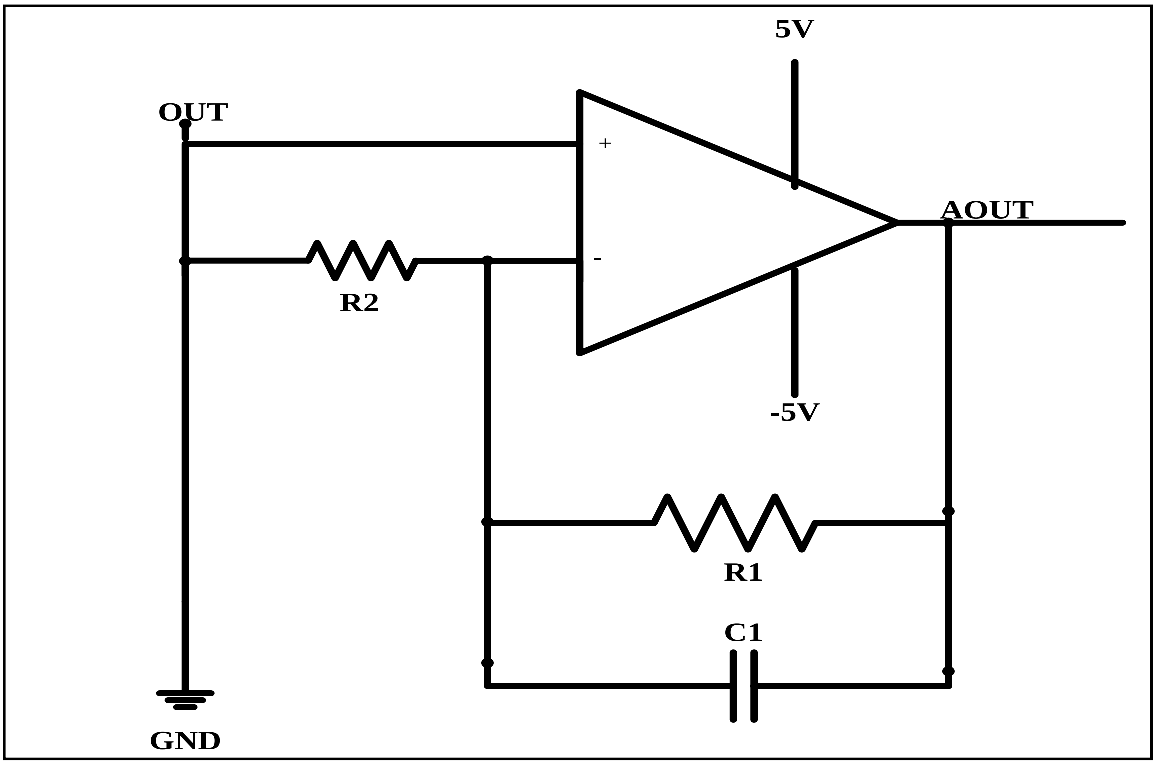


Figure 3.14: Offset amplifier circuit

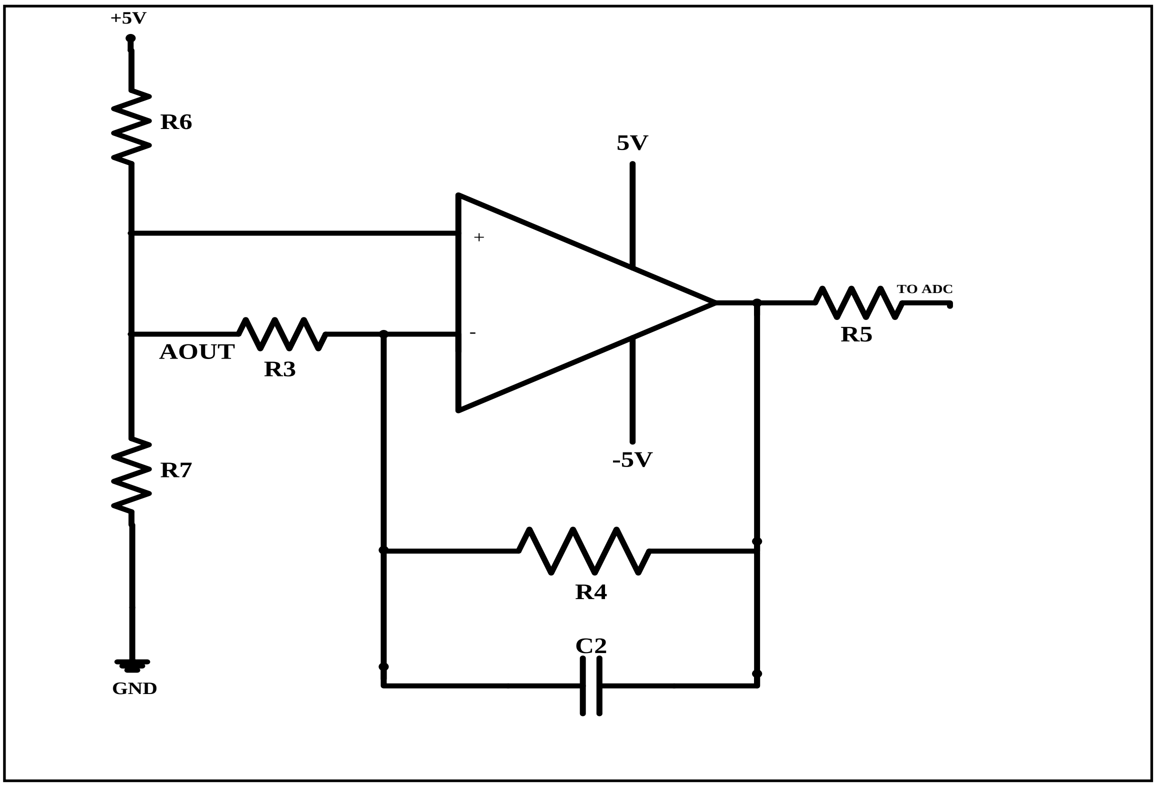


Figure 3.15: Operational amplifier clamper circuit

The readings given by the PH sensor to the gain circuit board should be normalize with the adjustable offset control probe. In order to use it for commercial application it has to give the reading of 0V at 7 PH value it has done with help of gain adjustment in the gain circuit board as the gain factor does not alter the readings.

3.2.4: Wi-Fi Module ESP 8266

ESP 8266 is the Wi-Fi module which is used in this system to overcome the drawback of Arduino Board as it doesn’t have its own self-contained Wi-Fi module like Raspberry Pi. ESP 8266 Wi-Fi module is works as the bridge between the Arduino Board and Wi-Fi. ESP module can send the data from Arduino Board to the design IoT platform so that uses can access it from remote place by one simple login id and password. ESP module has integrated with TCP/IP protocol and has self-contained SOC. ESP module easily provides the Wi-Fi when gets connected with Arduino Board as it has its own program meaning. Wi-Fi module has a capability of understanding the programing language which is used for the programming of an Arduino Board. One can write a program in IDE and dumped it in the ESP module after verifying then it can perform the work of microcontroller. It is capable of driving the application on its own. ESP module has a GPIO (General purpose input output pins) with the help of which it has been connected to the external peripherals.

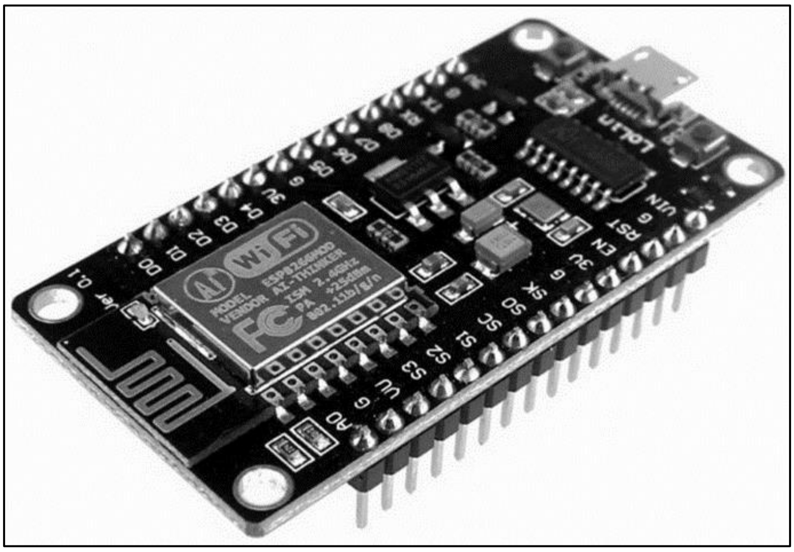


Figure 3.16: ESP 8266 Wi-Fi Module model

Figure 3:16 shows the ESP 8266 Wi-Fi module which is used in this system in order to provide on-field data on to the IoT platform. Node mcu has 32-bit micro control unit integrated with the low power. It has current consumption of 10µA to 170mA which provide by the 3.3V power supply. Wi-Fi module has the flash memory of 16MB with RAM of 32KB used for storing the program which is dumped on the module. Tensilica L106 which is 32-bit processor is used in this module whose processing speed is near about 80 MHz to 160 MHz Module has peer to peer Wi-Fi direct communication.

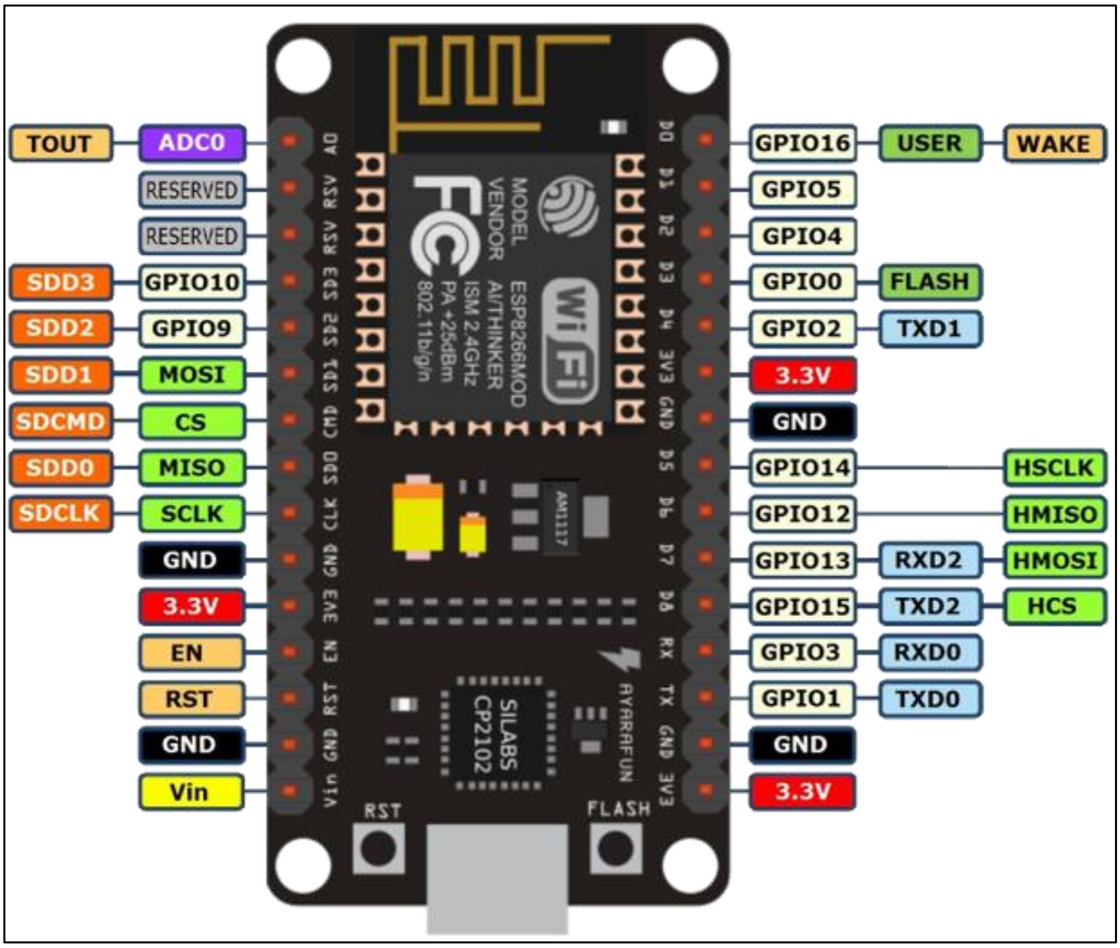


Figure 3.17: ESP 8266 Wi-Fi Module pin configuration

Figure 3.17 shows the pin configuration of Wi-Fi module ESP 8266. It comprises of 16 general purpose input output pins. Among that GPIO1, 3, 13, 15 are used as a receiver and transmitter pins namely TXD0, RXD0, RXD3, TXD2 respectively. These pins are used for serial communication with external peripherals and can upload the program on ESP module through it. GPIO10 and 9 are for super delay lines and used for on board SPI flash. 3.3V and GND are used for providing the power supply to the ESP module to maintain the Wi-Fi module in the current range of 500mA peak to peak. There is RST pin which used to reset the controller with 3.3V supply. This pin is used when the module is not working properly without any interrupts and if the module causing many problems while performing the operation or during the debugging the program. There are two pins named as RSV which means reserved, these pins reserved on the module to perform some operation in rare condition otherwise they are always open. EN is the enable which is connected to the ground in case user must switch off 3.3V voltage regulator supply. Vin pin is used in order to apply the input voltage of 3.3V. D4 to D8 pins namely GPIO 2, 14, 12, 13 and 15 respectively are used with two recommended resistors, pull up resistors and pull down resistors GPIO 15 should not be high at the time of startup this helps in avoiding the boot mode operation because if controller goes in to the boot mode state then it permits the program loading with in that operating system only which may causes problem letter on. This condition reverses in the case of GPIO 2, it requires pull up resistor it should be at high output state during the startup of the system to avoid the boot mode operation. There are two separate buttons name as RST and FLASH, RST is used to reset the module if interrupts occur and start the calculation from initial stage. FLASH is used while dumping the program on the module. Initially, if ESP module is loaded with some kind of program then for uploading the new one in to that FLASH button performs the major role. ESP module has the separate pin for MISO i.e. Multiple Input Single Output it can performs the role of multiplexer for connecting the multiple peripherals. It also has SCLK pin to deliver synchronous clock input to the board. This module has one pin of analog to digital converter which provides 1024 steps revolution. When the Arduino board receives the signal information from the sensor it is provided to the Wi-Fi module to analyze and take proper action according to the parameters values from remote area. Module helps this system to expand its area than the previous models which is the main advantage of this system.

3.2.5: Liquid Crystal Display (LCD)

Liquid crystal display is a small display unit which is used to display the numerical values computed by the various microcontroller and microprocessor. It is called as 16 x 2 display because it has 16-character x 2 display lines means it can display 2 lines with maximum of 16 characters presents in it that with 5 x 8 dots with cursor. It has built in controller to display various numerical values. This display supports various display mode and can vary the contrast and brightness of the backlight with the help of variable resistors. LCD display has two types of register one is command register and another one is data register. Instruction given to LCD is store in the command register to perform the presume operations. Operations like initializing, governing display, monitoring cursor in order to defined its position on the display, screen clearing etc. The data which is to be displayed on the display is stored under data register. ASCII values are used to store the data in the data register. Display has an ability to show the any data within the ASCII range of 0 to 255.

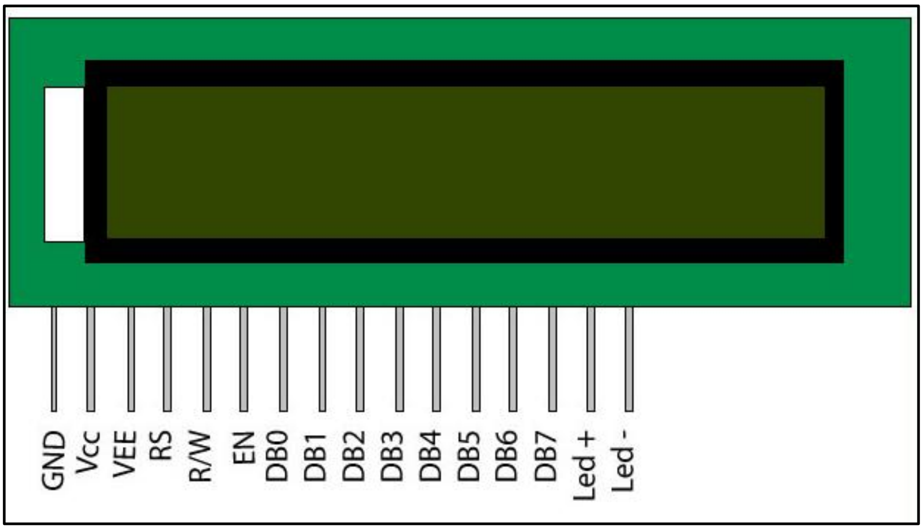


Figure 3.18: LCD pin configuration

This optical device has 16 pins which is used for interfacing with various external peripherals like microcontroller and microprocessor. Among that 16 pins namely DB0 to DB7 is 8-bit data pin used to select register and its state. According to input given to the LCD it makes these pins high and low. There is a pin called EN which is used to enable the high-low state of the pins. RS and R$\hat{W}$ is used to select H/L register and to read/write the selected H/L signals respectively. If R$\hat{W}$ pin is at low state then it writes the register and when it is in high state it used to read the register. If RS pin is low then it is used to select command register and when high it selects data register. Vcc and GND is used to provide power supply to the display. +3V or +5V supply is required for the LCD to start the operation. Vee is used to provide +4.2V supply for LED and used for adjusting the contrast of the display with help of variable resistor. LCD's backlight plays the important role in order to give notification to the user. LED+(5V) and LED-(0V) is used to provide the supply and making it ground at the same state. This pins also named as backlight Vcc and backlight ground respectively. 16 x 2 LCD is used to get the on-field sensor value on the system itself. It is connected to an Arduino board to know the parametric values of the sensor. According to that user can take immediate action on the field itself.

3.3 Software

Two different parts of software are used in this project. The first part is an Arduino Integrated Development Environment (IDE) for an Arduino which is front end of the system and the second part is the server-side software or an IoT platform called Thingers to view the data and control it remotely.

3.3.1 Arduino IDE (Integrated Development Environment) software

Arduino is the open source platform which can perform the operation using hardware and its software also. Arduino IDE software application is used to dump the program in Arduino and ESP module 8266. The programming which is done usually in Arduino IDE is most user friendly as it uses C and C++ programming language with the less than 80% of instruction set. Arduino IDE has the huge library count which supports maximum of the external peripherals or the microcontrollers, microprocessors and various sensor. If one has to access the proper sensor through Arduino board the Arduino IDE must have contained the existing library of the sensor. The Arduino IDE software uses the text editor window to write the program, it also has the special area to show the message given by the board or external peripherals called as the message space. Arduino Board has the different number of applications according to that it has to provide the various tools in order to write the proper program which are present in the toolbox button. The program which is written on Arduino IDE is called as Sketches. Firstly, one has to download the Arduino IDE software with the as possible as many libraries in order to used it in the wide manner. It has four brief steps starting from opening the software to write the code for the desired operation to dumping the code on the Arduino board.

a) Arduino IDE: Primary Setup: When programmer starts the IDE software by double clicking on its icon in the system it opens up the blank window or sketch. This helps user to write the code and edit it with necessary conditions which are required to perform the given operation in exact manner. After writing the program user should have configure the type of board used in the system and state the Arduino board ports in order to give expected or resulting signals and for receiving essential signals from the interfaces. This permits us to dump the program in the board which is to be connected via universal serial bus to the personal computer.

b) Arduino IDE: Board Setup: When board is connected to the PC user has to inform the software that which board is going to use in the system from available Arduino boards in the world. Software is always updated with information about the boards present in current position so, by going in to tool option on the title bar of the system and dragging it down to the board one can select the Arduino or any other board which is required in the system.

c) Arduino IDE: COM Port Setup: If Arduino board is not connected with system on which program is return in initial state then it is dumped inevitably after it gets connected. Software now sates the COM ports of the Arduino board after downloading the sketch in the board. After selecting the Arduino board which is connected to the system COM ports also gets initialize if it is a standard Arduino board. Bottom right corner gives the total information about the Arduino board and the COM port which are going to use in the system. COM ports are used to show the numerical values shown by the external peripherals.

d) Arduino IDE: Uploading Setup: After performing all relevant operation user has to select proper boud rate and upload the program in the desired Arduino board.

Summarizing the steps:

1) Install Arduino IDE software on the PC.
2) Write a program for sensors, IoT platform and wi-fi module 8266.
3) Select baud rate.
4) Select the proper board.
5) Select the proper port.
6) After completion of the above steps, it can run the program and it can dump on an Arduino board.

Arduino Programming: - Arduino programming language is used for programming. Arduino is a reliable programming language that is convenient and suitable to use with Arduino Board and Genuino Board. It even uses very fewer lines of codes as compared to C or C++. There are two main instruction that are present on the system while writing the program one is void setup () and another one is void loop (). The code which is written in the void setup () is executed only one time after compiling and running the program while after executing void setup () commands the void loop () is continuously produce the output until some interrupt occurs or reset the system down. pinMode (pin, mode) is used to initialize the port and its pins to give proper input and output. digitalWrite(pin, value) is used to write the appropriate value in the exact pin or providing some information to the user. digitalRead(pin) is used for reading the information from the system. In this system, Arduino programming language is used in order to make connections with Arduino Board and ESP module to get desired outcomes.

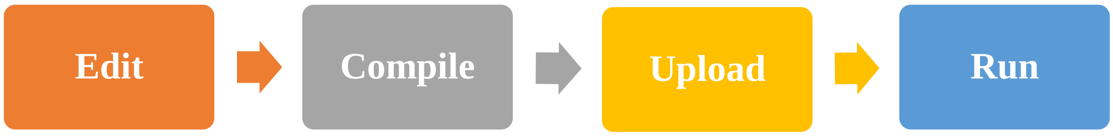


Figure 3.19: Flow of an IDE programming

Edit: Program or sketch is written on the blank sheet which is opened at the start of the IDE.

Compile: Compile stands for converting the code in that language which machine can understand.

Upload: Uploading means to write or dump the sketch on the board.

Run: Run stands for executing the sketch after the completion of uploading process.

3.3.2 IoT Platform Thinger

Thinger is open source API platform that can acquired the real-time sensor data of several Internet of Things applications and depict the data in pictorial form of analysis graphs. The Internet Connection serves as Data packet carrier between sensor assembly and the cloud to store, recall & retrieve the data sensed on the host microcontroller like Raspberry Pi, Arduino UNO etc. The channels in Thinger cloud have distinct field for data, location & status. All sensed data can be visualized graphically with statistics involved if MathWorks account is synchronized with Thingers cloud.

The primary element of Thinger activity is the channel, that contains data fields, location fields, and a status field. Once a Thinger channel is created, user can write data to the channel, process and view the data with digital platform, and react to the data with tweets and other alerts. Thinger has a main advantage over other IoT platforms that it can write the data means it can sends the signal to the external peripherals to control it. Again, it also helps in storing the back dated information to give user the actual knowledge about the process going on.

Thingers is an IoT platform which is open source and can access by anyone. It has a following steps:

1) Create an account with proper login id and password.
2) Create dashboard for various external peripherals.
3) Select the proper device from which the results are drawn.
4) Plot the graph, display the values numerically if necessary.
5) Create a two switch on the dashboard for controlling purpose.

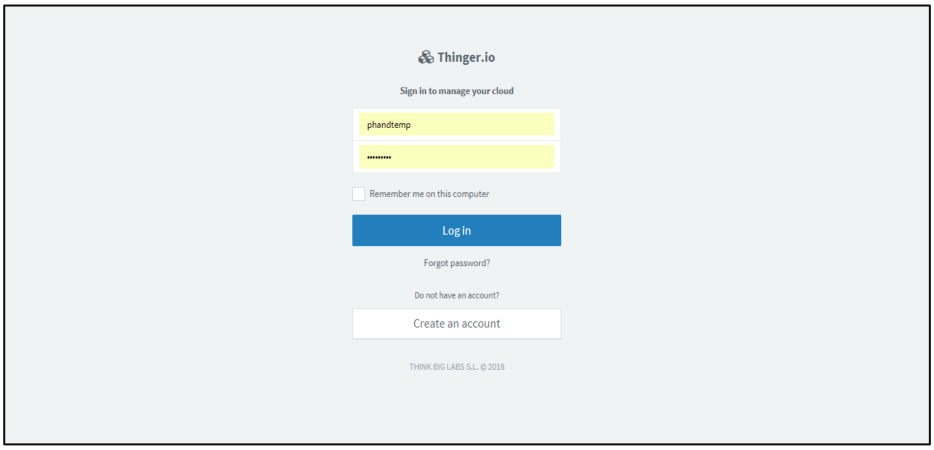


Figure 3.20: Thingers Login page

Thinger can transfer the data through the web server and web application as it has RESTful API's. It can provide users some facilities over the period of time. It contains Dashboard, Statistics, Devices, Data Buckets and End points.

a) Dashboard: Dashboard is providing important asset to the Thinger in order to view and analyze the parameters provide by the external interfaces. Dashboard is customizing with the requirement of the user which is differ with the application it has been used. It provides the pictorial and numerical information about the entity which is present there at the other end of the process. Dashboard provides gadgets to give the illustrative information about the sensor. This gadget consists of various graphs, pie chart, speedometers, range meters, bar graph, scattered graph, time series chart etc. one can add, delete or modified the gadgets while compiling the system.

b) Statistics: It gives the information of dashboards, devices, end points and data bucket.

It shows how many devices are connected to the cloud and from which device or controller the data has been taken is going to decide. It again shows the in short information of dashboard platform that how many parameters are going to give output to the dashboard. Again, it enables the data bucket and end points of the system. It is also called as console dashboard which gives the time and current location of the system.

c) Device: Thinger permits to manage and control at max to devices. One can produce several devices but Thinger can operate on maximum of two devices. Unique device token has been given to the each and every device which is connected to the system for identification purpose. Once device gets connected with cloud it shows the wholesome information about the device, its transmission speed, data reception speed, online and offline status, IP address, from how many times the device is connected and most important the time and date of the last instance of device when it is connected with system.

d) Data Bucket: Data Bucket is an important parameter behind the selection of Thinger as an IoT platform. Data Buckets stores the back dated information of the field or the external peripherals connected to the cloud or platform. Normally, it allows the storage of last 30 days but upgraded platform comes with more duration.

e) End Points: End points gives the authentication about the authorized transmission of the data and format of the data which has been access by the user.

3.3 Working

This scrutiny method comprises of mainly two sections:

1. The first part consists of setting up an Arduino board and interfacing it with sensors.
2. The second part consists of developing an IoT platform and linking it to the server for notification purpose.

The smart irrigation system implemented in this project is an easily installable system built using Arduino Board, Wi-Fi module ESP 8266 and different sensors. Sensors used here are PH Sensor, Moisture Sensor and Temperature Sensor. The Arduino Board does not have onboard Wi-Fi module so, ESP module is used here in order to connect an Arduino Board with a Wi-Fi to access a cloud server.

This system can be implemented anywhere in the field whose inspection is in the radar. It thoroughly depends upon the quality of soil which is present in the farm that how many numbers of such prototype required in order to access the full farm. The range is not an issue as IoT platform is used here for remotely accessing of data but the soil parameters like PH, temperature and moisture varies from point to point in the field. This is why number of prototypes are required in the field depending upon the dimension and quality of the soil. System comprises of Arduino UNO Board which has an input-output pins is used here to control the whole system. Arduino Board has an analog input pins which are required to access the three sensors which are used here. Among the six analog pins it uses A0, A2 and A5 pins to connect, access and control the PH sensor, temperature sensor and moisture sensor respectively. Each and every sensor works on the different platform and on different phenomenon. This creates difficulties to the Arduino Board in order to interface it with these three sensors simultaneously. Moisture sensor and Temperature sensors are slightly easy for interfacing than the PH sensor. Interfacing the PH sensor with an Arduino board is the most difficult phase of the system that with fetching the data from moisture sensor and temperature sensor at once. Gain circuit board is used here in order to connect PH sensor to the Controller. When ESP module transmits the signal to the IoT platform, this system actually controls the outcome which has been cause naturally.

Moisture Sensor is used to sense the water contain in the soil. Moisture sensor based on the measurement of water contain of the soil via frequency dependent capacitor. Soil act as the dielectric constant and the two probes acts as two conducting plate. When the power gets turn ON charges induced on the one plate and soil act as a dielectric constant, as mention dry soil has a dielectric constant on higher side and wet soil has a dielectric soil on the lower side. Dielectric constant directly proportional to the moisture contain in the soil. Moisture sensor ranges from 0 to 100 % depending upon the moisture content in the soil. This moisture sensor is connected to A5 pin of the Arduino board which conceptualize the values and passed the information to the IoT platform Thinger via ESP module. If the moisture level is on lower side then with help of motor connected to the board and water tank get initiated via IoT platform. When moisture level reaches the well-defined value then one can turn off the motor through the cloud.

Temperature sensor is used to sense the temperature of the soil. LM35 temperature sensor is used here to get the temperature ratings of the soil. Temperature is the important parameter which is required in perfect proportion for the healthy growth of the crops in the field. Soil temperature and air temperature varies in some degrees which can be another parameter for the growth. Temperature sensor used in this system works on the principle of temperature is directly proportional to the applied voltage. LM35 directly gives the reading in terms of degree centigrade which is the main advantage of using this sensor in the system. This system uses full range centigrade LM35 temperature sensor. In comparison with the basic centigrade temperature sensor this sensor is available with wide range of input voltage and it provides the output in relation with the temperature of the material or the environment. For 150°C it gives the reading of 1500mV and for -55°C it provides the output of -550mV. LM35 temperature sensor is linearly varies with the increase or decrease in temperature by the factor of 10mV/°C which is also called as linearity factor. This temperature sensor is connected to A2 pin of the Arduino board which manipulate the values and passed the information to the cloud via Wi-Fi module. If the temperature of the soil is more than the required value then with help of motor connected to the board and water tank get originated via IoT platform. When temperature level reaches the well-defined value then one can turn off the motor through the wireless platform.

The PH sensor is very tricky to interface with the Arduino Board as it works on the dual polarity power supply of +5V to -5V. PH sensor works on the phenomenon of hydrogen ion concentration present in the soil. PH sensor deals with the acidic and basic nature of soil. More acidic or more basic nature of the soil is also dangerous to the vigorous growth of the plant so, the PH contain of the soil must be in control to avoid all the calamities. PH sensor used here is of rod shape and made up of glass membrane. Glass membrane contains one bubble of the particular solution which defines the PH of the on-field soil. When hydrogen ions immersed on the glass causes the diffusion of ions on the glass membrane while most of the hydrogen ions are still in to the solution. Potential difference is generated in between the hydrogen ions and which provoked the small current flows through the solution. The hydrogen ions contain in the solution is directly proportional to the small amount of current flows through the solution. This phenomenon causes the measurement of the PH level of the soil. PH sensor is connected to the A0 pin of the Arduino Board with help of gain circuit board which performs the action which is essential for the communication between PH sensor and controlling board. Gain circuit Board Shifts the dual polarity power supply to the unipolar power supply which triggered the output to the Arduino board. Gain circuit board uses the low impedance and voltage offset phenomenon in order to perform the most important operation. Basically, PH sensor is uncapable of driving the controller because it produces less amount of current, as shown in the figure 3.12 is used to amplify the current in order to run the circuitry. When the PH of the soil exceeding beyond the certain limit means if the soil becomes more acidic then with help of switch available on the IoT platform one can start the motor which is connected to the fertilizer tank and it will get turn off when the PH level is in total control.

ESP 8266 is the Wi-Fi module is used here to established the connection in between the Arduino Board and open source IoT platform called Thinger. Arduino UNO board does not have inherent Wi-Fi module like Raspberry pi. ESP module connected to the two motors which are connected to the water tank and fertilizer tank. Pin D0 of the ESP module is connected to the motor which is connected to the water tank and pin D1 of the module is connected to the fertilizer tank. Wi-Fi module is connected to the Arduino Board with three interconnections. Vin of the module is connected to the supply pin available on the controller, GND pin is connected to the GND pin of an Arduino Board. Reception and transmission of the signal is the essential action perform by the Rx and Tx pin of the ESP module and the Arduino Board respectively. ESP8266 can easily provide Wi-Fi when it gets attached to an Arduino board as it has its own program meaning. Basically, it works as a bridge in between Wi-Fi and existing Arduino UNO board. Wi-Fi module is responsible for the remote access and control of the system through IoT platform called Thinger. Using Thinger is advantageous while controlling action as it provides the easy approach to dealing with peripherals in simplest way.

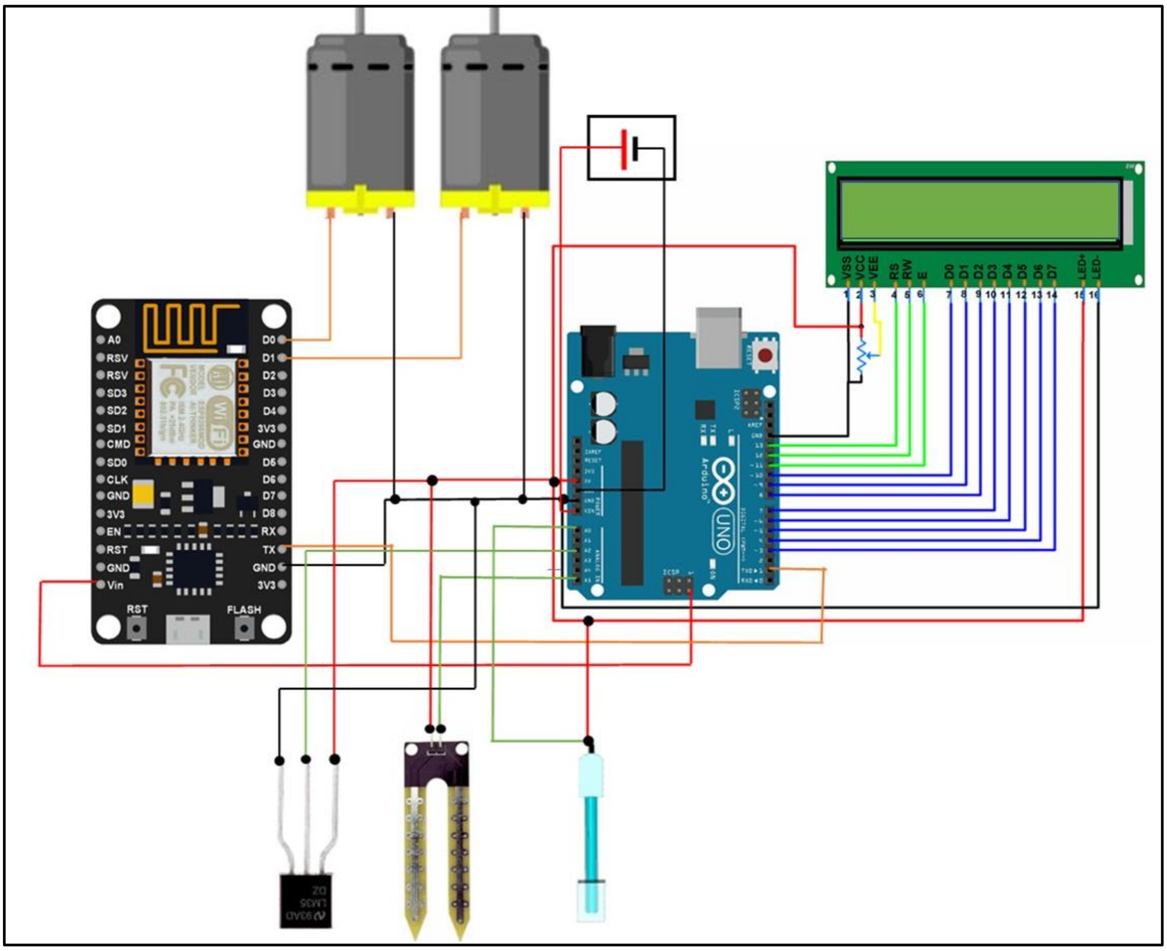


Figure 3.21: Schematic of proposed system

Figure 3.21: shows the circuit diagram of the proposed system it comprises with Arduino Board, PH sensor, Moisture Sensor, Temperature Sensor and ESP 8266 Wi-Fi with two motors connected to it. Arduino board is connected with all types of sensors, power supply, wi-fi module and two motors which are used to drive the pumps. When power get turn ON an Arduino board get triggered and it takes the current status from the moisture, temperature and PH sensor. After receiving the data from sensors Arduino manipulate the data and send the desired output to the LCD and IoT platform through wi-fi module. Thingers is an IoT platform which is used here to display the data to the user remotely. After log in to Thingers one can select the board from which data is appeared on the platform, select dashboards according to

the sensors so that received data can display remotely. User can also select the pattern of exhibition like statistical, numerical graphical etc. After taking glimpse at result user can turn ON and OFF the motors which are connected to the Arduino board and two tanks containing water and fertilizer to manage the desire condition for good fertility of the crops.

This smart irrigation system is use full in order to analyze and controlling the basic parameters of the on-field soil. Smart Irrigation is responsible for the healthy growth of the crops.

4. PERFORMANCE ANALYSIS

4.1 Experimental Setup

The system needs 650 mA and 12v power supply and strong internet connection for initiated the process. The system works on Arduino Board, different types of sensors and ESP module is used to release the information to the cloud and programming is done in Arduino programing language. The hardware implementation of the system is as shown below.

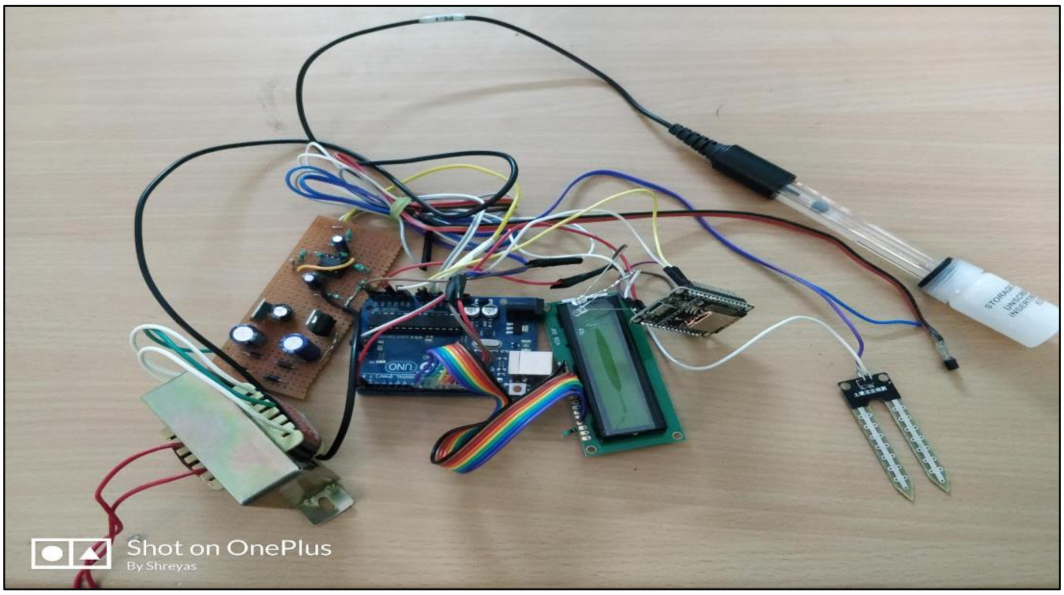


Figure 4.1: Hardware Implementation

Above figure 4.1 displays the experimental arrangement of the proposed system. It displays the results on the LCD board which is connected to the Arduino Board as well as on the desktop or android cell phone. This system contains Arduino Board which controls the whole mechanism of the system from receiving the signals from PH sensor, Moisture sensor and temperature sensor to controlling the motors from the remote area. ESP Wi-Fi module played an important role in the system when it comes to uploading an information on the open source cloud platform called Thingers. Gain circuit board is used there in order to make PH sensor more compatible with an Arduino platform. LCD which is connected to the Arduino board is used to display the on-field parameters on the system itself.

4.2 Calculation

Each sensor has its own specification and can give the different output when connected to the Arduino board. Specification plays an important role in calculation which is compatible with real value which user can understand.

4.2.1 Moisture Sensor

Moisture Sensor FC28 is used in this system for detection of moisture level of the on-field soil. The output of the moisture sensor is got differ in the interval of 0 to 1023. These values are mapped in between 0 to 100 as the moisture level is measured in terms of percentage. It delivers the maximum ADC output when there is 0% of the moisture present in the soil. The formula for moisture sensor is design like

moist = ((analogRead (moist Pin) /100)

i.e. for analog pin which gives the output of 50 then by this formula it gives the final reading of 19 %.

moist= (50/255) *100;

moist= 19 %.

4.2.2 Temperature Sensor

Temperature sensor LM 35 is used in this system because its electrical output is proportional to temperature in degree centigrade. For increase of 10mV there is increase of 1°C in the output of LM35 and that with exactness of +/- 0.4°C at room temperature and +/- 0.8°C at 0°C to 100°C. LM35 produce more accurate values than thermocouple and RTD.

Arduino analog pin resolution is 1023. Starting from 0V on the input of +5V it counts 1023. Considering +5 V as reference and 1023 as resolution of Arduino board the formula has been design like

temp = ((5.0* analogRead (temp Pin)) *1023)/ 1000

i.e. for the analogRead pin which gives the output of 74 then by this formula it gives the final reading of 36.17°C.

temp= ((5.0*74)/1023;

temp= 0.36168;

temp= 0.36168 * 100;

temp= 36.17°C.

4.2.3 PH Sensor

PH sensor L10530 is used in this system to calculate the PH level of the soil. Arduino analog pin resolution is 1023. Starting from 0V on the input of +5V it counts 1023. When PH sensor is immersed in the solution of PH value 6 and it delivers the value of 5.88 then consider the offset is equal to 0.12. Offset is nothing but the difference between expected value and obtaining value. The formula is given by considering +5 V as reference and 1023 as resolution of Arduino board for converting the analog reading which ranges from 0-1023 to 0V-5V.

$$\text{Voltage} = (\text{analogRead (PH Pin)} *5)/1023$$

$$\text{PH Value} = 3.5 * \text{Voltage} + \text{offset}$$

PH value is obtained by limiting the sensor reading to 3.3V and adding it with difference called offset.
i.e. for the analogRead pin which gives the output of 300 and has the offset of 0.12V then by this formula it gives the final reading as PH value is 5.25
Voltage = (300 *5) /1023;
PH value = 3.5 *1.4662 +0.12;
PH Value = 5.25.

4.3 Results and Discussion

The open source platform Thinger is created to get notification from the server. Two clients are connected to the one cloud server. One server is Arduino Board which is connected to the main server via the IP address. Second server is the ESP Wi-Fi module which is used to establish the communication between the sever and controller. Data is sent from Arduino Board to Cloud server and Server to second client which is an Android or desktop system user.

When power supply get turns on system gets initiated and Arduino board fetch the data from the sensor. PH sensor, temperature sensor and moisture sensor give the feedback to the controller in terms of sense voltage depending upon the different phenomenon. When the sensor data appeared to the Arduino Board, it will manipulate the sense information using different types of the formulas. Then it will send notification to the IoT platform with help of Wi-Fi module. IoT platform Thinger shows all the parameter like PH, temperature and moisture of the soil with different types of gadgets like speedometer and scattered graphs. One can monitor the system remotely and take specific action as system gives the notification. There is availability of two buttons on the cloud so, with help of an IoT platform farmer can turn ON/OFF the motor and control the irrigation remotely.

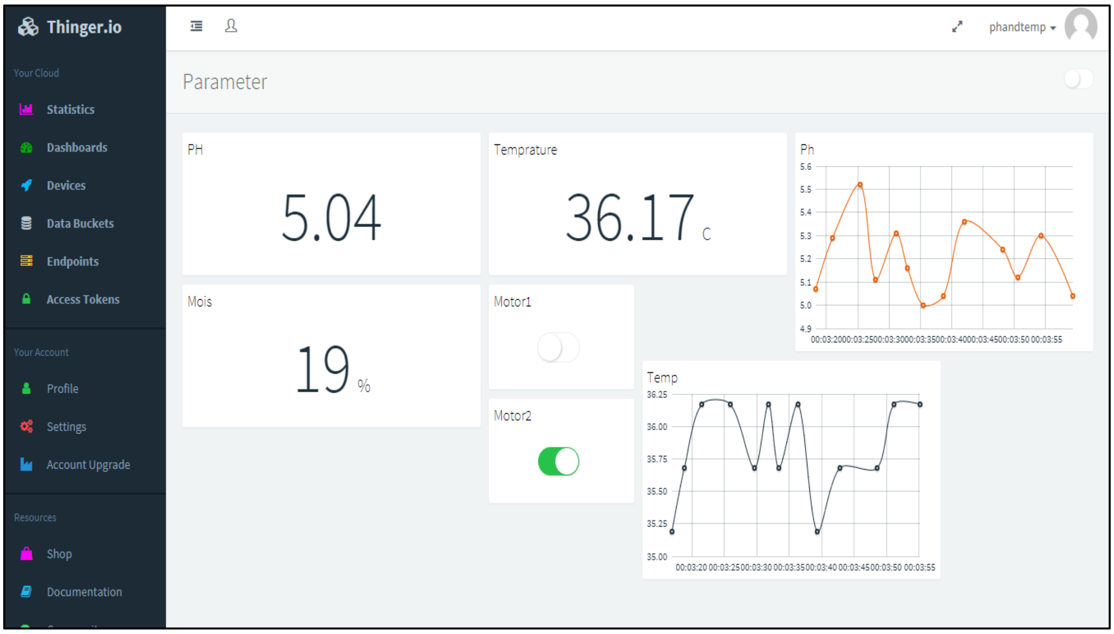


Figure 4.2: Thingers output

Figure 4.2 shows the desktop view of the Thingers output window. It consists of detail information about the three parameters which is going to analyze and control in this system. It shows the temperature, PH and moisture level numerically with the help of gadgets which is available on the cloud platform. There are two scattered graphs also which gives the pictorial assessment of the PH level and temperature of the on-field soil. Two buttons are present for the controlling purpose of PH level, moisture and temperature of the coil with the help of two motors which are connected to the water tank and fertilizer tank respectively. These two buttons can get turn ON and OFF from remote place after analyzing the soil parameters.

Thinger is an open source IoT platform which is easily available on one click. Firstly, user has to make account on Thinger with unique ID and password with the help of which user is able to access all the facilities of the IoT platform after designing the dashboard with required parameters and proper gadgets. The parameter switch can give the access to the user to edit, delete or add the gadgets to the board. One can view the parameters on the any smartphone which is easily available nowadays.

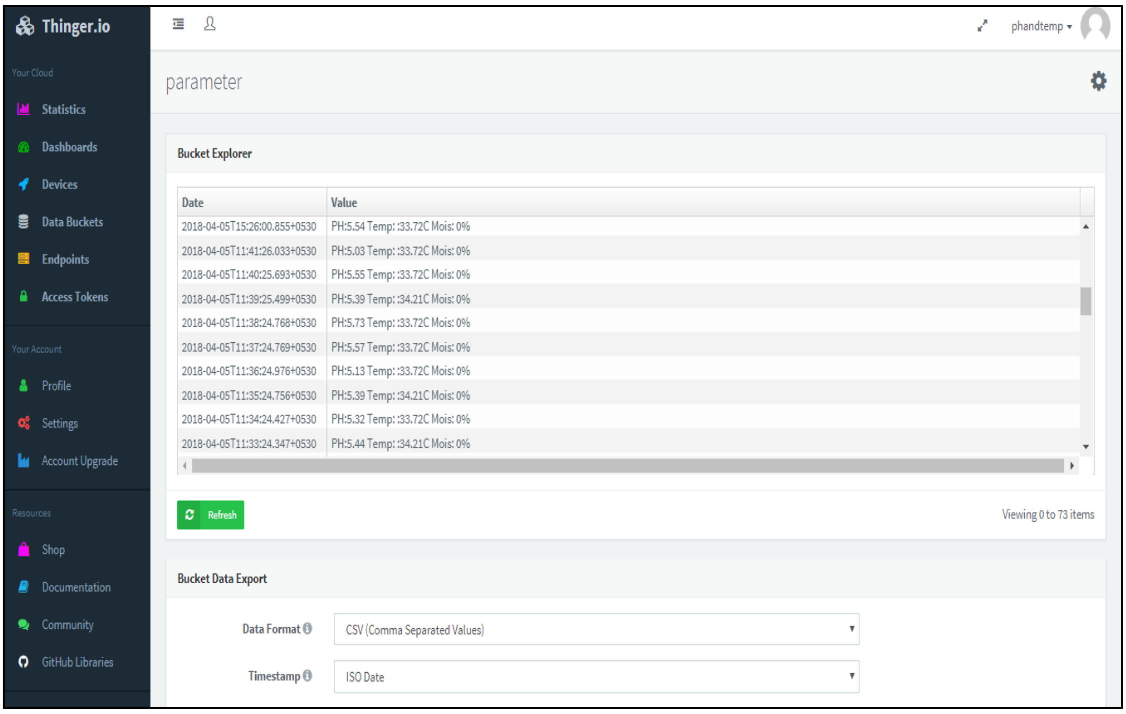


Figure 4.3: Thingers previous data (Data Buckets)

Figure 4.3 shows the one window of data buckets which gives the back dated information about the soil and its parameter. Data buckets shows the time and date of system when user log on to the platform last time. Again, it shows the values of PH, temperature and moisture sensor with time and date. According to this information user can understand the situation of the field thoroughly and able to take a decision to control the crops from various decease. The smart irrigation system helps user with the knowledge of under nutrition and over nutrition of the fertilizers. This system helps in the growing of the healthy plant.

Figure 4.4 shows the performance analysis of the temperature sensor which is used in this system with existing thermometer. Blue line defines the sensor values and red line shows the actual reading of temperature of soil using thermometer. To check the capability of the sensor it is tested in different environment and in different temperature and also in different time zone. Soil temperature is somewhat different than the actual temperature of an environment. Thermometer gives the temperature reading in the degree centigrade and the temperature sensor used here in this system is also gives the output in terms of degree centigrade so, there is not necessity of converting the temperature value in to the degree centigrade from degree kelvin. Graphs shows the different readings at the different date and different environment. The temperature in the summer of May is on higher side so it shows the pick value of 46^0 C and in the night of June- July it falls down up to 15^oC.

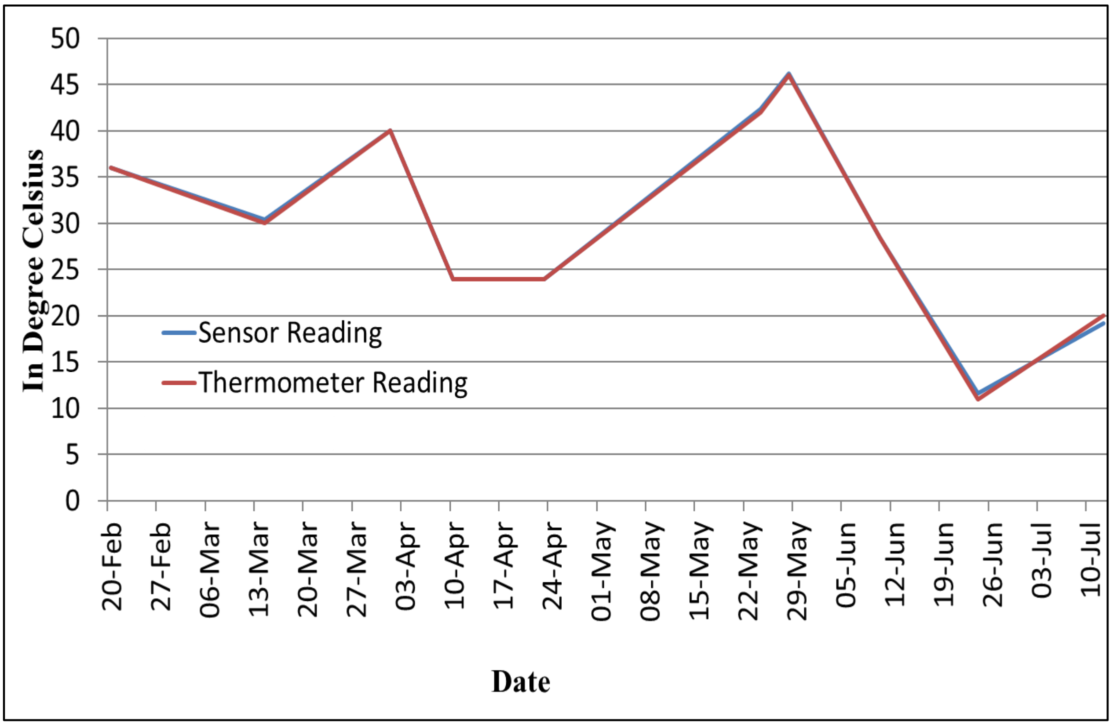


Figure 4.4: Performance analysis of temperature sensor

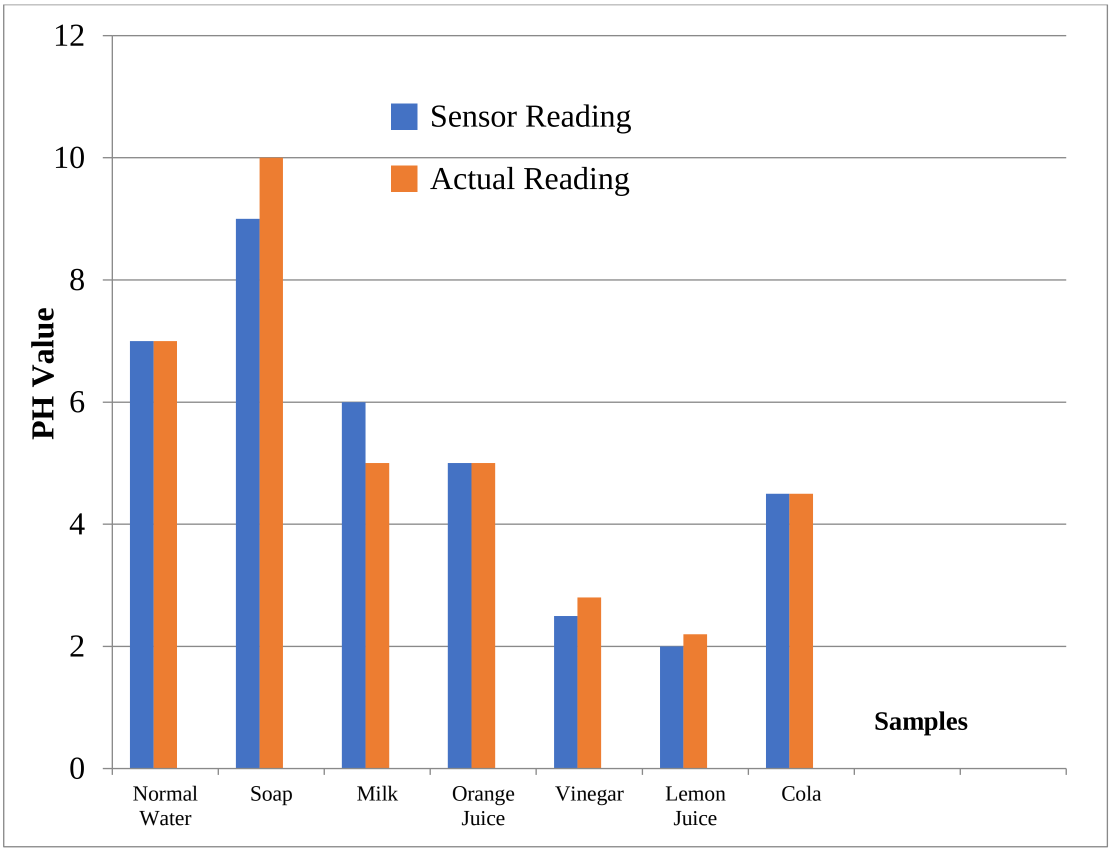


Figure 4.5: Performance analysis of PH sensor

This gives the actual information to the farmer with very less error and the user can blindly trust the values or the output given by the temperature sensor. This analysis shows that the precision of the temperature sensor is better than most number of sensors which are used to measure the on-field temperature.

Figure 4.5 shows the performance of the PH sensor in the bar graph format. PH means examine the solution as if it is more acidic or basic and it is depending on the hydrogen ion concentration presents in the solution. Here PH sensor is examined in the solution of some acidic and some basic solution whose values are predefine and can easily available in the world. Normal water has the PH value of 7 and sensor shows the exact reading when immersed in the water. When threshold occurs then at a time PH sensor stop reading the value as it knows the nature of the solution. This helps farmer in order to spread acidic or basic solution in the farm for the betterment of the irrigation that from the remote area.

5. CONCLUSIONS

5.1 Conclusion

Smart irrigation system significantly contributes to the situational awareness in real time also it has been aimed to design in such a way that it has unorthodox, watchful and can provide regular updates. It is advantageous as it offers reliability and privacy on both sides. After getting notifications, necessary action can be taken place in short period of time in case of emergency condition. In this case it minimizes energy, power and human influence. It provides regular update to the user so one can get proper information about system can work ideally for unspecified time period.

5.3 Future Scope

The database for the system can be stored either by interfacing system with the personal computer or using SD card. So, this will be useful for the authorized person to get all the results for further inspection. Hence a Graphical User Interface (GUI) may be generated for a surplus addition.

Wireless system interface can also be developed in the present system. There is no limit for the future scope in the monitoring and control operations. Irrigation is no longer limited by the manual operation. More and more operations are being handled using automation techniques.

Addition of the knowledge of the parameters required for the each and every crop which has been taken in the field in India is useful in making the system fully automotive. Designing the android phone application with lower cost and with full amenities is the need of current society.

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PUBLICATIONS

Paper on **"Arduino-Based Smart Irrigation Using Sensors and ESP8266 Wi-Fi Module"** presented in IEEE sponsored International Conference on Intelligent Computing and Control Systems (ICICCS'18), 2018 organized at Vaigai College of Engineering, Madurai, Tamil Nadu and is going to be published in IEEE Explore and conference proceedings.

APPENDIX

Publication

Arduino-Based Smart Irrigation Using Sensors and ESP8266 WiFi Module

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***Abstract* - This paper presents a smart irrigation system which is economical and gives the automation in the farm. The aim of this paper is to design an Arduino based controlled irrigation system using Wi-Fi module. The proposed system detects the moisture content in soil, PH level of Soil and temperature using moisture sensor, PH sensor and the temperature sensor. The moisture level of soil is sensed and according to that irrigation can be done. If the level of moisture is below the threshold level the moisture sensor sends the signal to the Arduino board and notification is send through IoT platform. As Compared with the other systems, this system gives better efficiency and it is also less expensive. Arduino collect the data from all the sensors and link that data with the cloud. The main advantage of the system is that the owner of the farm can remotely monitor their farm on IoT. The main aim of the project is to make agriculture smart using automation and IoT technology.**

Keywords—**Arduino, Sensors, Wi-Fi Module**

I. INTRODUCTION

Nowadays, water scarcity and water logging has become an unpreventable issue to tackle with. Water plays an important role in the day to day life of a human being. In India lot of agricultural land and industries are already facing the drought problems, so with the help of current technology this issue can be sorted out to some extent. Today's technology requires a user-friendly device which is economical in cost and most effective as well and which is provided by Arduino board. In today's generation, it is very convenient to send the notification to IoT platform because of widespread use of smartphones and PC. The whole system is distributed into two parts. The first part comprises of setting up an Arduino Board and interfacing it with the several sensors. The second part consists of developing the IoT platform and connecting it to the server. The ESP 8266 Wi-Fi module is used because of which the transmission becomes simpler and faster. It consists of two motors one for water pump, and second for fertilizers pump. It also helps the owner to monitor system globally throughout the world. After getting the proper information about the field, farmer can turn ON/OFF the motors parenthetically. This system is simple to implement. This System is designed to improve the security, flexibility and to remove the flaws of the existing system.

II. LITERATURE SURVEY

William Isaac et.al [1] demonstrate a system which delivers all the characteristic values of soil like PH, moisture and temperature. It sends all the data to cell phone by bluetooth. The main drawback of the system is that it cannot establish the communication outside the bluetooth range.

Joaquin Gutierrez et.al [2] proposed a system which gives sensor information through the gateway unit. This gateway unit is also used to precipitated the actuators and linking up the data to web application. All the scrutiny of the data and scheduling is programmed through the web page. It is triggered by photovoltaic panel and has cellular interface with the user.

Yunseop Kim et.al [3] mentioned a smart irrigation system which uses six field sensors for the continuous monitoring of the field. The farmer gets all the information about the field through GSM and wireless communication but the system is incapable of storing the previous values.

G. Parameshwaran et.al [4] implemented a smart water drip irrigation technique using humidity, PH and temperature sensor. All the sensed data is uploaded on the cloud using personal computer. It is helpless of storing the previous reckonings and also impotent to give information about the moisture contained in the soil.

Dinesh V. et.al [5] demonstrate a highly automated irrigation system in which motor pump is triggered ON/OFF from the computed values given by PH, temperature, moisture and humidity sensor but it is incapable of providing real time data.

R. Subalakshmi et.al [6] proposed a smarter and simpler system which is good blend of automation and the things which are important in order to tackle the irrigation entanglement. In this system moisture and humidity level of the field is detected by the sensor and whenever that values are on the verge of surpassing then that values are provided to the user in the form of text message using microcontroller and GSM based assembly. But this system does not provide real time data.

Priya et.al [7] proposed an irrigation system in which humidity and moisture sensor are placed near the root area of the crop and according the values provided by the microcontroller the watering is done. But this system doesn't allow in-depth knowledge about the field to the farmer.

Sonal M et.al [8] proposed a water dripping system to avoid scarcity of water as it is big issue now a day, also it prevents the soil from becoming more acidic or basic by using PH sensor. All the data is sent to android app and according to that the motor is operated and which makes this system costlier.

Cruz et.al [9] proposed a system which is based on Artificial Neural Network. This system used neural network toolbox from MATLAB to implement it for proper and balanced use of water. This system is hard to understand and it fails to deliver real time data to the user.

Pushkar Singh et.al [10] implemented a smart irrigation system using Arduino which gives real time data of moisture and temperature of the soil with help of sensors. This system also uses water flow sensor for controlled irrigation system. But it fails to give real rime information about the PH level of the soil.

III. PROPOSED SYSTEM

The main objective of the system is to develop on intelligent irrigation system which can be scrutinized by landlord distantly throughout the world via IoT platform. This system is connected to cloud so it can be accessible through the PC or any other smartphone. It also gives the current status about the moisture, temperature and PH level of the field through moisture sensor (FC28), temperature sensor(LM35) and PH sensor (L10530) respectively which are connected to the Arduino. It can be access by the destined user remotely through PC or smartphone.

This system can prevent the crops from water logging effect by measuring the moisture of the field by using moisture sensor. Temperature sensor can used for sensing the temperature on the field and if crop is too much sensitive towards temperature then it can be cool down by sprinklers or by drip irrigation technique. PH sensor can prevent the field from being more acidic which could hamper the growth of the crops

This scrutiny method comprises of mainly two sections:

1. The first part consists of setting up an Arduino board and interfacing it with sensors.
2. The second part consists of developing an IoT platform and linking it to the server for notification purpose.

IMPLEMENTATION OF SYSTEM

The block diagram shows that the project is divided into two sections. One section is the Arduino board for monitoring activities which also contains different sensors for scrutiny and it is controlled by an IoT platform from any part of the world. The system also consists of LCD display in order to show the field readings.

The figure 1 shows an Arduino Board which is connected to the different sensors like moisture sensor, temperature sensor and PH sensor with the help of GPIO pins. The Arduino collects all the data from sensors and sends it to the IoT platform which can be access through smartphones and PC subordinately across the world.

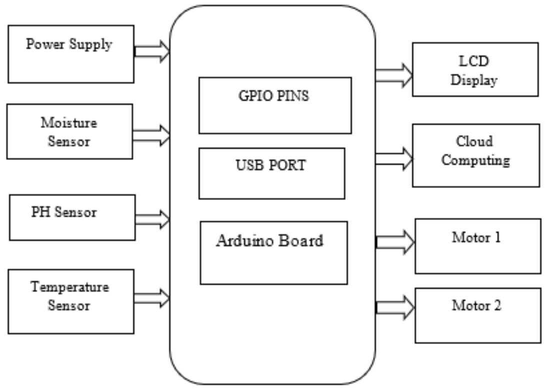

Fig.1. Block Diagram of Proposed System

IV. HARDWARE REQUIREMENT

1. Sensors:

A. PH Sensor: - PH sensor is used to measure the particular PH value of the field. PH sensor is of the rod shape in which one bubble of the particular solution is there at the top to measure the particular value. There is a one assembly of ADC circuit which is used to interface PH sensor with Arduino as it works on dual power supply of +5 V. Normally the pure water or ground water has a PH value of 7. If the solution having PH value less than 7 then it is acidic and if it is greater than 7 then called as basic solution.

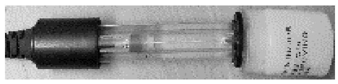

Fig.2 PH Sensor

B. Temperature Sensor: - Temperature sensor LM35 is used to measure the temperature of the soil. It ranges from -550 C to 1500 C. Temperature sensor operates on +5 V DC supply and gives analog output to the Arduino board. The desired output is then calculated by the formula (temp=temp*500; temp=temp/1023).

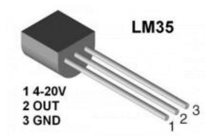

Fig.3 Temperature sensor

C. Soil Moisture Sensor: - The amount of water contain in the soil is measured with the help of soil moisture sensor. Moisture sensor ranges from 0 to 100 % depending upon the moisture content in the soil. +5 V power supply is sufficient to give analog output to the Arduino board. When the soil is completely dry it shows moisture level of 0% and 100% when the soil is completely wet.

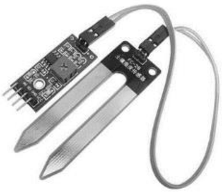

Fig.4 Moisture Sensor

3. ESP-MODULE 8266: - Figure shows the esp module 8266 which is used to sends the data from an Arduino to IoT platform from which it can be access by the user. Wi-fi module integrated with TCP/IP protocol and Has self-contained SOC. ESP-8266 can easily provide wi-fi when it gets attached to an Arduino board as it has its own program meaning. Basically, it works as a bridge in between wi-fi and existing micro-controller.

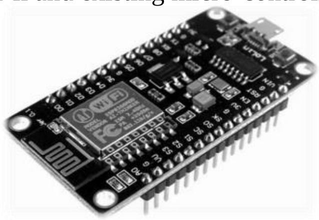

Fig.5 ESP Module 8266

4. Arduino Uno (ATmega 328): -Figure 6 shows Arduino Uno board layout and its 14 pins. The board uses ATmega328P microcontroller. The details of the board are available at the Online resource-https://www.arduino.cc/en/Reference/Board.Digital I/O pins have a current limit of 40 mA and provide 5V signal. Thus, a Driver IC is required to drive the two 9V DC Motors.

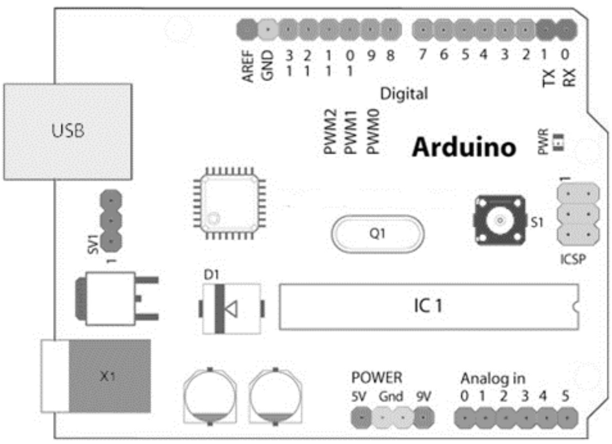

Fig.6 Arduino Uno Board Layout and Pin out

5. LCD Display: - 16 x 2 LCD display is used to display the numeric data which is calculated by an Arduino board.

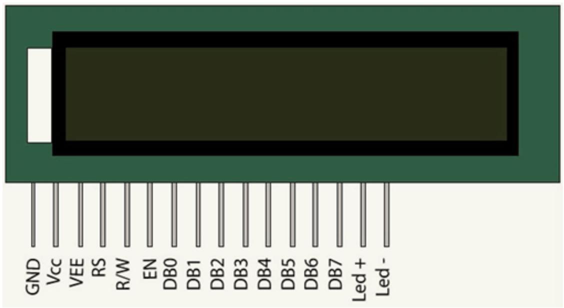

Fig.7 LCD Display

V. SOFTWARE REQUIREMENT

Here we have used two applications one is an Arduino Integrated Development Environment (IDE)for an Arduino and another is an IoT platform called Thingers to view the data and control it remotely.

Arduino IDE software application is used to dump the program in Arduino and ESP module 8266. It has a following steps:

1) Install Arduino IDE software on the PC.
2) Write a program for sensors, IoT platform and wi-fi module 8266.
3) Select boud rate.
4) Select the proper board.
5) Select the proper port.
6) After completion of the above steps, it can run the program and it can dump on an Arduino board.

Arduino Programming: - Arduino programming language is used for programming. Arduino is a reliable programming language that is convenient and suitable to use with Arduino Board and Genuino Board. It even uses very fewer lines of codes as compared to C or C++. In our project, we use Arduino programming language in order to make connections with Arduino Board and ESP module.

Thingers is an IoT platform which is open source and can access by anyone. It has a following steps:

1) Create an account with proper login id and password.
2) Create dashboard for moisture, PH and temperature sensor.
3) Select the proper device from which the results are drawn.
4) Plot the graph, display the values numerically if necessary.
5) Create a two switch on the dashboard to ON/OFF the motor.

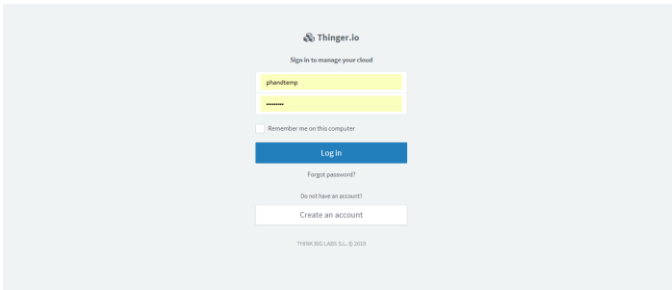

Fig.8 Thingers Login Page

VI. PROJECT IMPLEMENTATION:

Arduino board should connect with all types of sensors, power supply, wi-fi module and two motors which are used to drive the pumps. When power get turn ON an Arduino board get triggered and it takes the current status from the moisture, temperature and PH sensor. After receiving the data from sensors Arduino manipulate the data and send the desired output to the LCD and IoT platform through wi-fi module.

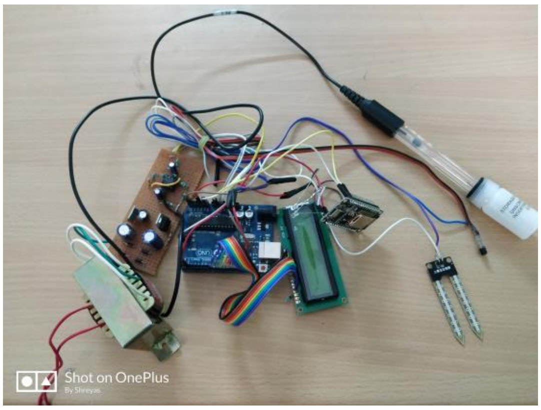

Fig.9. Arduino Board Setup

Thingers is an IoT platform which is used here to display the data to the user remotely. After log in to Thingers one can select the board from which data is appeared on the platform, select dashboards according to the sensors so that received data can display remotely. User can also select the pattern of exhibition like statistical, numerical graphical etc. After taking glimpse at result user can turn ON and OFF the motors which are connected to the Arduino board and two tanks containing water and fertilizer to manage the desire condition for good fertility of the crops.

VII. RESULT

Fig. 10 shows the desired output provided by an Arduino board and ESP Module 8266 with help of an IoT platform Thingers. One can monitor the system remotely and take specific action as system gives the notification, with help of an IoT platform farmer can turn ON/OFF the motor.

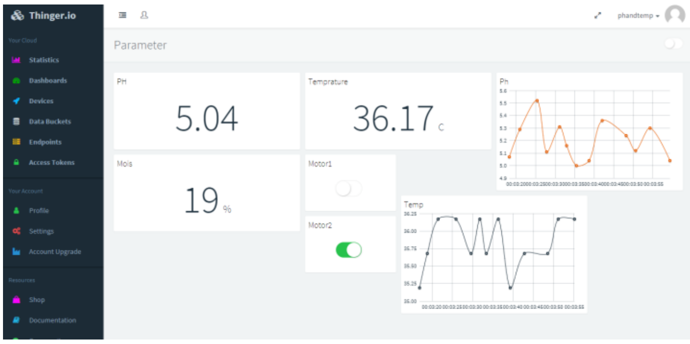

Fig.10 Thingers Output

Thingers provided the back-date information with the help of Data Bucket function available on the platform with the help of which farmer gets all the information about the current and back dated information about the field. Fig. 11 shows the Previous data with help of Data Bucket.

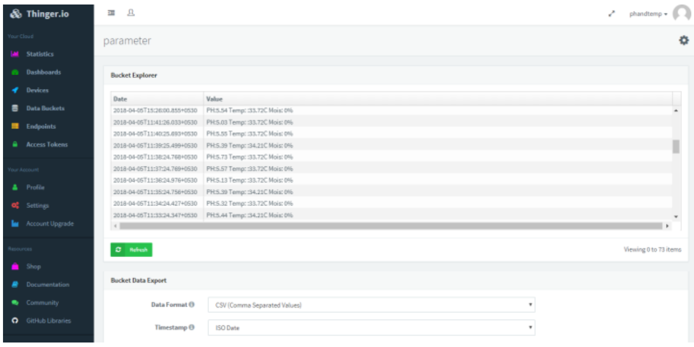

Fig.11 Previous Data (Data Bucket)

VII. CONCLUSION

Smart irrigation system significantly contributes to the situational awareness in real time also it has been aimed to design in such a way that it has unorthodox, watchful and can provide regular updates. It is advantageous as it offers reliability and privacy on both sides. After getting notifications, necessary action can be taken place in short period of time in case of emergency condition. In this case it minimizes energy, power and human influence. It provides regular update to the user so one can get proper information about system can work ideally for unspecified time period.

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