IoT BASED SMART AGRICULTURE MONITORING SYSTEM

Project report submitted in partial fulfilment of the requirement for the degree of Bachelor of Technology

In

Electronics and Communication Engineering

By

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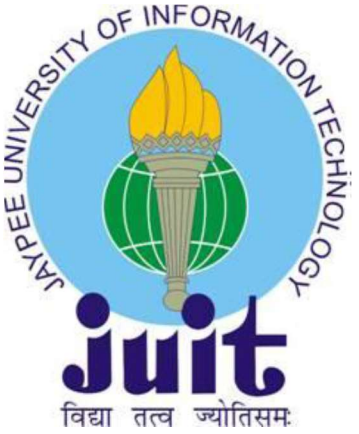
Under the supervision of

Dr. Meenakshi Sood



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CANDIDATE DECLARATION

We hereby declare that the work reported in the B. Tech. project entitled **"IOT BASED SMART AGRICULTURE MONITORING SYSTEM"** in partial fulfillments of the requirements for the award of the degree of bachelor of technology in electronics and communication engineering submitted at **Jaypee University of Information Technology, Waknaghat, India**, is an authentic record of my work carried out over a period from July 2018 to May 2019 under the supervision of **Dr. Meenakshi Sood** (Asst. Professor, E.C.E Department). We have not submitted this work elsewhere for any other degree or diploma.

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CERTIFICATE

This is to certify that the work reported in the B.tech project report entitled **"IoT BASED SMART AGRICULTURE MONITORING SYSTEM "** which is being submitted by **Bhumika, Jasleen, Mahima** in fulfillment for the award of Bachelor of Technology in Electronics and Communication Engineering by the Jaypee University of Information Technology, is the record of candidate's own work carried out by him/her under my supervision. This work is original and has not been submitted partially or fully anywhere else for any other degree or diploma.

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ACKNOWLEDGEMENT

We would like to express our heartfelt gratitude to our project coordinator **Dr. Meenakshi Sood** for her guidance, invaluable support and encouragement throughout the project. We would also like to thank our Head of the Department for providing us this opportunity to work on a project.

This project would have been impossible without our project guide and we want to extend sincere thanks to her for her guidance and constant supervision as well as for providing necessary information regarding the project.

We would also like to express our gratitude towards our parents and Jaypee University of Information Technology for their kind co-operation and encouragement which helped us in completion of this project. Our thanks and appreciations also go to our colleague in developing the project and people who have willingly helped us out with their abilities.

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ABSTRACT

Agriculture is an integral part of Indian economy. Over 60% of Indian population based upon agriculture and one third of the income of nation arises from agricultural practices. Hence it plays a vital role in the development of the country. Various issues related to farming is continuously hampering the development of the country. Possible solution for these problems is to opt for modernized agriculture that comprises of modern trends. Hence, agriculture can be made smart using IoT and other technologies. Smart agriculture increases crop yield, decreases water wastage and imbalanced use of fertilizers.

The highlighting feature of this project is that it measures the different agricultural parameters affecting the yield and it also uses a GPS module to get the information about the location. Secondly it sends all the data to the cloud where it can be further analyzed. Thirdly this project also contains an android mobile app providing an easy access of information to the farmer. Moreover this project presents a smart irrigation system that optimizes water usage.

CHAPTER 1
INTRODUCTION

1.1 Introduction

Internet of Things (IoT) is the interconnection or network of physical devices that is interrelated computing devices, digital and mechanical machines, people or animals, objects that can sense, accumulate and transfer data over web without any human involvement. Everything is provided with unique identifier. It is a progressed examination and mechanized frameworks which uses detecting, organizing, enormous information and man-made consciousness innovation to convey total framework for an administration. Basically IoT is about extending the power of internet beyond smart phones and computers.

IoT has changed today's world. Smart cities, smart car, smart homes everything around us can be turned into a smart device with the help of IoT. It also has applications in agriculture, business sectors, healthcare, transport and logistics.

There are four main components of IoT-

- ***Low power embedded system***- High performance and less battery consumption are the inverse factors that play an important role in design of electronic system.
- ***Cloud computing***- Data collected from devices is stored on reliable storage servers so here cloud computing comes into action.
- ***Availability of Big Data***- As IoT is highly dependent on sensors that are real time. So the usage of electronic devices is spread throughout every field that is going to trigger a massive flux of data.
- ***Network connection-*** For communication, internet connectivity is necessary where each physical object is assigned by an IP address. A network connection is build between the devices with the help of these addresses

Technology today has not reached its 100% capability. So the advantages and disadvantages of this technology are given below-

Advantages of IoT

1. Utilization of Resources Efficiently
2. Minimization of Human Efforts
3. Time-saving
4. Increase Data Collection

Disadvantages of IoT

1. Security
2. Privacy
3. Complexity

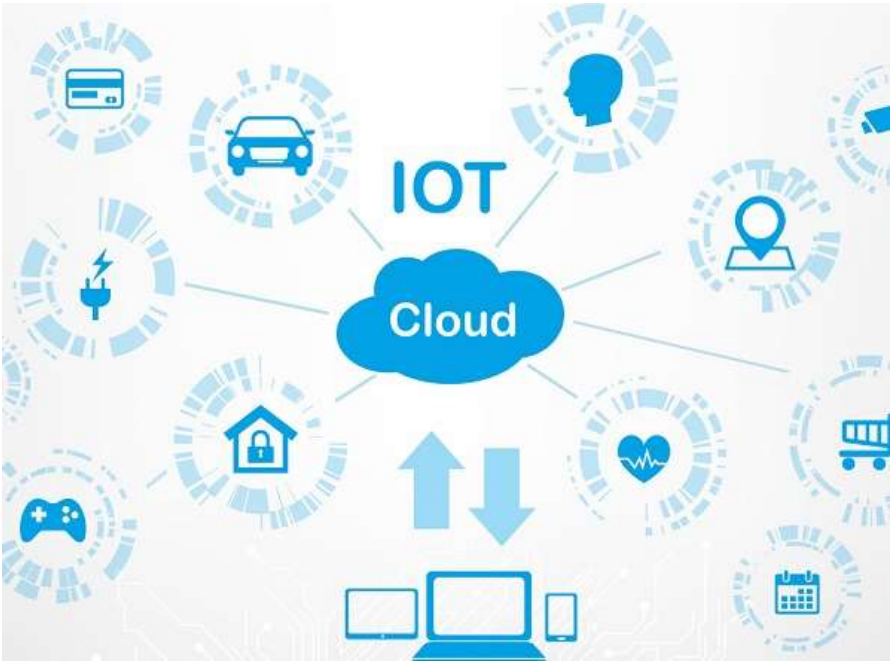


Figure 1.1 Description of IoT

1.2 IoT in Agriculture

Internet of Things has capacity to transform the lives of people in the world in an efficient manner. The ever growing population would touch more than 3 billions in few years. So to feed such an immense population, agriculture industry need to embrace IoT. The demand for more food has to address challenges that include excessive climate conditions, weather change and different environmental affects that results from farming practices.

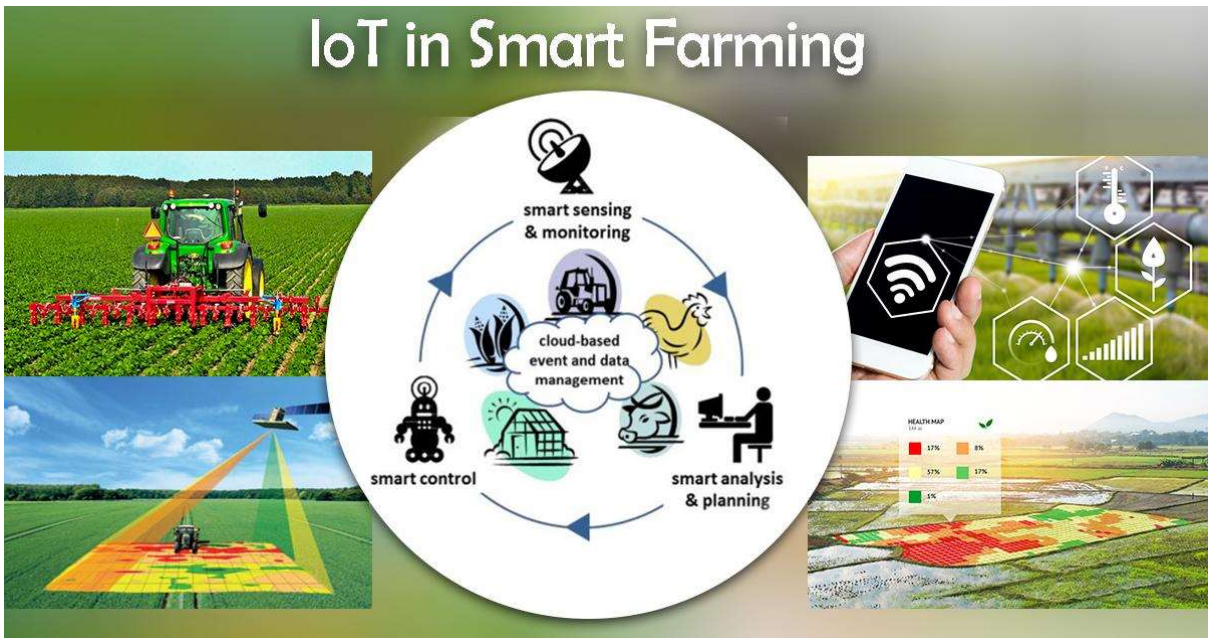


Figure 1.2 Smart Farming

The destiny of Indian agriculture must be worked with understanding and excessive cease technologies that can expand production and furthermore regains the attention of farmers in this industry. So these smart farming techniques would assist farmers to lessen scrap and enhance capacity. It is basically a high tech and capital intensive system for growing crops in a sustainable manner for masses. This technology can help farmers to monitor field conditions from anywhere with the help of sensors and can also irrigate fields with an automated system. It is the application of Information and Communication Technology into the field of agriculture.

1.3 Structure of IoT in Agriculture

Basically this system structure consists of 3 layers that are sensor layer, transport layer, application layer and the functions of these layers are below –

1) *Sensor layer*- One of the challenge of the sensor layer is to obtain automated and real time transformations of the figures of actual world agricultural manufacturing into digital transformation or information which could be processed in virtual world through different or various means. The data that they collect are-
    - Sensor information- Humidity, temperature, gas concentrations, pressure etc.
    - Products information- name, model, price and features.
    - Working condition - operating parameters of different equipments, apparatus etc.
    - Location information

    The major challenge of Information layer is to mark diverse kinds of information or data and gathering the information and marked information in the actual world by means of techniques of sensing, after which remodels them for processing into digital information. This sensor layer includes some strategies- RFID tags, cameras, two dimension code labels, sensor networks.
2) *Transport layer*- This layer's task is to acquire and summarize the data of agriculture acquired from the above layer for processing. It is believed as the nerve centre of IoT. This layer includes the combination of telecommunication management centre and also internet network, information centre, smart processing centres.
3) *Application layer*- The function of this layer is to analyse and process the information collected for the cultivation of digital awareness of actual world. It is considered as a fusion of IoT and agricultural market intelligence.

Benefits of IoT in Agriculture

- IoT empowers simple gathering and the executives of huge amounts of information which is gathered from sensors used and with the help of joining of distributed evaluating administrations such as cloud storage, farming field maps and more information can be retrieved from any place and everywhere which enables live monitoring and connectivity which is end to end.
- IoT is viewed as an important segment for smart farming because with precise use of sensors and also the smart gadgets, farmers could expand the output by 72% upto year 2050 as delineated by specialists.
- By the use of IoT creations expenses could be diminished to an astounding dimension that would thus expand productivity and survivability.
- By the use of IoT efficiency level would be further expanded as far as utilization of water, soil, fertilizers, pesticides etc.

Applications of IoT in Agriculture

- Precision farming
- Agricultural drones
- Livestock monitoring
- Smart greenhouses

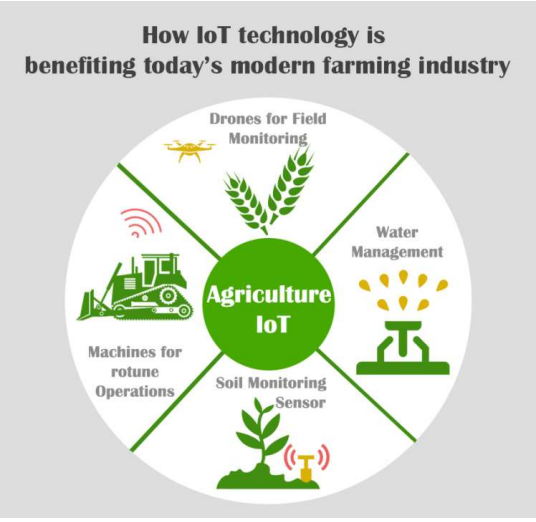


Figure 1.3 Applications of IoT

1.4 MOTIVATION

Different kind of problems faced by the farmers motivated us for the recommended system that are: the Indian farming is on the hitch because of the limited technical know how of the best and efficient agricultural practices and moreover they are still dependent on conventional methods of agriculture that leads to lesser productivity of crops. So by using upcoming technology the productivity of crops can be maximized at minimal cost. This also reduces burden of taking up of heavy loans on farmers which they have incurred on themselves in order to sustain their livings or to get good yields of their crops. Apart from these issues scarcity of resources also adds up in their problem causing hindrance or stopping framers from cultivating and hence Indian economy is also additionally getting influenced to large extent as most of the fruitful lands of the nation are being destroyed that forms the vital part of GDP.

So through this framework we are presenting solution for this issue by introducing an automated and systematic farming strategies that enable farmers to cultivate in a productive way also with limited resources and greater yield which is assured and efficient.

1.5 OBJECTIVES

1. To update farmers with the new technology and to avoid manual labour.
2. To reduce wastage of water and enhance productivity of crops by providing them ideal condition.
3. To meet the difficulties such as severe weather conditions and advancing climate change, and environmental consequences resulting from intensive farming practices.
4. Design a model and connect it to the android app and cloud server.

Figure 1.4 IoT based Smart Farm

CHAPTER 2
LITERATURE REVIEW

1. S.Sivachandran, K.Balakrishnan, K.Navin, "Real Time Embedded Based Soil Analyser", International Research Journal of Engineering and Technology (IRJET). Volume: 3 Issue 3 | March 2014 [1]

In this paper, authors propose an embedded soil analyser with measures the pH value of the soil and based on this value gives measure of various soil nutrients. The system proposed here uses signal conditioning, display, microcontroller unit, sensors, power supply and thermal printer. This model helps in prediction of the soil sequence based on the availability of nutrients. Many techniques monitors various soil parameters and this paper points at soil fertility. The main aim of this model is to replace the conventional method of soil testing by automated soil testing. It automatically measures the major soil nutrients like potassium, phosphorus and nitrogen by calculating the pH value.

2. Anand Nayyar, Er. Vikram Puri, "IoT Based Smart Sensors Agriculture Stick for Live Temperature and Moisture Monitoring using Arduino, Cloud Computing & Solar Technology" May 2015. [2]

This paper presents an IoT based smart stick that enables live monitoring of the different agricultural parameters. This stick helps farmer acquire live data of temperature, soil moisture. The agricultural IoT stick gives the idea of plug and measures in which farmers can instantly enact smart monitoring system by positioning the stick in the field and obtaining live data feeds on different smart gadgets like smart tablets, phones etc. and the information which is produced through sensors could be simply analysed and processed by agricultural experts even in remote areas via cloud computing technologies.

3. Chandan Kumar Sahu, Pramitee Behera, "A Low Cost Smart Irrigation Control System", IEEE sponsored 2nd International Conference on Electronics and Communication System (ICECS2015) [3]

In this paper, the author proposes a model where the flow and direction of water is supervised and controlled. This is done with the help of DHTT11 and soil moisture sensor. This method also proposes a way to select the direction of water and this information is also sent to the

phone and gmail account of the farmer. This model also enables the farmer to switch on and off the motor with a single click. This paper proposes a prototype where number of sensors are deployed at different positions in the field. This paper also shows how the proposed model makes the traditional irrigation system more effective and sustainable. This paper also suggests an efficient energy and network model. This paper presents a model that is energy efficient, sustainable, automated and cost effective.

4. Apurva C. Pusatkar, Vijay S. Gulhane, "Implementation of Wireless Sensor Network for Real Time Monitoring of Agriculture", International Research Journal of Engineering and Technology (IRJET). Volume: 03 issue: 05 | May-2016 [4]

In this paper, authors focus on using WSN that is Wireless Sensor Network. Use of WSN helps in real time monitoring of the agricultural field. The paper stresses on the fact that the yield rate in agriculture has become stagnant and hence they have included additional agricultural parameters that has to be monitored. In addition to the conventional parameters like humidity, temperature and soil moisture, this paper focuses on water level, flood, wind direction, wind speed, weather etc. Agricultural projects usually use wired communication which has various problems and hence this paper points on the use of wireless network. The writer also proposes an alarm system that sends an alert to the farmer. The proposed model also includes the use of Global system for Mobile(GSM), ZigBee, General Packet Radio service (GPRS), Global Positioning system(GPS) for secure transmission of data. It also suggests the use of automated irrigation system that constitutes of embedded system leading to lesser use of farmer energy and money. This paper also helps in increasing the yield of the farm by optimizing water usage. The proposed irrigation system enhances water management and sustainability.

5. Laxmi C. Gavade, A.D Bhoi , "N, P, K Detection and Control for Agriculture Applications using PIC Controller", International Research Journal of Engineering and Technology (IRJET). Volume: 6 Issue: 4 | April 2017 [5]

This paper suggests a model to detect humidity of the soil, temperature, sunlight, N, P and K contents using sensors in the agricultural field. By measuring these parameters farmer can increase the productivity of the soil as it detects the nutrients deficient in the soil. The average productivity in India is less than the world average and this paper presents a way to attain

‘evergreen revolution’ in agriculture. Fertilizers play a vital role in good yield but imbalanced use of P, K, N causes decrease in crop production. In conventional method soil sampling is done manually but this paper presents chemical analysis that consists of three techniques: optical method, conductivity measurement and electrochemical methods. These methods helps in measuring the primary nutrients.

6. Mrs.T.Vineela, J. NagaHarini, Ch.Kiranma, G.Harshitha, B.AdiLaksh, “IoT Based Agriculture Monitoring and Smart Irrigation System Using Raspberry Pi”, International Research Journal of Engineering and Technology (IRJET). Volume: 5 Issue: 1 | Jan 2018 [6]

In many research papers it is devised that information must be collected from different sensors and live monitoring should be done but in this research paper the stress is laid on getting things automated. In this paper the writers aims at increasing the crop yield by using different technologies. It also presents a cost efficient WSN for getting information from humidity sensor, soil moisture sensor and temperature sensors. This paper suggests an automated system for better crop production. The authors suggest a methodology that does sensing of data smartly and also proposes a smart irrigation system. In the proposed model various sensors are interfaced with raspberry pi hence making an efficient wireless sensor network.

Limitations

A major drawback is that models proposed in above research papers are cost ineffective. Moreover the models in the above research papers are quite complex. In some research papers only data collection is done and no action is taken. In one of the research papers nitrogen, phosphorous and potassium are measured but the standard testing time for NPK is increasingly because of complex soil pre-treatment and compound examination. Another drawback is high technology. The model proposed by us is way simpler as well as affordable. It uses cheap yet effective technology and includes all the advantages of the models proposed above.

CHAPTER 3

SYSTEM DEVELOPMENT

3.1 Methodology

The basic building blocks of an IoT System are Sensors, Processors and applications. So the block diagram below is the proposed model of our project which shows the interconnection of these blocks. The sensors are interfaced with Microcontroller, data from the sensor is displayed on the mobile app of the user. Mobile app provides an access to the continuous data from sensors and accordingly helps farmer to take action to fulfil the requirements of the soil.

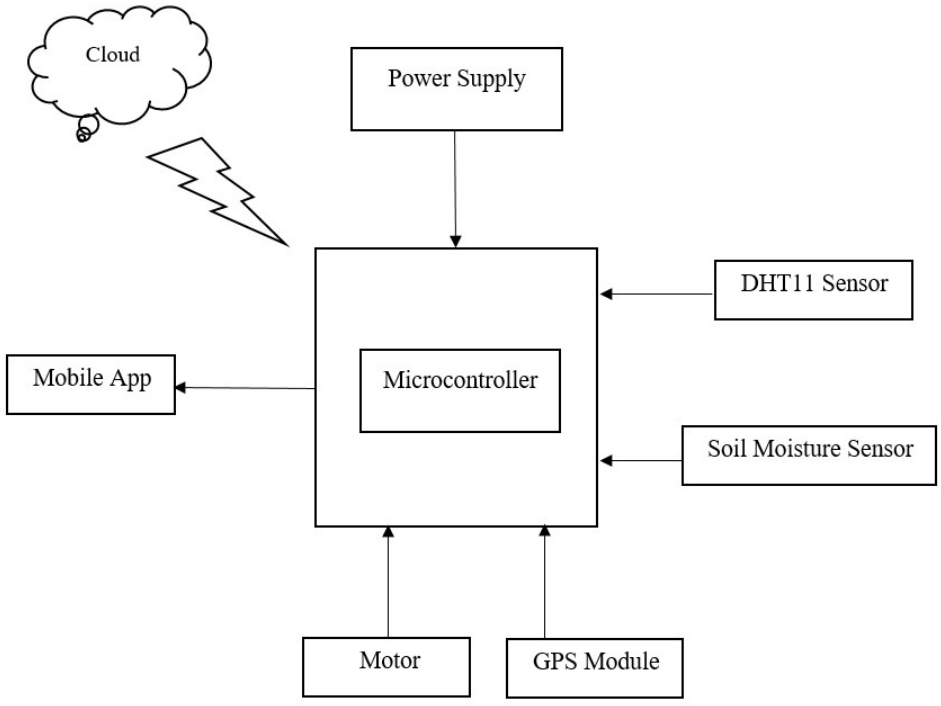
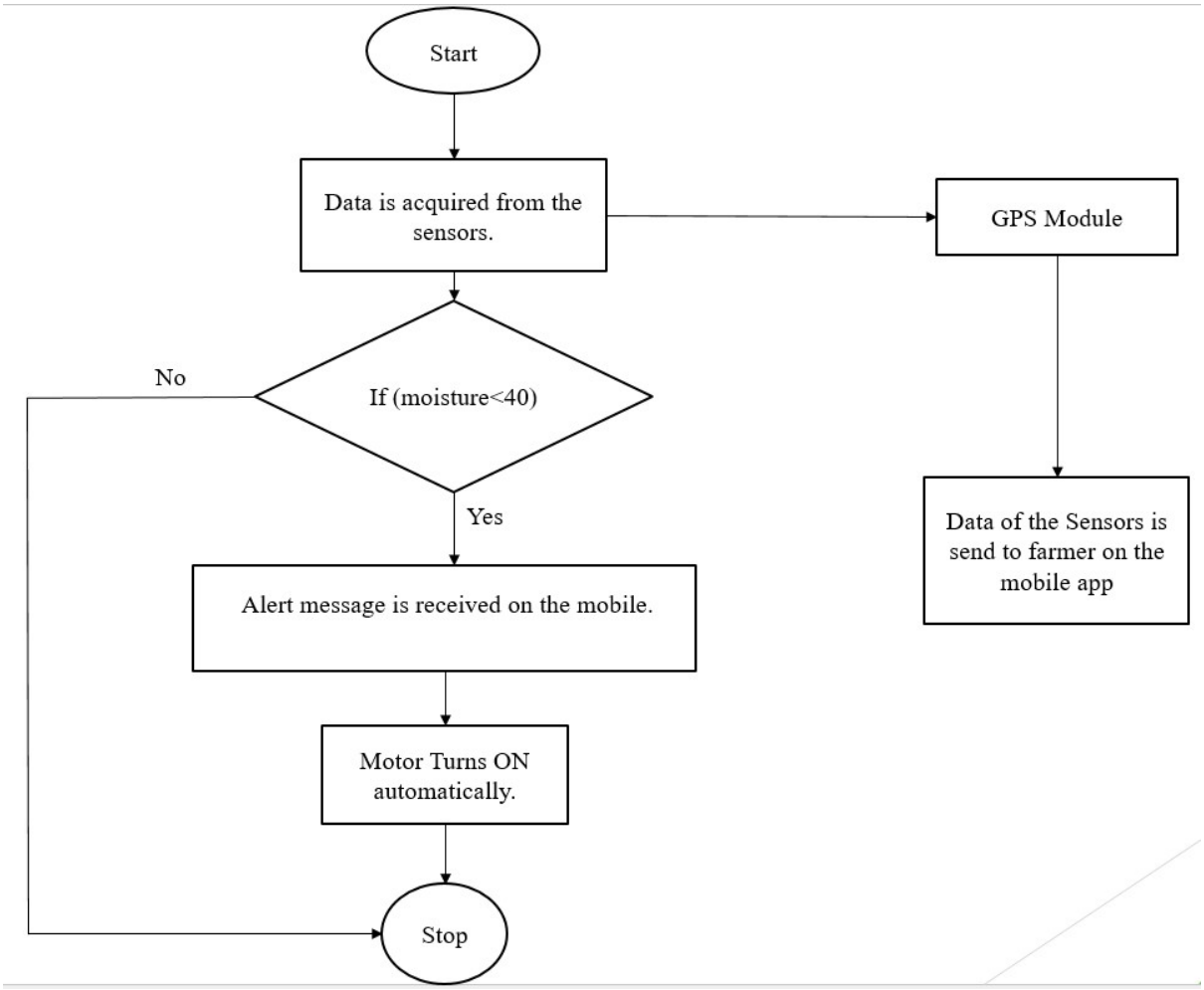


Figure 3.1 Block Diagram of Proposed Model

3.2 Flow Chart



When the data of different sensors that are humidity, temperature, soil moisture and location is acquired it is sent to the mobile app of the user and if the water content in the soil is less than the cut off value then an alert message is received on the app of the user and motor gets switched on automatically using relay.

3.3 Hardware Tools

3.3.1 NodeMCU

It is an open sources firmware and development kits to build IoT products. It includes firmware that run on ESP8266 WiFiSoC and hardware that has an ESP-12 module. The kit has analog (A0). It also has digital (D0-D8) pins on the board. It even assists serial ports communications such as SPI, UART, I2C etc.

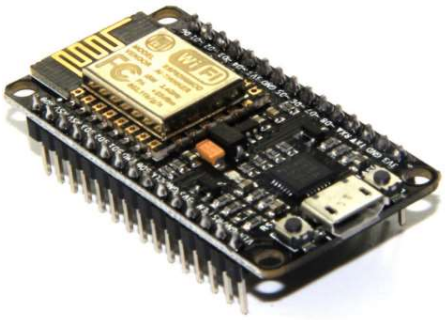


Figure 3.2 NodeMCU

- **Features**
    - The version of the NodeMCU used here is DevKit1.0.
    - It can be used on a breadboard easily.
    - It is small and light weight.
    - It supports Arduino C programming language.
    - NodeMCU is operated at a voltage of 3.3V and can be powered using USB.
    - It has a wireless protocol that is 802.11 b/g/n.
    - It has a PCB antenna on the ESP-12E chip.
    - It also contains built-in capabilities.
    - It operates CP2102 Serial Communication interface module.
    - It can be used with Arduino easily.

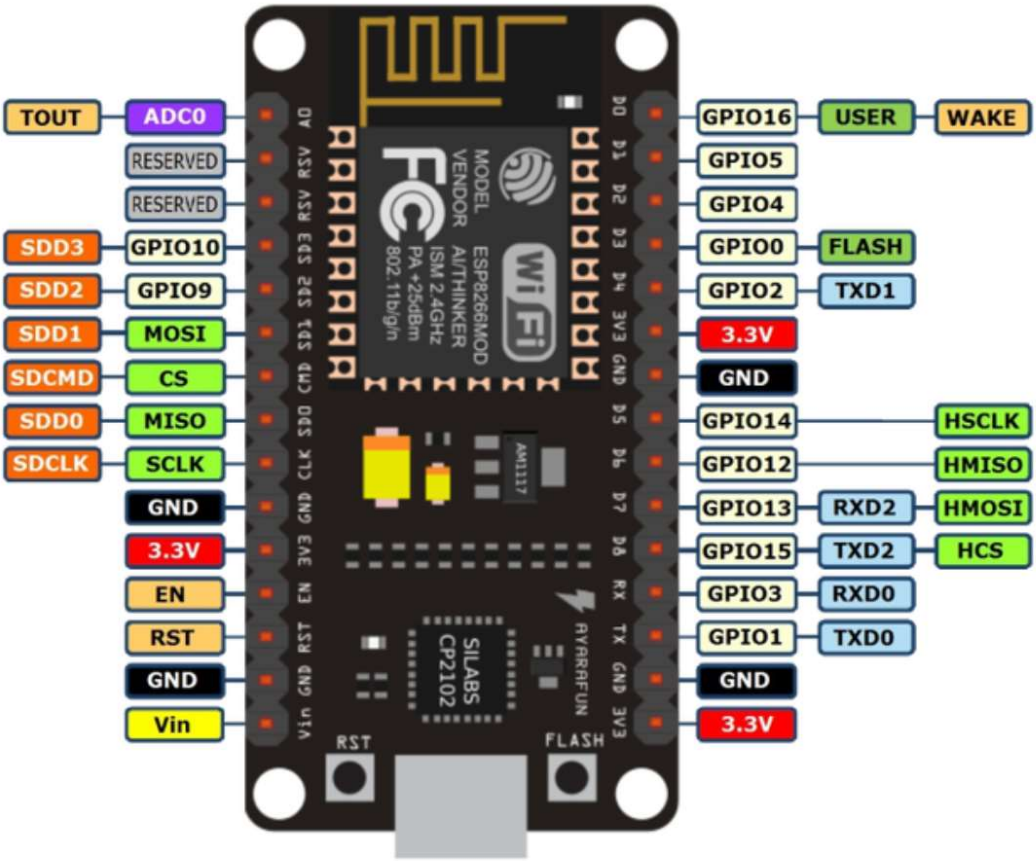


Figure 3.3 Pin Diagram of NodeMCU

The figure 3.3 gives the description about the different pins of the microcontroller NodeMCU. There are 17 GPIO pins that are for general purpose input output functions with transmitter and receiver pins. All the sensors are attached to different analog and digital pins of this microcontroller to acquire the data.

3.3.2 DHT11 Sensor

This sensor is basically a cost efficient digital humidity & temperature sensor. This sensor supplies digital output and therefore can be directly connected to data pins of microcontroller in spite of using ADC. It also consists of eight bit microcontroller to provide values of temperature & humidity in the form of data that is serial. It has 4 pins they are VCC, GND, DATA and NC. It operates from 3.3-5 volts power supply. This sensor has exceptional quality, anti-interference capability, economical performance and fast reaction benefits. Humidity is calculated by means of measuring the conductivity of liquid substrate that alters with exchange in humidity and temperature is calculated by the usage of a thermistor.

The function called read() is used to take readings from the sensor which is included in <DHT.h> library.

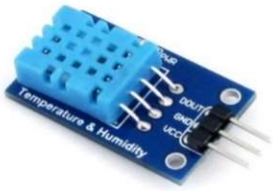


Figure 3.4 DHT11 Sensor

Table 3.1 Parameters of Temperature and Humidity (DHT11)

Parameter	**Specifications**
Input/output voltage	3V / 5V
Humidity Range	20-80 percent
Temperature Range	0-50 deg C
Sampling Rate	1Hz
Response time	50 ms
Sensing Range	20-90%RH
Accuracy	+\-5%RH
Temperature Accuracy	+\-2% deg C

3.3.3 Soil Moisture Sensor

Moisture sensor has 3 pins – one is for voltage input, second for ground and third is for analog input. Moisture content of the soil (volume %) is measured by this sensor. The analog value need to be mapped in the range of 0-100 as moisture content is evaluated in percentage. The property used by this sensor is electrical resistance of soil. There are 2 probes in this sensor that permits the current to pass through the soil. After that it gets the value of resistance to measure the water content level. This implies that higher the water content higher is the conduction of electricity which means lesser resistance. If the soil is dry then the conduction in the soil is poor, this leads to increase in level of resistance. Hence it uses the property of resistance to measure the moisture in soil. It could be joined in two different ways they are Analog and Digital mode.

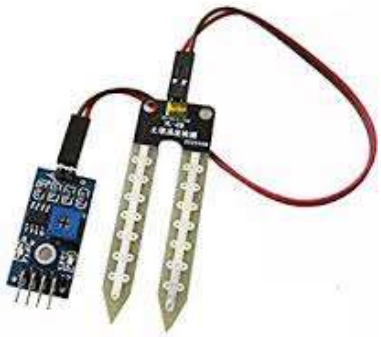


Figure 3.5 Soil Moisture Sensor

Table 3.2 Performance parameters of Soil Moisture Sensor

Parameter	Specifications
Model name	YL-38
Operating Temperature	-40 to +60 deg C
Sensing Range	0-45%volumetric water content of soil
Operating Voltage	5V DC
Power Consumption	3mA

3.3.4 GPS Module

The full form of GPS is global positioning system so through this module anyone can always obtain the information regarding position anywhere in the world, generally used in smart phones. It is basically a satellite based system which uses satellite and ground stations to compute position on the earth. It needs to receive data from a minimum of 4 satellites for accuracy. So the NEO-6MV2 GPS module gives output in National Marine Electronics Association. This module provides data in the form of longitude and latitude positions. It has a built in 25 x 25 x 4mm ceramic antenna that provides a strong satellite search capability. It has default baud rate of 9600 and excellent navigation performance in adverse challenging environments. This module contains four output pins for communication interface.

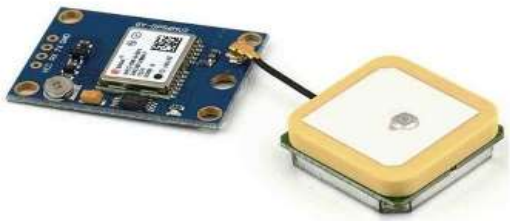


Figure 3.6 GPS Module

Table 3.3 Pin Description of GPS

Pin Name	Description
VCC	Power input(3.3v)
GND	Ground
RX	UART receive pin
TX	UART transmit pin

Interfacing of GPS Module

This is one of the most popular module that can provide accurate location to most of its application. Baud rate of the controller should match the module otherwise error will occur.

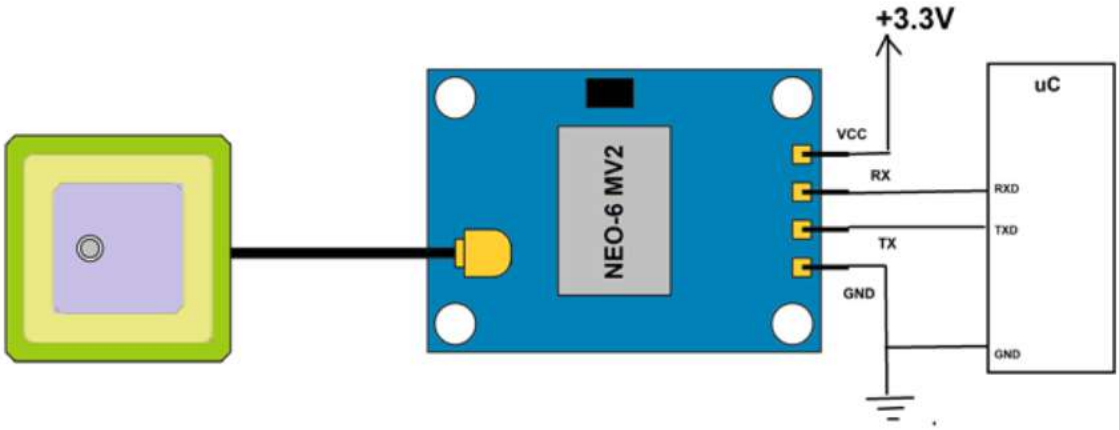


Figure 3.7 Interfacing of GPS with microcontroller

Features of GPS module

- Standalone GPS receiver
- Anti-jamming technology
- UART Interface at the output pins (Can use SPI,I2C and USB by soldering to the chip core)
- Under 1 second time-to-first-fix for hot and aided starts
- Receiver type: 50 channels- GPS L1 frequency – For Warm Start 23s, For Hot Start < 1s
- Time-To-First-Fix : For Cold Start 23s , For Hot Start < 1s
- Maximum navigation update rate : 5Hz
- Default baud rate : 9600 bps
- EFROM with battery backup
- Sensitivity : -160 dBm
- Supply voltage : 3.6V
- Maximum DC current at any output : 10mA
- Operation limits : Gravity 4g , Altitude - 50000m , Velocity – 500 m/s
- Operating temperature range : -40 deg C to 85 deg C

3.3.5 Relay

It is a switching device. To mechanically control a switch many of the relays use electromagnet but some other fundamentals can also be used like relays that are solid state. When it is important to operate a circuit by a way of independent low power signal or if different circuits are managed by means of a single signal, then relays are used. So relay acts as an automated switch that operates on circuit having high current using low current signal.

Features –

- Great in safety. In high voltage and power system, the higher current is controlled by the lower one.
- Wide scope of controllable Voltage.
- Have the capacity to manage high load current, that could attain 240V, 10A with Normally-open(NO) and Normally-closed (NC) contacts.
- Board has a power indicator(Red LED) and relay status(Green LED) for debugging.

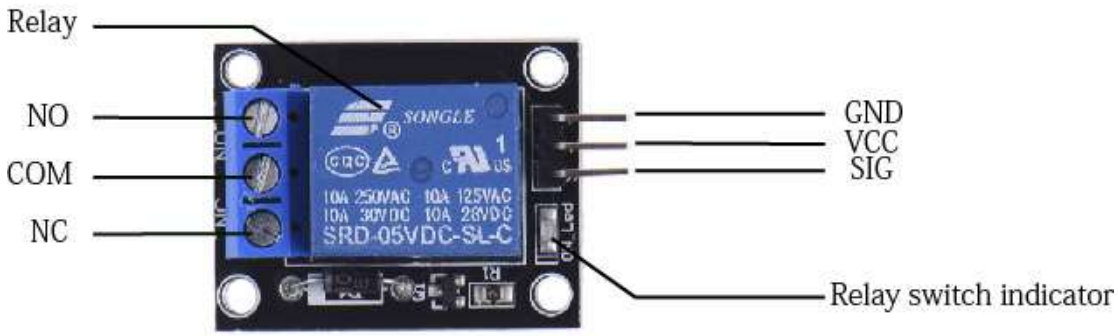


Figure 3.8 Pins of Relay

Working of Relay

Working of relay is explained in the below figure-

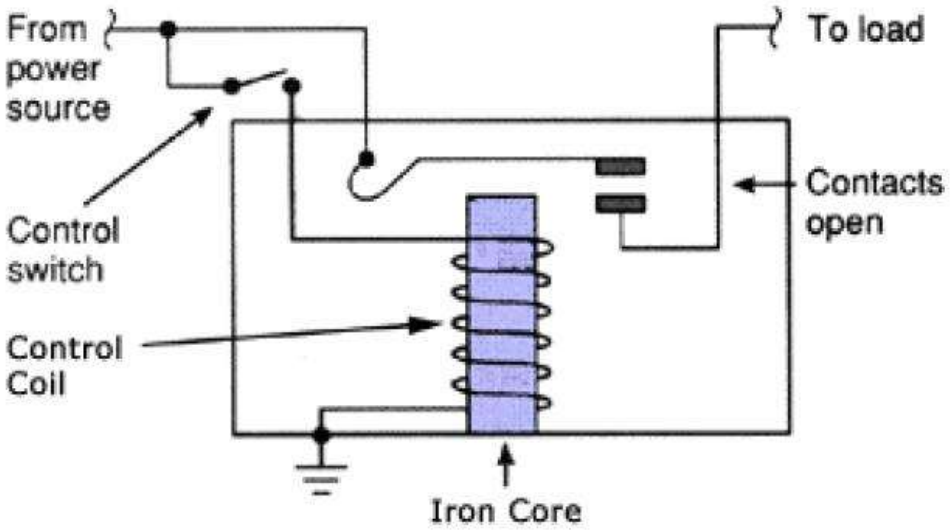


Figure 3.9 Working of Relay

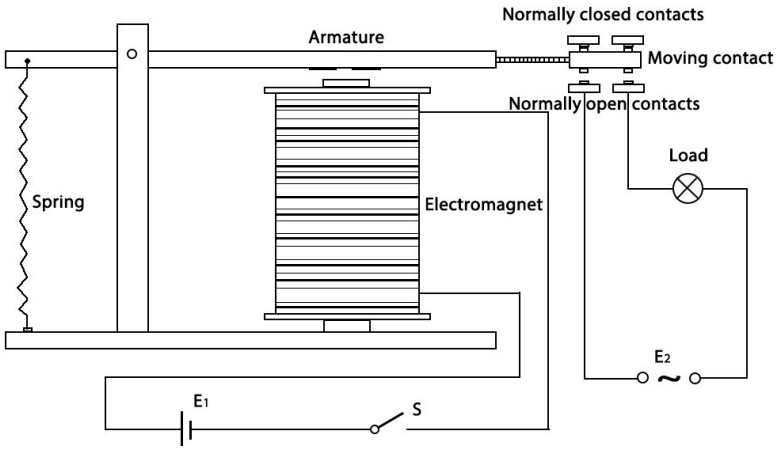


Figure 3.10 Parts of Relay

In figure 3.10 With the help of control switch and load contacts power source is provided to the electromagnet. The magnetic field is strengthened and electromagnet is energized when the current begins to flow in the control coil. A short circuit is made that helps in loading the power by pulling the upper arm into the lower arm according to the contacts. Whereas an open circuit is made when the relay gets de-energized beforehand and the contacts are closed and they move in opposite directions. When the current in the coil is, the transportable armature would go back with the aid of a force back to its original position.

3.3.6 Motor

It is a micro submersible pump which works on dc 3-6v with cost efficient and portable. It is able to take around 120 litres for every hour with extremely low current utilization. Water level should be higher as if the motor is used without water it can harm the parts of this device due to overheating. There are many applications such as controlled fountain water flow, hydroponic systems, controlled garden watering system.

Figure 3.11: Motor

Features of Water pump motor

- DC Voltage : 2.5-6 V
- Maximum lift : 40-110 cm
- Flow rate : 80-120 L/H
- Outside diameter of water outlet : 7.5mm
- Inside diameter of water outlet : 5mm
- Diameter : approx. 24mm
- Length : approx. 45 mm
- Height : approx. 30 mm
- Material : engineering plastic
- Rated speed : 9000rpm / 150Hz

3.4 Software Tools

3.4.1 Arduino Ide (Integrated Development Environment)

Arduino IDE is an open source programming which is basically used to write & compile code using a module that is Arduino. This is an official programming software which makes compiling of code simple so a typical man can understand the learning procedure. This software is readily available for all operating systems like MAC, windows, Linux. Arduino Mega, Arduino Uno, Arduino Leonardo and more are range of Arduino modules that are available.

It basically has a text editor which is used for writing code, a text console, a message area, a toolbar with buttons for some of the common functions. Sketches are called as the programs that are written using this software. Coding on this software mostly uses functions of c/c++.

Figure 3.12 Arduino IDE

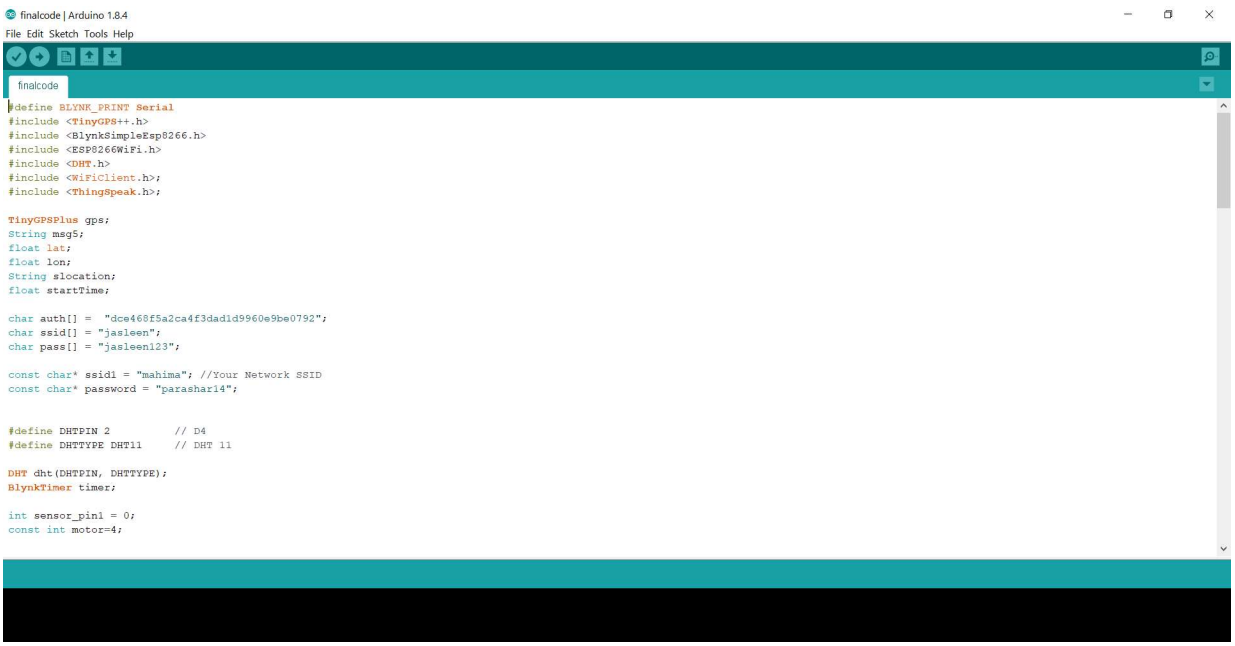


Figure 3.13 Sketch Area of Arduino

The above figure shows the picture of Arduino sketch. The tool bar consists of many icons. The first icon from the left is to verify, the second one is to upload, the third one is for opening new project, the fourth one is to open a project and the fifth one is to save the project. The icon on the extreme right is for opening serial monitor. The white area in the middle is coding area.

3.4.2 Blynk

It was designed for IoT. This app has capacity to remotely control hardware and also shows sensor information. This app also helps to visualize and store data.

This platform contains 3 main elements:

1) Blynk app- With the help of various widgets amazing interfaces for the projects can be created.
2) Blynk Server- Establishes a communication network between smartphone and hardware.
3) Blynk Libraries- All incoming and outgoing commands are processed and also enables communication between server and process

Features

1) Has similar API and UI for supported hardware and devices.
2) With the use of WiFi, Bluetooth, GSM, USB connects to the server.
3) Direct manipulation of pins with no code writing.
4) With the use of virtual pins of this app it is easy to add functionalities and integrate.
5) By the use of bridge widget it is possible to have device to device communication.

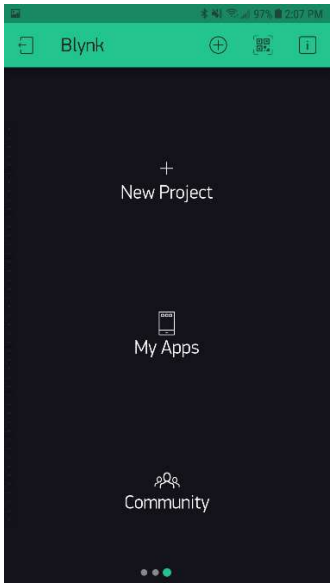


Figure 3.14 Blynk App

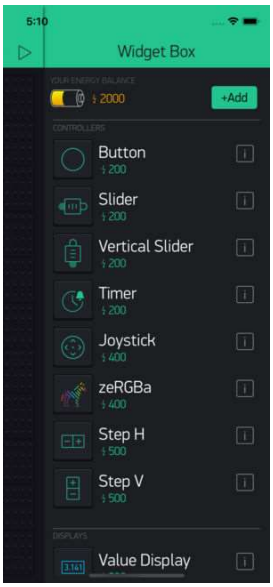


Figure 3.15 Widgets of Blynk app

3.4.3 Thingspeak Cloud Server

It is an open source application. This platform provides services that allows to visualize, analyse & aggregate live data streaming on cloud server. It presents instant visualizations of information published by different devices to this cloud server. It has the capacity to execute MATLAB code on this server we can carry out online evaluation and processing of statistics as it comes in. It is regularly used for prototyping.

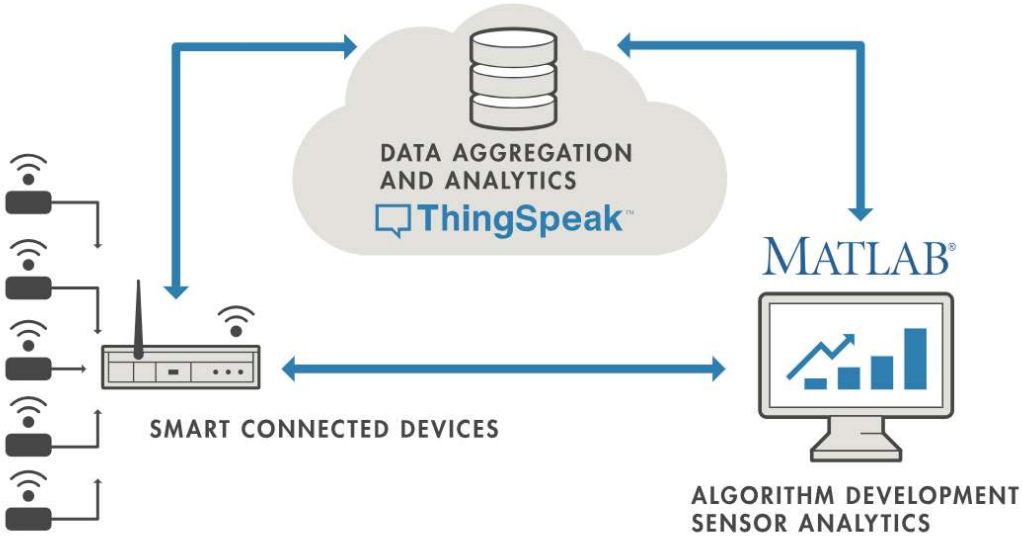


Figure 3.16 IoT systems

On the left side there are smart devices that live at the edge of the network. These devices collect information and include things like heart rate monitors, wireless sensors, wearable devices etc. In the middle there is a cloud where data from different sources is analysed in real time. The right side depicts the algorithm development connected with IoT application.

Features of Thingspeak

4 With the use of IoT protocols devices are easily configured to transmit data to the cloud.

5 In actual time the data of sensors are visualized

6 Collect data on demand from sources.

7 Makes sense of IoT data with the power of MATLAB.

8 Builds IoT system and prototype without developing softwares and servers.

Figure 3.17 Plots in Thingspeak

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Circuit description

The Figure 4.1 shows the experimental setup of our smart agriculture monitoring system. The setup contains Microcontroller that is NodeMCU then sensors they are soil moisture, DHT11, GPS module and the last is Motor which is connected through relay. In this NodeMCU gives base for live streaming of temperature, humidity, soil moisture and sending the sensor information to the server using ESP8266 WiFi module and also the data of these sensors are send to the mobile app along with the GPS location. The sensors are interfaced with the microcontroller (NodeMCU) and are given power supply. Values from the sensors is read by NodeMCU and this microcontroller posts the information to the cloud server. When the value of moisture of the soil reaches below a certain threshold value which results the relay to get ON that leads to switching ON of the motor automatically and whenever the moisture value reaches the threshold level relay automatically switches OFF the motor.

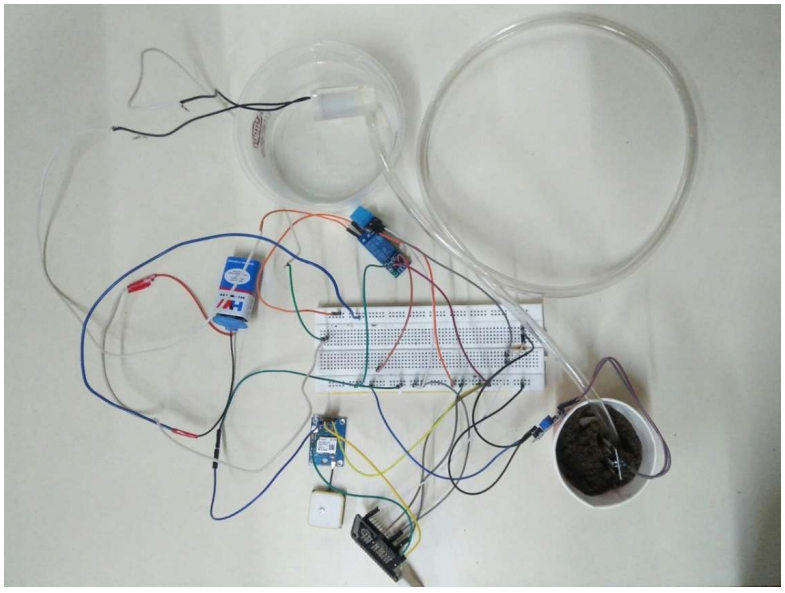


Figure 4.1 Hardware Setup

4.2 Results

We have measured the moisture of soil at different times of the day and figures below show the results of all the sensor readings at different platforms.

1) At the time of day

a) The figures shown below depict the sensor readings of temperature, humidity and soil moisture, GPS location when the soil is **DRY** on serial monitor, mobile App and Cloud server.

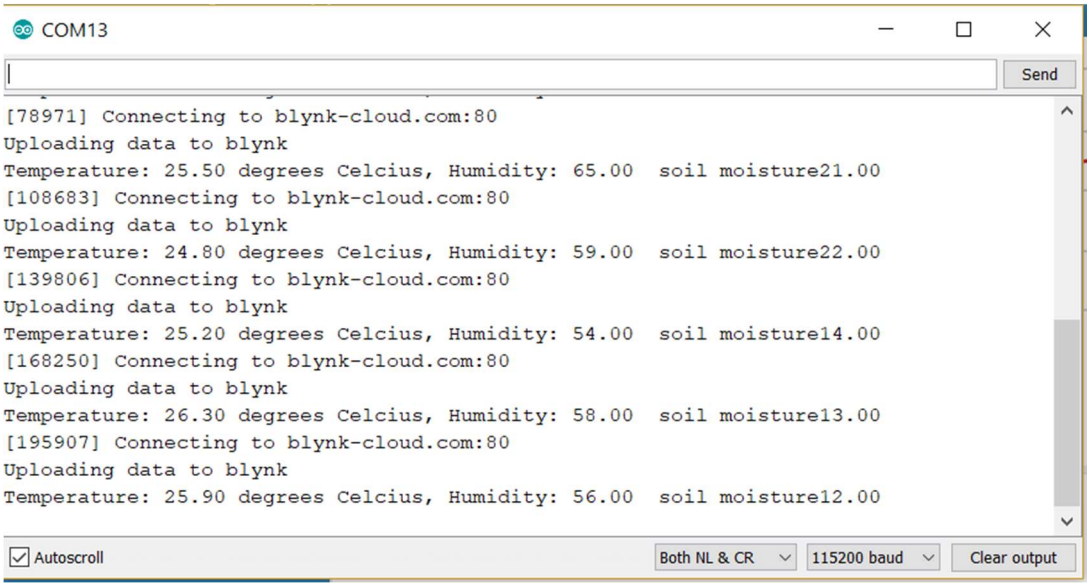


Figure 4.2 Sensor readings on serial monitor

Readings of the sensors on the mobile app

Figure 4.3: Readings on the Blynk app

Figure 4.3 shows the value of temperature that is 25.4 deg celcius , value of humidity that is 61% and value of soil moisture is 13% on the mobile app during the day when the soil is dry

Graphs of sensor data on Thingspeak cloudserver

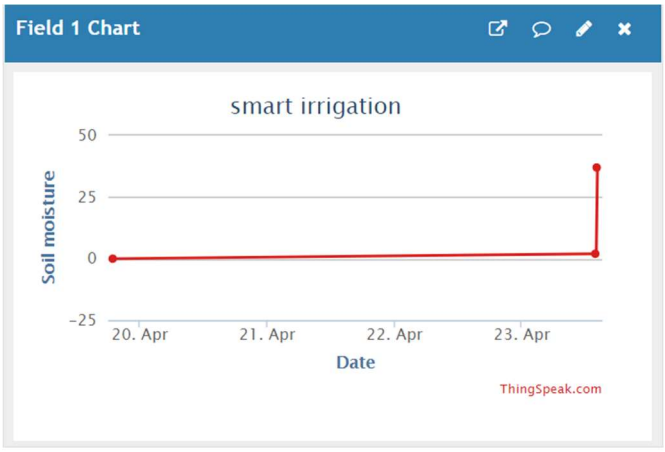


Figure 4.4 Graph of soil moisture

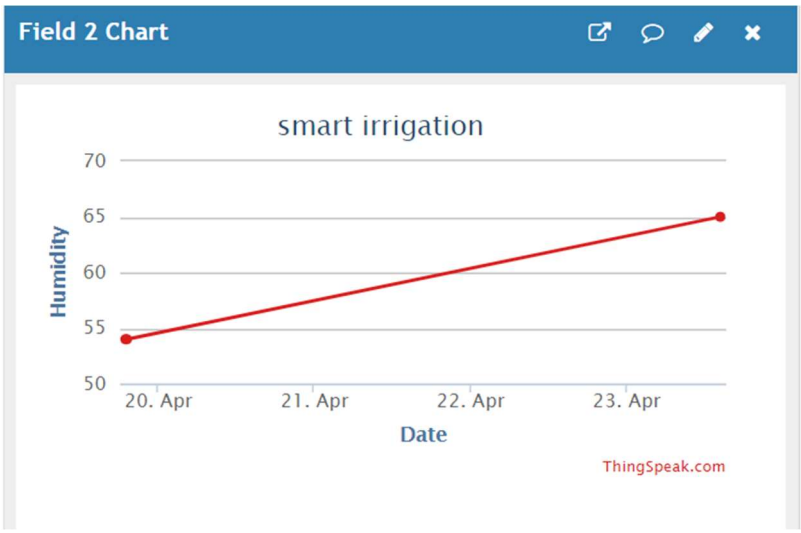


Figure 4.5 Graph of Humididty

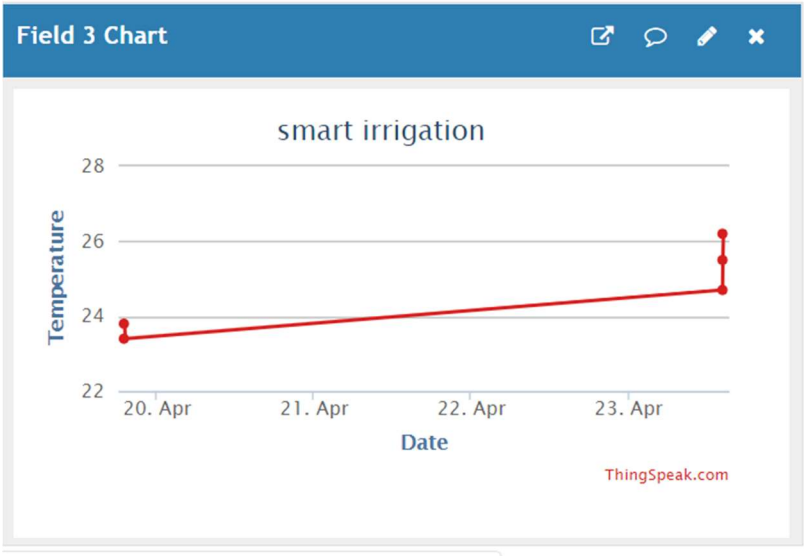


Figure 4.6 Graph of Temperature

Figure 4.4, Figure 4.5 and Figure 4.6 shows the variation of soil moisture, humidity and temperature respectively with time. These graphs depict the real time data acquired on thingspeak.

b) The figures shown below depicts the sensor readings of temperature, humidity and soil moisture when the soil is **WET** on serial monitor, mobile App and Cloud server.

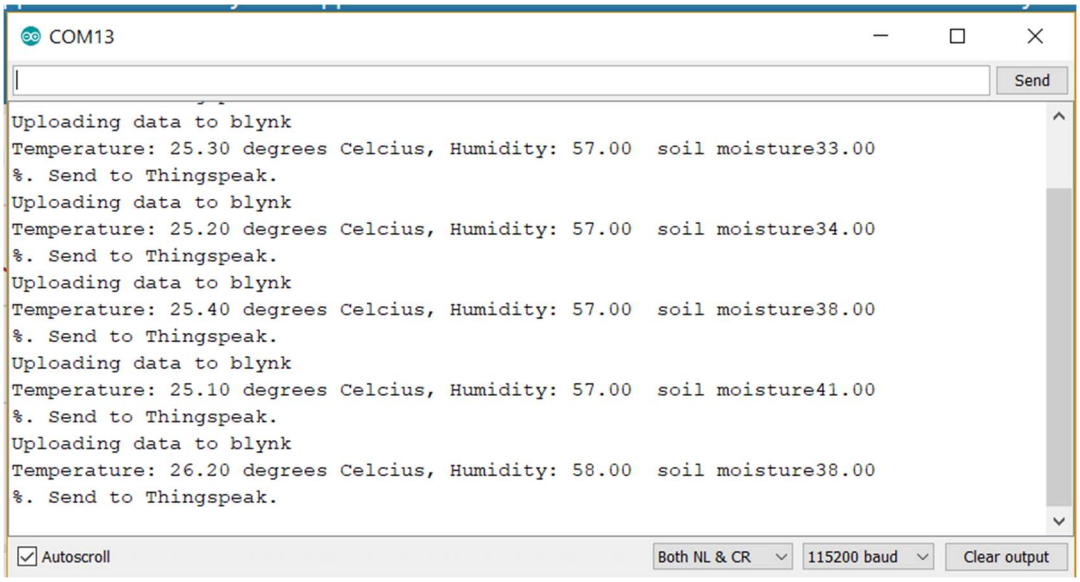


Figure 4.7 Sensor readings on serial monitor

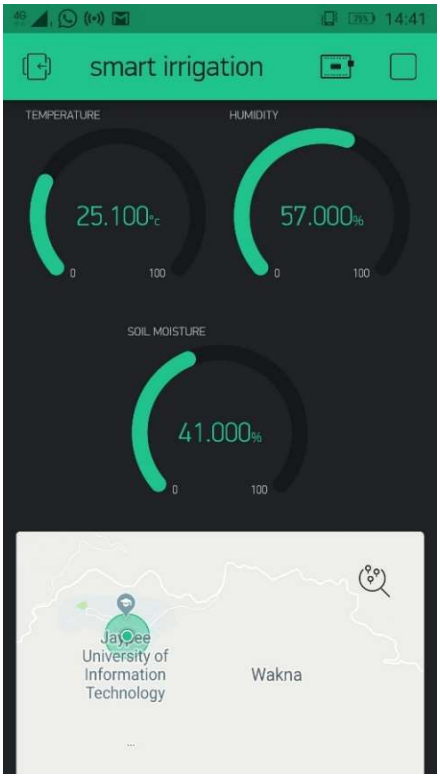


Figure 4.8 Readings on Blynk app

Figure 4.8 shows the value of temperature that is 25.1 deg celcius , value of humidity that is 57% and value of soil moisture is 41%on the mobile app during the day when the soil is wet

Graphs of Sensor Data on Thingspeak cloud server.

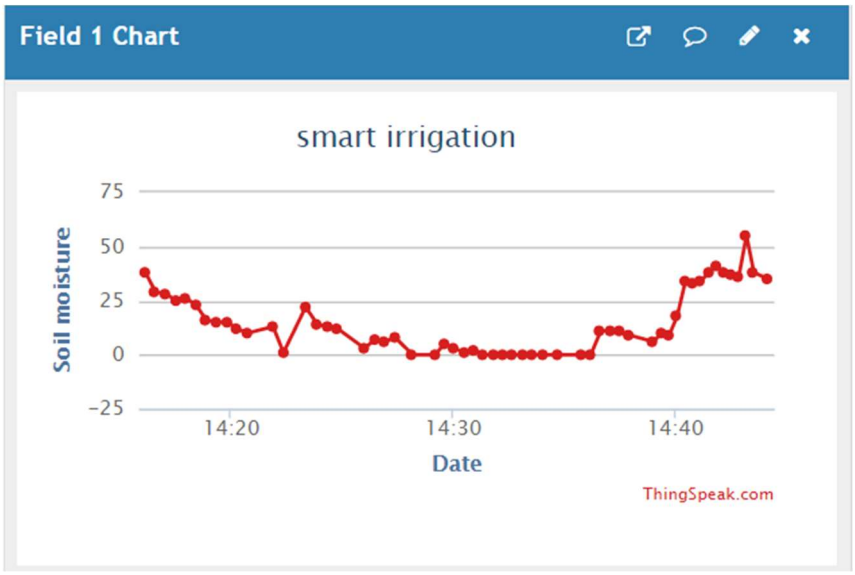


Figure 4.9 Graph of soil moisture

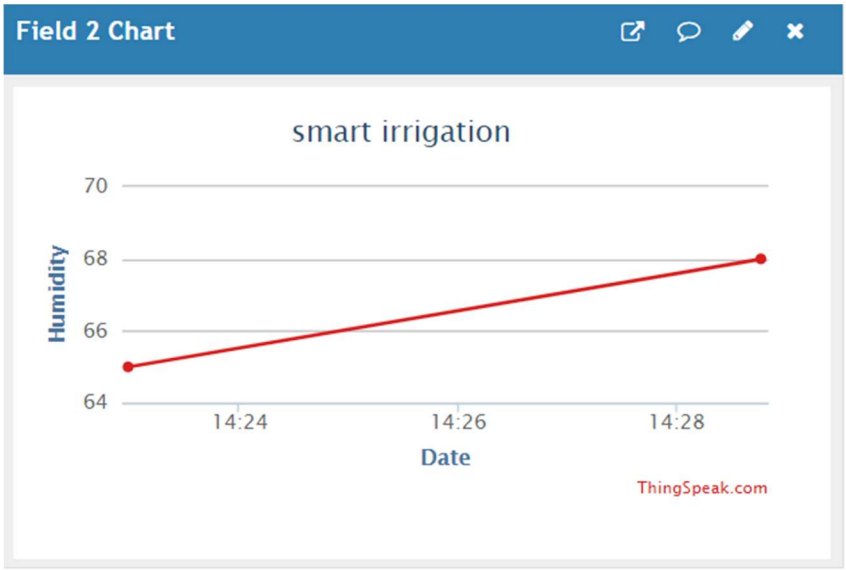


Figure 4.10 Graph of Humidity

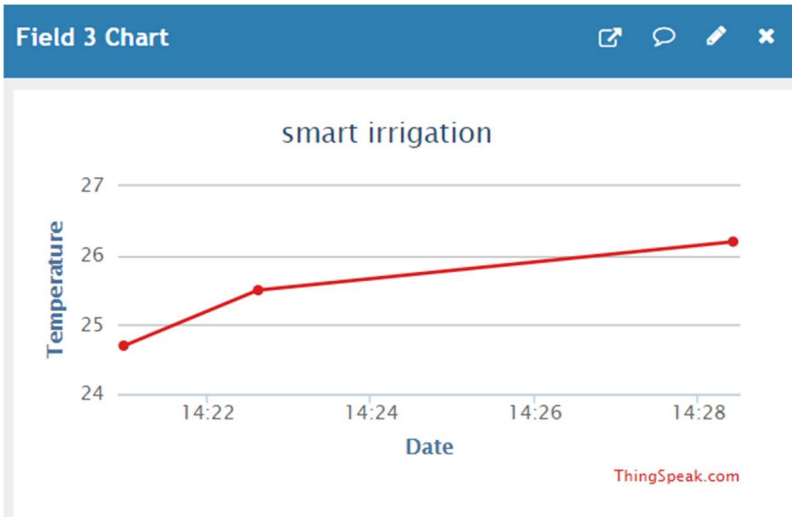


Figure 4.11 Graph of Temperature

Figure 4.8, Figure 4.9 and Figure 4.10 shows the variation of soil moisture, humidity and temperature respectively with time. These graphs depicts the real time data acquired on thingspeak.

2) At Night

a) The figures shown below depict the sensor readings of temperature, humidity and soil moisture, GPS location when the soil is **DRY** on serial monitor, mobile App and Cloud server.

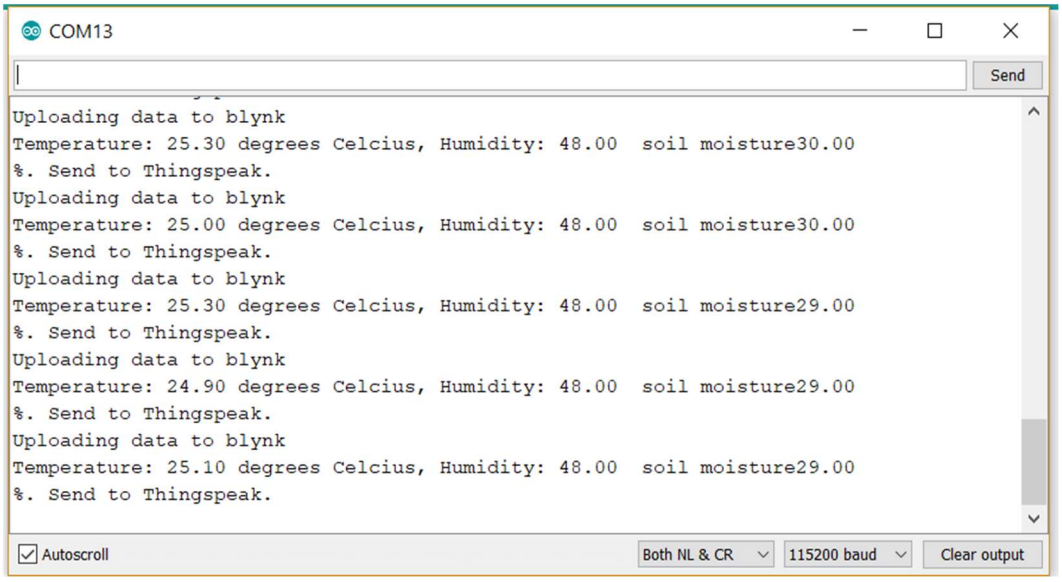


Figure 4.12 Sensor readings on serial monitor

Readings on Blynk APP

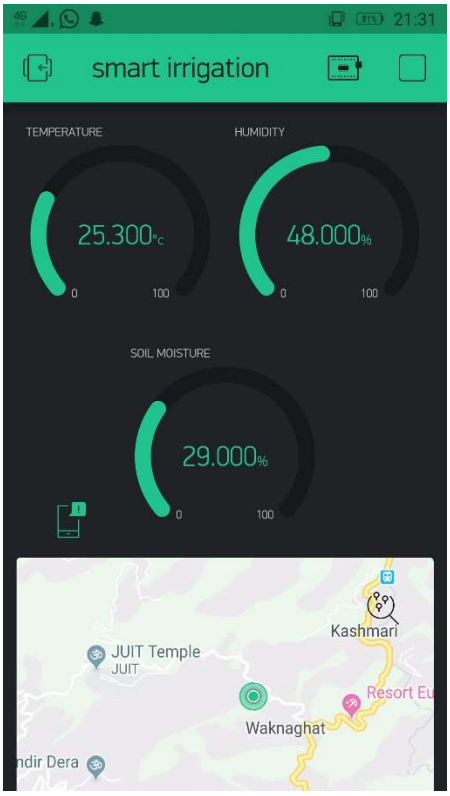


Figure 4.13 Sensor readings on Blynk app

Figure 4.13 shows the value of temperature that is 25.3 deg celcius , value of humidity that is 48% and value of soil moisture is 29% on the mobile app during the night when the soil is dry.

Graphs of Sensor Data on Thingspeak cloud server.

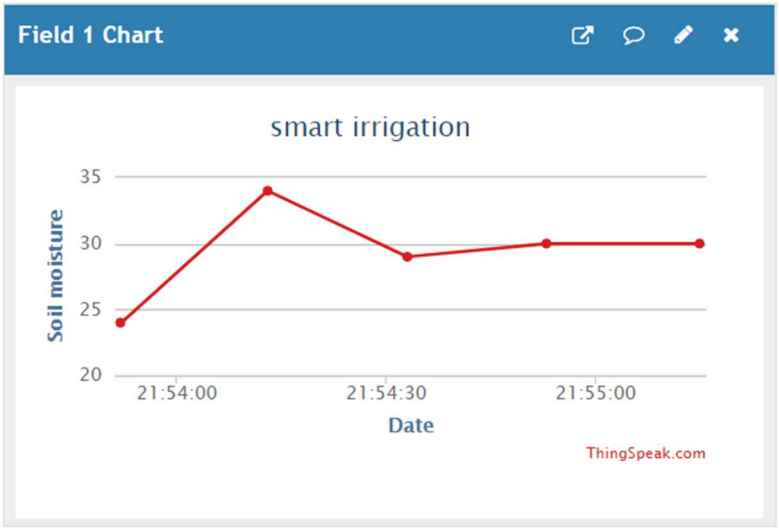


Figure 4.14 Graph of Soil Moisture

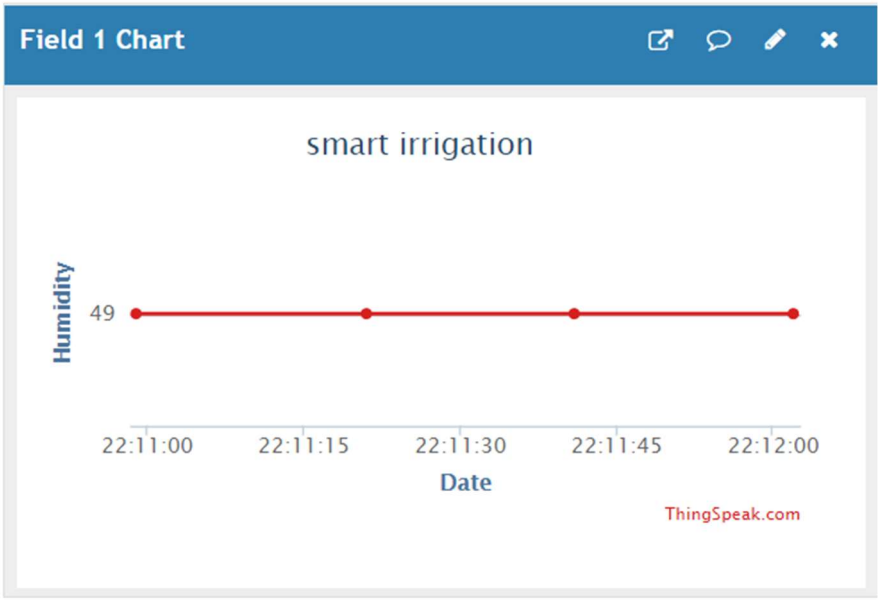


Figure 4.15 Graph of Humidity

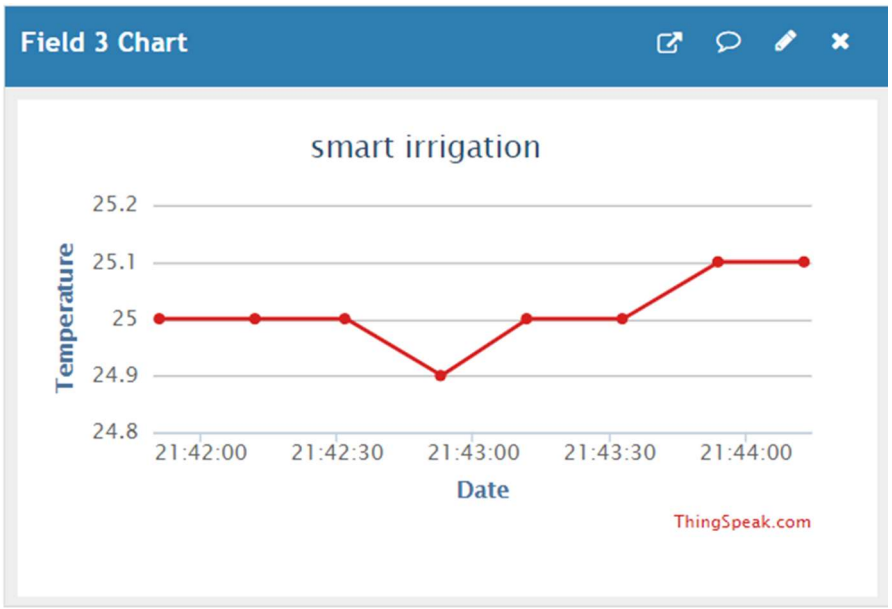


Figure 4.16 Graph of Temperature

Figure 4.14, Figure 4.15 and Figure 4.16 shows the variation of soil moisture, humidity and temperature respectively with time. These graphs depicts the real time data acquired on thingspeak.

b) The figures shown below depict the sensor readings of temperature, humidity and soil moisture, GPS location when the soil is **WET** on serial monitor, mobile App and Cloud server.

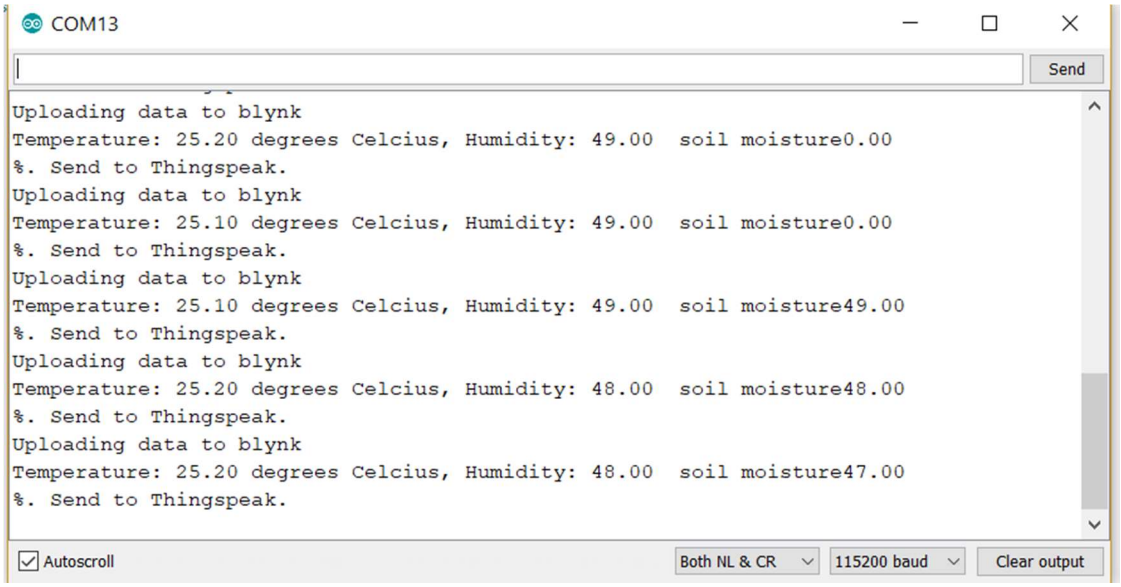


Figure 4.17 Sensor readings on serial monitor

Figure 4.18 Readings on Blynk app

Figure 4.18 shows the value of temperature that is 25.1 deg celcius, value of humidity that is 49% and value of soil moisture is 49% on the mobile app during the night when the soil is wet.

Graphs of Sensor Data on Thingspeak cloud server

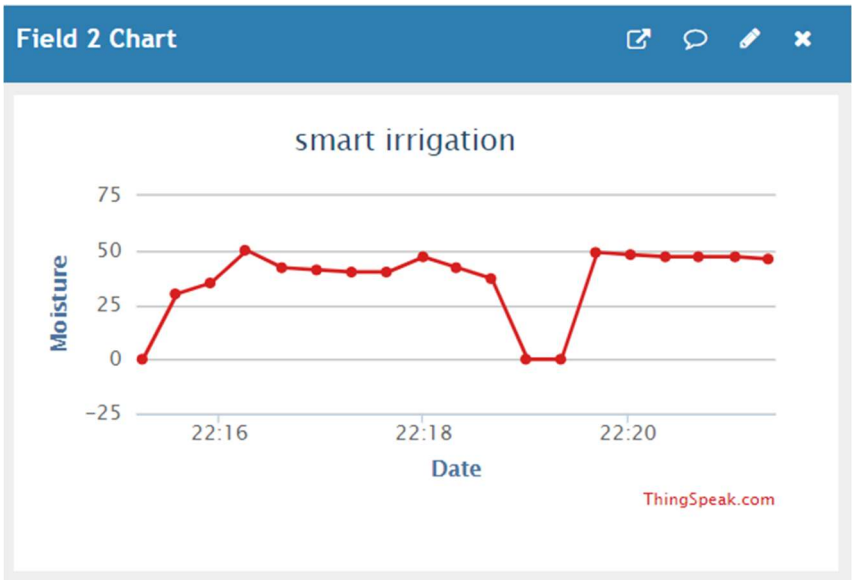


Figure 4.19 Graph of soil moisture

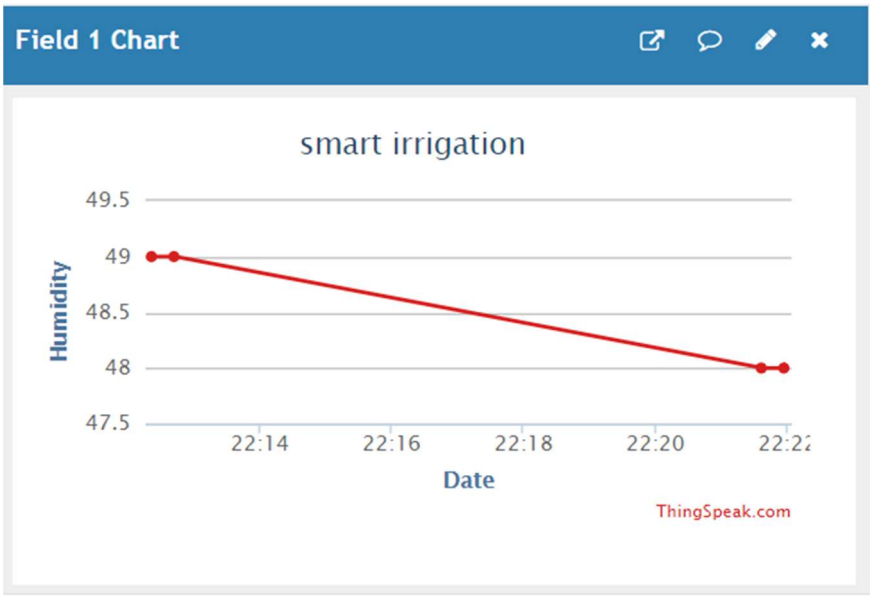


Figure 4.20: Graph of Humidity

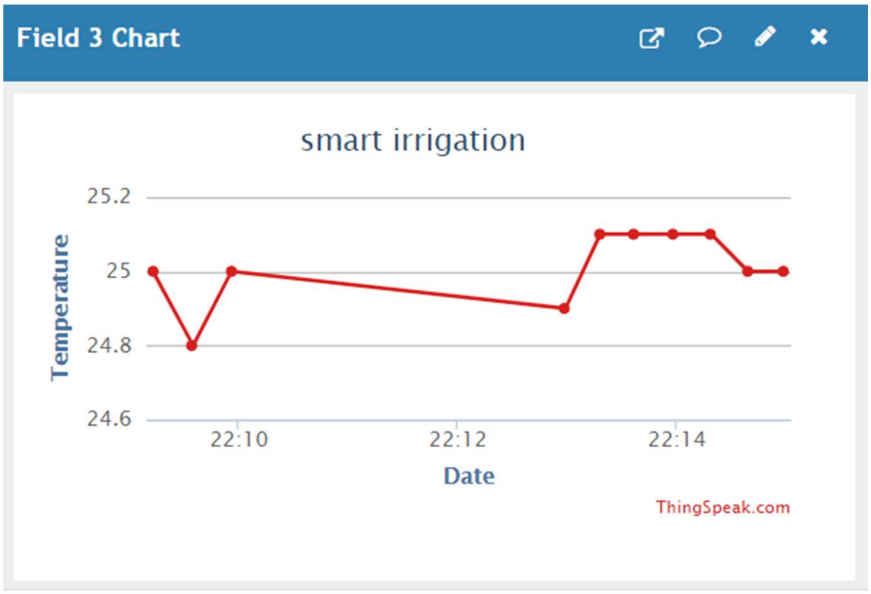


Figure 4.21: Graph of Temperature

Figure 4.19, Figure 4.20 and Figure 4.21 shows the variation of soil moisture, humidity and temperature respectively with time. These graphs depicts the real time data acquired on thingspeak.

From our above observations we can say that at the time of day the moisture in the soil is low as the temperature is high and at night moisture of the soil is high as the temperature reduces.

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1 Conclusion

The proposed model explores the use of IoT (Internet of things) in the agriculture sector. This model aims at increasing the crop yield by helping in predicting better crop sequence for a particular soil. Thingspeak helps in real time sampling of the soil and hence the data acquired can be further used for analysing the crop. We have also taken many readings of the soil moisture, temperature and humidity of the environment for various days at different times of the day. Data on the cloud also helps the agriculturists in improving the yield, evaluating the manures, illness in the fields. This system is cost effective and feasible. It also focuses on optimizing the use of water resources which combats issues like water scarcity and ensures sustainability. This model focuses on the utilization of IoT in agriculture and the solutions proposed in this paper will improve farming methods, increase productivity and lead to effective use of limited resources.

5.2 Future Scope

The future scope of this project could be including variety of soil sensors like pH sensor, Rain sensor and then collecting and storing the data on cloud server. This would make the predicting and analysing processes more accurate. It also includes making different data mining algorithms suitable for data analysis in agriculture.

Figure 5.1: Rain Sensor

Figure 5.2: pH Sensor

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