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## BLDEA's V.P. Dr. P.G. HALAKATTI COLLEGE OF ENGINEERING AND TECHNOLOGY, VIJAYAPUR

## DEPARTMENT OF
## ELECTRONICS AND COMMUNICATION ENGINEERING

A Mini Project report on

# "SMART PLANT MONITORING SYSTEM"

*Submitted in partial fulfillment for the award of degree of Bachelor+ of Engineering Electronics and Communication Engineering*


**Submitted by**

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2023-24

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY,
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## B.L.D.E. Association's

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# CERTIFICATE

This is Certified that the Mini project work entitled **"SMART PLANT MONITORING SYSTEM"** carried out by **Sandeep ,Santosh , Sourabh , Yosgesh** Bonafide students of **VP Dr P.G Halakatti College of Engineering and Technology, Vijayapura** in partial fulfillment for the award of **Bachelor of Engineering** in **Electronics and Communication Engineering** of the **Visvesvaraya Technological University, Belgaum** during the year 2023-2024. It is certified that all corrections/suggestions indicated for internal assessment have been incorporated in the report deposited in the departmental library. The Mini project report has been approved as it satisfies the academic requirement in respect of Mini project work prescribed for the said degree.

| GUIDE | H.O.D | PRINCIPAL |
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# DECLARATION

We, students of Sixth semester B.E, at the department of Electronics & Communication Engineering, hereby declare that, the Mini Project entitled **SMART PLANT MONITORING SYSTEM**", embodies the report of our mini project work, carried out by us under the guidance of **Prof. M.S. KANAMADI,** We also declare that, to the best of our knowledge and belief, the work reported here in does not form part of any other report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this by any student.

Place:-Vijayapur Date:-

# ACKNOWLEDGEMENT

The satisfaction and euphoria that accompany the successful completion of any task would be incomplete without the mention of people who made it possible, whose consistent guidance and encouragement crowned our efforts with success. We consider it as our privilege to express the gratitude to all those who guided in the completion of our Mini Project.

First and foremost, We wish to express our profound gratitude to our respected Principal **Dr. V.G. Sangam, B.L.D.E. Association's VACHANA PITAMAHA Dr. P.G. HALAKATTI COLLEGE OF ENGINEERING & TECHNOLOGY, Vijayapura** , for providing us with a congenial environment to work in.

We would like to express our sincere thanks to **Dr. U D Dixit** , the HOD of **Electronics and Communication Engineering**, **B.L.D.E.Association's VACHANA PITAMAHA Dr. P.G. HALAKATTI COLLEGE OF ENGINEERING & TECHNOLOGY, Vijayapura**, for his continuous support and encouragement.

We are greatly indebted to our guide **Prof. Guide name**, Department of **Electronics and Communication Engineering**, **B.L.D.E. Association's VACHANA PITAMAHA Dr. P.G. HALAKATTI COLLEGE OF ENGINEERING & TECHNOLOGY, Vijayapura**, who took great interest in our work. He motivated us and guided us throughout the accomplishment of this goal. We express our profound thanks for his meticulous guidance.

# ABSTRACT

The efficient irrigation management practices based on the monitoring of the moisture in the soil provide a great benefit for the appropriate amount of water applied in the fields. This presents soil moisture sensor and a response monitoring system. The probes used in this sensor are made of nickel which is an anti-corrosive and robust material for use in agricultural related applications. The response monitoring system measure the moisture of the soil, compare it with the desired values given by the user and generate alert if soil moisture goes below desired value. It helps in problems related to growing of crops in which irrigation is required at irregular interval. It is also helpful in monitoring of soil moisture in golf fields. Here we are building an IoT based Irrigation System using ESP8266 NodeMCU Module. Initially this sensor identifies the moisture content and sends the data to application particularly data can be measured using gauge systems. Which shows us the moisture level and the type of soil (wet or dry). It indicates whether the motor has to be turned OFF or ON. The moisture is also monitored by Mobile Application Dashboard which displays the level of moisture content in soil. The project runs mobile application to display moisture content in soil which is to acquire the moisture of the soil. The moisture content of the soil is acquired to application dashboard through connected Wi-Fi. This application provides multiple sources such as switches, gauges, display meters to control motors and monitor or any other appliances which are needed manually through your hand-held devices.

# INDEX

# CHAPTER 1

## INTRODUCTION

Soil moisture information plays an important role in environmental monitoring, agricultural production and hydrological studies. Particularly, agricultural yield depends on several growing parameters like temperature, humidity, soil moisture and pH of the soil, etc. In this project, we have designed and developed a system for measuring and monitoring soil moisture by interfacing low-cost soil moisture sensor with Internet of Things (IoT), Cloud computing and Mobile computing technologies.

## INTERNET OF THINGS WITH ThingSpeak Cloud Services

Thingspeak is a cloud Platform as a service. It supports several programming languages and services as well as integrated Dev Ops to build, run, deploy and manage applications on the cloud. Thingspeak is based on Cloud Foundry open technology and runs on Soft Layer infrastructure. Bluemix supports several programming languages including Java, Node.js, Go, PHP, Swift, Python, Ruby, Sinatra, Ruby on Rails and can be extended to support other languages such as Scala through the use of build packs.

## OVERVIEW OF THE PROJECT

In India, agriculture contributes about 16% of total GDP and 10% of total exports. Water is main resource for Agriculture. Irrigation is one method to supply water but in some cases, there will be lot of water wastage. Therefore, in this regard to save water and time we have proposed project titled NodeMCU ESP8266 Wi-Fi module based automatic irrigation system using Arduino IDE-IoT. In this proposed system, we are using various sensors like temperature, humidity, soil +moisture sensors that sense the various parameters of the soil. In addition, based on soil moisture value land is automatically irrigated by ON/OFF of the motor. These sensed parameters and motor status will be displayed on user android application. The Internet of Things (IoT) is a technology where a mobile device can be used to monitor the function of a device. The Internet of Things (IoT) is concerned with interconnecting communicating objects that are installed at different locations that are possibly distant from each other. Internet of Things (IoT) is a

type of network technology, which senses the information from different sensors and make anything to join the Internet to exchange information. It can also be used to modify the status of the device. The central processing unit will also include communication device to receive data from the sensors and to be relayed to the user's device. This will be done using a higher communication device such as a Wi-Fi module. The data processed by the central module is converted to meaningful data and relayed to the user. The user can view the data with the help of a handheld device such as a mobile phone or a tablet. Nowadays water scarcity is a big concern for farming. This project helps the farmers to irrigate the farmland in an efficient manner with automated irrigation system based on soil moisture.

## RELATED WORKS

There are many techniques to perform this soil moisture sensing using not only ESP8266, we can also use Arduino board and many other cloud platforms such as Thingspeak Cloud, AWS Cloud, adafruit etc., we can connect to many cloud databases. Nowadays, for irrigation, different techniques are available which are used to reduce the dependency of rain. And mostly this technique is driven by electrical power and on/off scheduling. In this technique, soil moisture sensors are placed root zone of plant and near the module and gateway unit handles the sensor information.

## EXISTING SYSTEM

Many existing, well established soil moisture systems are based on wired communication. IoT is a system that uses computers or mobile devices to control basic agriculture functions and features automatically through Internet from anywhere around the world. Proposed system is using free IoT platform, ArduinoIDE using NodeMCU Wi-Fi web service to configure the smart agriculture. It is very simple and user free smart agriculture system compared to existing system.

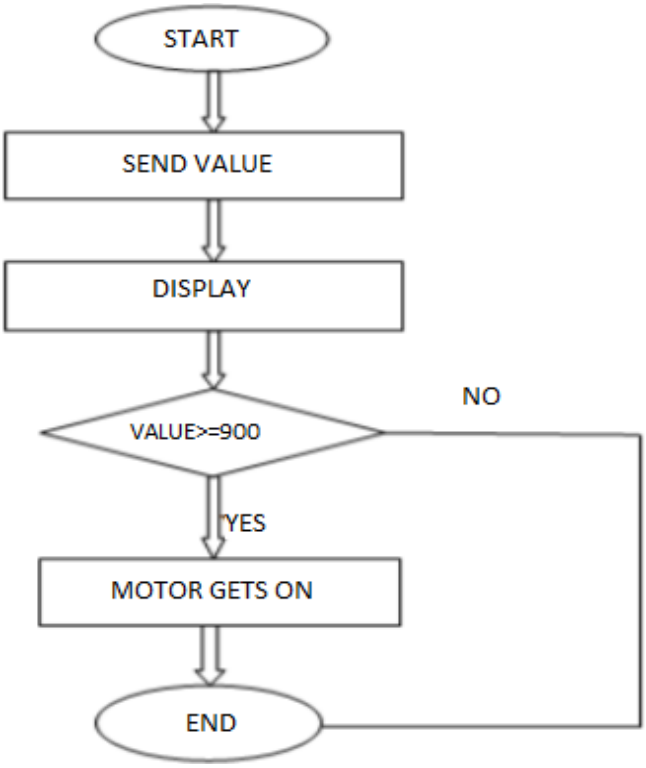



**FIG 1.1 STEPS PERFORMED IN SMART AGRICULTURE SYSTEM**

Above block diagram represents the process and working of soil moisture sensor:

- Initialize the NodeMCU(ESP8266) board.
- The sensor obtains the value and sends it to display.
- The values obtained are shown in serial monitor as well as **ThinkSpeak Dashboard.**

# CHAPTER 2

## AIM AND SCOPE OF THE PRESENT INVESTIGATION

The proposed system has been designed to overcome the unnecessary water flow into the agricultural lands. Moisture readings are continuously monitored by using moisture sensor and send these values to the assigned IP address. Android application continuously collects the data from that assigned IP address. Once the soil moisture values are exceeded the particular limit then the relay, which is connected to the NodeMCU microcontroller controls the motor. The android application is a simple menu driven application. This includes motor status, moisture values. The motor status indicates the current status of the pump.

## OBJECTIVE OF THE PROJECT

The main objective of this project is to provide an automatic irrigation system thereby saving time, money and power of the farmer. The traditional farm-land irrigation techniques require manual intervention with the automated technology of irrigation the human intervention can be minimized.

Most of the farmers use large portions of farming land and it becomes very difficult to reach and track each corner of large lands. Sometime there is a possibility of uneven water sprinkles. This result in the bad quality crops which further leads to financial losses. In this scenario the Smart Irrigation System using Latest IoT technology is helpful and leads to ease of farming. The Smart Irrigation System has wide scope to automate the complete irrigation system. Here we are building a IoT based Irrigation System using ESP8266 NodeMCU Module and moisture Sensor. It will not only automatically irrigate the water based on the moisture level in the soil but also send the Data to IoT Cloud Server to keep track of the land condition. The System will consist a water pump which will be used to sprinkle water on the land depending upon the land environmental condition such as Moisture. Excessive water use for agriculture is leaving rivers, lakes

and underground water sources dry in many irrigated areas, according to the World Wildlife Fund. The agricultural sector uses 70 percent of the world's accessible fresh water, which is three times more than industry and more than eight times more than municipalities use. So with this procedure using soil moisture with thinkspeak Cloud we can save water and preserve it for future use.

## ADVANTAGES OF PROJECT

- Simple method of measurement.
- It delivers the results immediately.
- Watermark sensors are very low in cost.
- Offers accurate results.
- Watermark sensors offer larger moisture reading range.

## DISADVANTAGES OF PROJECT

- It requires initial evaluation of site specific conditions before selection of appropriate moisture sensor.
- It requires probe to be inserted in the soil. It requires labor to collect the data and maintain the measurement processes.
- The measured values depend on properties of various materials. The correct interpretation and use of moisture data is needed.
- Watermark sensors provide less accuracy in sandy soils due to large particles.
- Watermark sensors are required to be calibrated for each soil types.

## SCOPE

The proposed agricultural system is designed to solve to find an optimal solution to the water crisis. The design implements IoT technology using an android device, a main controlling unit (NodeMCU), sensors to measure various parameters and a water pump, which will be used to supply water to the farm.

# PROTOTYPE

The microcontroller NodeMCU is connected to soil moisture sensor and motor. These sensors sense the various parameter of the soil; motor is used to provide water to the land. And relay is used control the motor

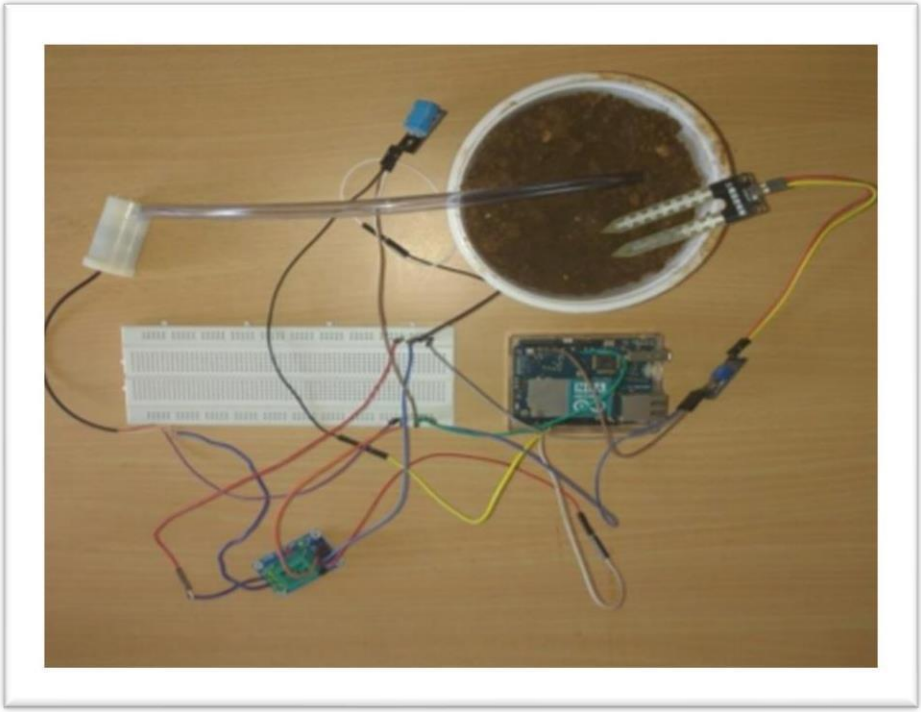


**FIG.2.1 CONNECTIONS AND SAMPLE OF SOIL MOISTURE CONNECTIONS**

# CHAPTER 3

## EXPERIMENTAL OR MATERIALS, METHODS AND ALGORITHMS USED

The Smart Agriculture System has wide scope to automate the complete irrigation system. Here we are building a IoT based Irrigation System using ESP8266 NodeMCU Module. It will not only automatically irrigate the water based on the moisture level in the soil but also send the Data to Thinkspeak Server to keep track of the land condition. The System will consist a motor connected to it which will be used to sprinkle water on the land depending upon the land environmental condition such as Moisture. Before starting, it is important to note that the different crops require different Soil Moisture condition. So, a crop which will require a soil moisture of below 900. So, when the soil loses its moisture to greater than 900 then Motor will turn on automatically to sprinkle the water and it will continue to sprinkle the water until the moisture goes up to below 900 and after that the pump will be turned off. The sensor data will be sent to Thinkspeak Server in defined interval of time so that it can be monitored from anywhere in the world.

## COMPONENTS REQUIRED

- NodeMCU ESP8266
- Soil Moisture Sensor Module
- Jumper wires

### NODEMCU ESP8266

NodeMCU is an open-source LUA based firmware developed for ESP8266 Wi-Fi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board. Since NodeMCU is open-source platform, their hardware design is open for edit/modify/build. NodeMCU board consists of ESP8266 Wi-Fi enabled chip. The ESP8266 is a low-cost Wi-Fi chip developed by Expressive Systems.

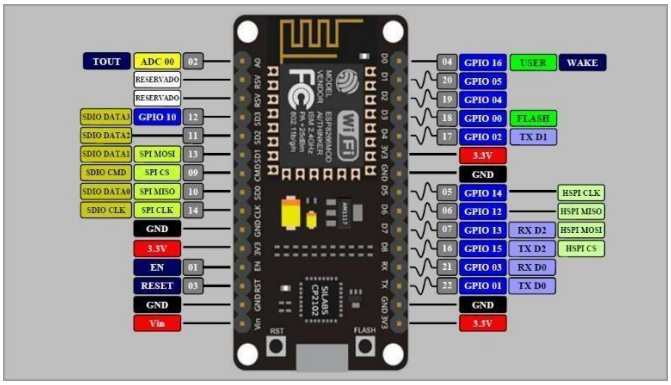



**Fig 3.1 NodeMCU** **Fig 3.2 NodeMCU Pin diagram**

NodeMCU Development Kit has Arduino like Analog (i.e. A0) and Digital(D0-D8) pins on its board. It supports serial communication protocols i.e. UART, SPI, I2C. Using such serial protocols, we can connect it with serial devices like I2C enabled LCD display, Magnetometer HMC5883, MPU-6050Gyrometer+Accelerometer, RTC chips, GPS modules, touch screen displays, SD cards etc.

## START WITH NODEMCU

NodeMCU Development board is featured with Wi-Fi capability, analog pin, digital pins and serial communication protocols. To get start with using NodeMCU for IoT applications first we need to know about how to write/download NodeMCU firmware in NodeMCU Development Boards. And before that where this Node MCU firmware will get as per our requirement. There is online NodeMCU custom builds available using which we can easily get our custom NodeMCU firmware as per our requirement. To know more about how to build custom NodeMCU firmware online and download it refer Getting started with NodeMCU

## CODE WRITES IN NODEMCU

After setting up ESP8266 with Node-MCU firmware, let's see the IDE (Integrated Development Environment) required for development of NodeMCU. NodeMCU with ESPlorer IDE, Lua scripts are generally used to code the NodeMCU. Lua is an open source, light weight, embeddable scripting language built on top of C programming language. For more information about how to write Lua script for NodeMCU refer getting started with NodeMCU using ESPlorerIDE NodeMCU with ArduinoIDE. Here is another way of developing NodeMCU with a well-known IDE i.e. Arduino IDE. We can also

develop applications on NodeMCU using Arduino development environment. This makes easy for Arduino developers than learning new language and IDE for NodeMCU.

## SOIL MOISTURE SENSOR

Soil moisture is basically the content of water present in soil. This can be measured using a soil moisture sensor which consists of two conducting probes that act as a probe. It can measure the moisture content in the soil based on the change in resistance between the two conducting plates. The resistance between the two conducting plates varies in an inverse manner with the amount of moisture present in the soil. The Moisture sensor is used to measure the water content (moisture) of soil. When the soil is having water shortage, the module output is at high level; else the output is at low level. This sensor reminds the user to water their plants and also monitors the moisture content of soil. It has been widely used in agriculture, land irrigation and botanical gardening.

- Working Voltage: 5V
- Working Current: <20ma
- Working Temperature: 10°C~30°C

**FIG 3.3 SOIL MOISTURE SENSOR**

## APPLICATIONS

- Agriculture

Measuring soil moisture is important for agricultural applications to help farmers manage their irrigation systems more efficiently. Knowing the exact soil moisture conditions on their fields, not only are farmers able to generally use less water to grow a

crop, they are also able to increase yields and the quality of the crop by improved management of soil moisture during critical plant growth stages.

- Landscape irrigation

In urban and suburban areas, landscapes and residential lawns are using soil moisture sensors to interface with an irrigation controller. Connecting a soil moisture sensor to a simple irrigation clock will convert it into a "smart" irrigation controller that prevents irrigation cycles when the soil is already wet, e.g. following a recent rainfall event.

Golf courses are using soil moisture sensors to increase the efficiency of their irrigation systems to prevent over-watering and leaching of fertilizers and other chemicals into the ground.

- Research

Soil moisture sensors are used in numerous research applications, e.g.in agricultural science and horticulture including irrigation planning, climate research, or environmental science including solute transport studies and as auxiliary sensors for soil respiration measurements.

- Simple sensors for gardeners

Relatively cheap and simple devices that do not require a power source are available for checking whether plants have sufficient moisture to thrive. After inserting a probe into the soil for approximately 60 seconds, a meter indicates if the soil is too dry, moist or wet for plants.

***JUMPER WIRES***

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed. A jump wire (also known as jumper wire, or jumper) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the

components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.

## INTERFACING DIAGRAM

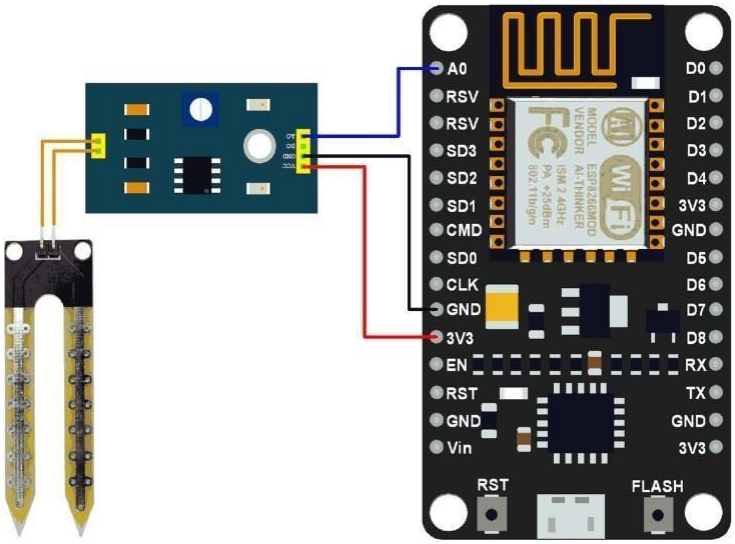



**FIG 3.4 INTERFACING CONNECTION DIAGRAM**

The sensor is interfaced with ESP8266 will be collecting the data from the sensor continuously. Using on-chip Wi-Fi the values are uploaded into the Cloud. The Cloud technology is used in this work is Thinkspeak Cloud technology. In this the cloud is accessed in the program with device ID: 2000, Organization ID:2igx64, Device Type: device1.1, Authentication Method: use-token-auth, Authentication Token:9700525256 and API key: a-2igx64-x1iyoxeukb.

## SOFTWARE COMPONENTS

The components required to obtain the readings of the soil moisture sensor through the Thinkspeak cloud. This Thingspeak cloud uses Cloud-ant database, json format, Thinkspeak Flows and the Thingspeak Dashboard.

- Thingspeak cloud services

- ArduinoIDE
- Json editor

## THINGSPEAK CLOUD SERVICES

Thinkspeak is a cloud Platform as a service. It supports several programming languages and services as well as integrated DevOps to build, run, deploy and manage applications on the cloud. Bluemix is based on Cloud Foundry open technology and runs on Soft Layer infrastructure. Bluemix supportseveral programming languages including Java, Node.js, Go, PHP, Swift, Python, Ruby Sinatra, Ruby on Rails and can be extended to support other languages such as Scala through theuse of build packs or Server less computing offering, that is built using open source from the Apache Open Whisk incubator project largely credited to Thinkspeak for seeding. This system, equivalent to Amazon Lambda, Microsoft Azure Functions, Oracle Cloud or Google Cloud Functions, allows calling of a specific function in response to an event without requiring any resource management from the developer.

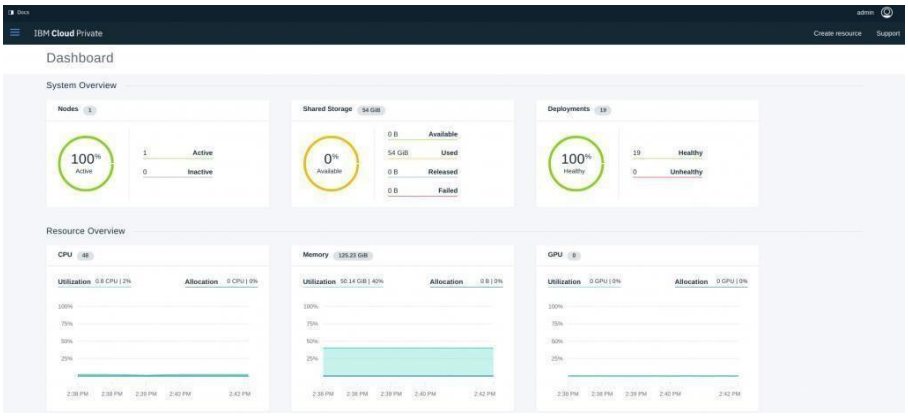



**FIG. 3.5 Thinkspeak Dashboard Types**

**ARDUINO-IDE**

The Arduino integrated development environment (IDE)is a cross platform application (for Windows, MACOS, Linux) that are to be written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third party cores, other vendor development boards. The source code for the IDE is released under the GNU General Public License, version2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires twobasic functions, for starting the sketch and the main program loop, that are compiled andlinked with a program stub main () into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs theprogram to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. Few points that address the Arduino IDE:

- Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module.
- It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process.
- It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.
- A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino micro and many more.
- Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code.

- The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board.
- The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module.
- This environment supports both C and C++ languages.

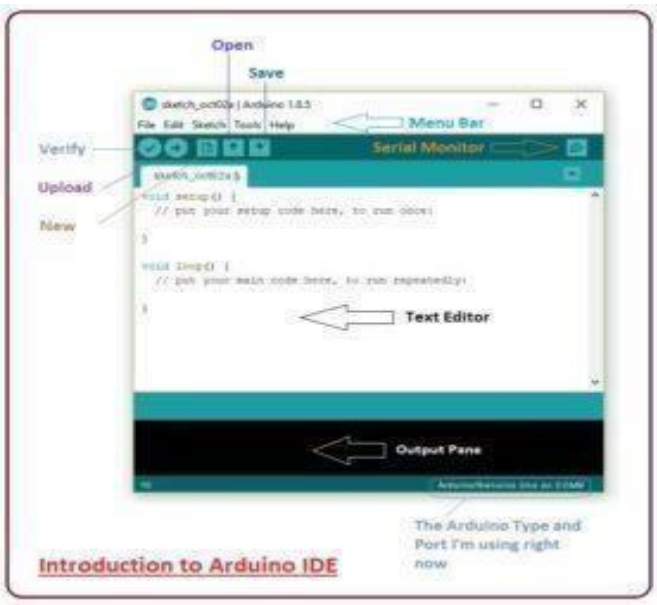



**FIG 3.6 Arduino IDE**

### JSON EDITOR

In computing, JavaScript Object Notation or JSON is an open standard file format that uses human readable text to transmit data objects consisting of attribute–value pairs and array data types (or any other serializable value). It is a very common data format used for asynchronous browser/server communication, including as a replacement for XML in some AJAX-style systems. JSON is a language independent data format. It was derived from JavaScript, but as of 2017 many programming languages include code to generate and parse JSON format data. The official Internet media type for JSON is “application/json”. JSON filenames use the extension”. json”. Json grew out of a need for stateless, real-time server-to-browser communication protocol without using browser

plugins such as Flash or Java applets, the dominant methods used in the early 2000s. Douglas Crock ford first specified and popularized the JSON format.

JSON's basic data types are:

- Number: a signed decimal number that may contain a fractional part and may use exponential E notation, but cannot include non-numbers such as NaN. The format makes no distinction between integer and floating-point. JavaScript uses a double-precision floating-point format for all its numeric values, but other languages implementing JSON may encode numbers differently.
- String: a sequence of zero or more Unicode characters. Strings are delimited with double-quotation marks and support a backslash escaping syntax.
- Boolean: either of the values true or false.
- Array: an ordered list of zero or more values, each of which may be of any type. Arrays use square bracket notation with comma-separated elements.
- Object: an unordered collection of name–value pairs where the names (also called keys) are strings. Since objects are intended to represent associative arrays, it is recommended, though not required, that each key is unique within an object. Objects are delimited with curly brackets and use commas to separate each pair, while within each pair the colon ':' character separates the key or name from its value.
- Null: An empty value, using the word Null.

Whitespace is allowed and ignored around or between syntactic elements (values and punctuation, but not within a string value). Four specific characters are considered whitespace for this purpose space, horizontal tab, line feed, and carriage return. In particular, the byte order mark must not be generated by a conforming implementation (though it may be accepted when parsing JSON). JSON does not provide syntaxfor comments.

Early versions of JSON (such as specified by RFC 4627) required that a valid JSON text must consist of only an object or an array type, which could contain other types within them.

## ALGORITHMS USED

There are many software installations used to run the project smart agriculture. Steps to be performed in this project are:

- Initially install the ArduinoIDE.
- To connect the NodeMCU to ArduinoIDE install the library link from google.
- Copy the link and paste in the in file->preferences as shown below in fig.3.10 and download it.

  Additional board manager URL's:

  https://arduino.esp8266.com/stable/package_esp8266com_index.json

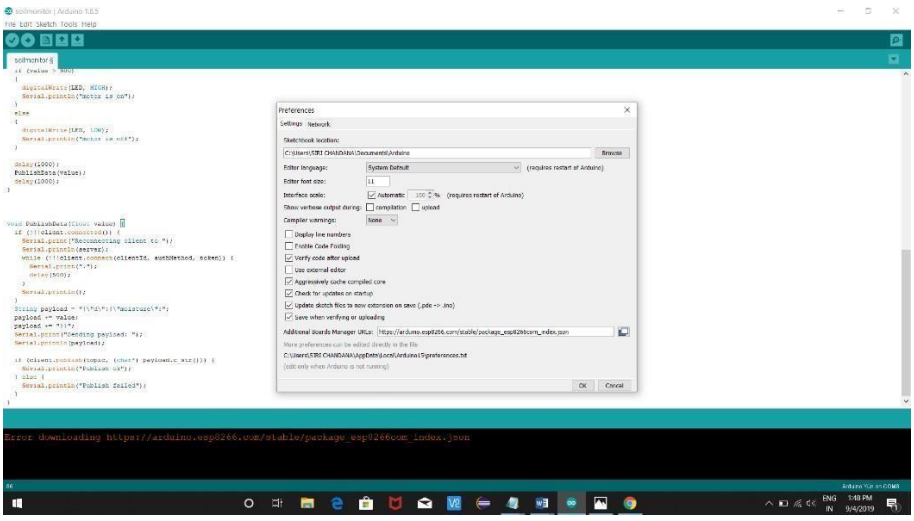


**Fig 3.10 Installation Path Procedure**

- Then go to tools->Board Manager and search for esp8266 community and install it. Then we can have ESP8266 libraries. And install the latest version.

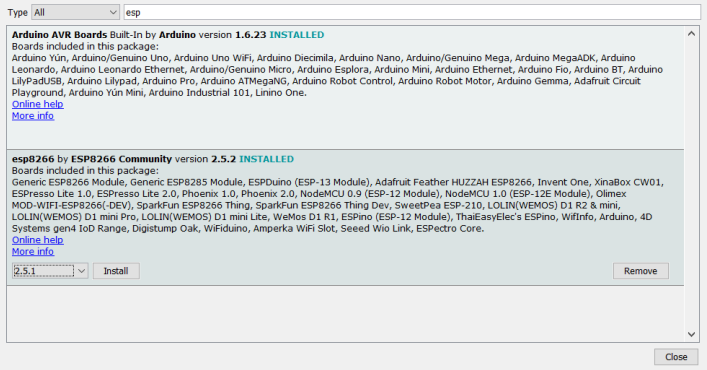



**Fig 3.11 ESP8266 Libraries Installation**

- Create an account in the Thinkspeak account.
- Setup and configure Arduino to the Thinkspeak - IOT Platform.
- Create a New Gauge to access and connect to Thinkspeak.
- Connect the Soil Sensor to the ArduinoIDE.
- Insert the soil sensor in pot.
- Configure the Thinkspeak to receive published data from the Arduino.
- The values of the soil moisture are to be displayed in debug window of the Thinkspeak.
- Create a dashboard which displays the Gauge meter representing the soil moisture content.
- Compile and upload the program to the board.
- The readings are displayed in the Serial Monitor of ArduinoIDE.
- Also, the values are represented on Thinkspeak Dashboard.

# CHAPTER 4

## RESULTS, DISCUSSION AND PERFORMANCE ANALYSIS

### Initialization of board

- Initially import the board data from tools-> board-> NodeMCU 1.0.

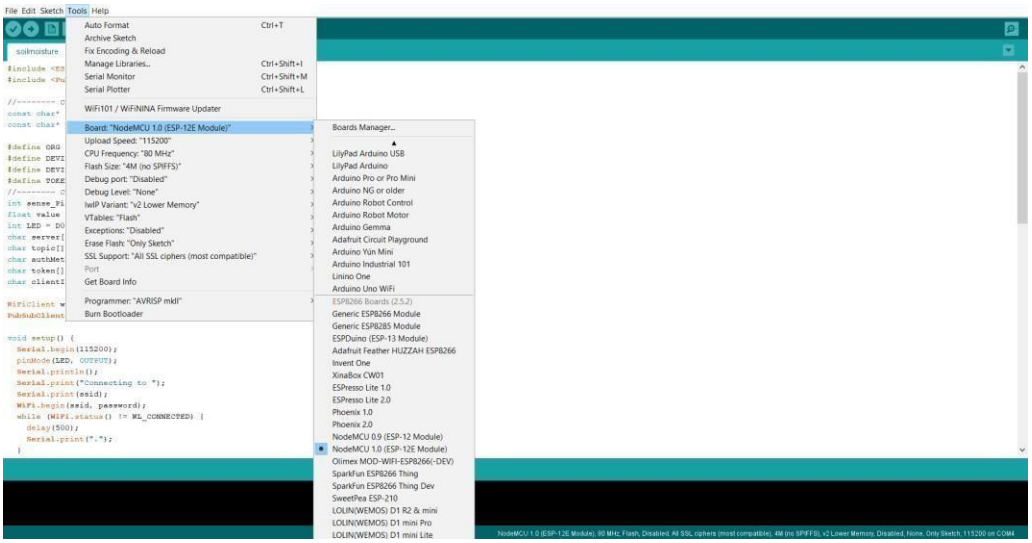
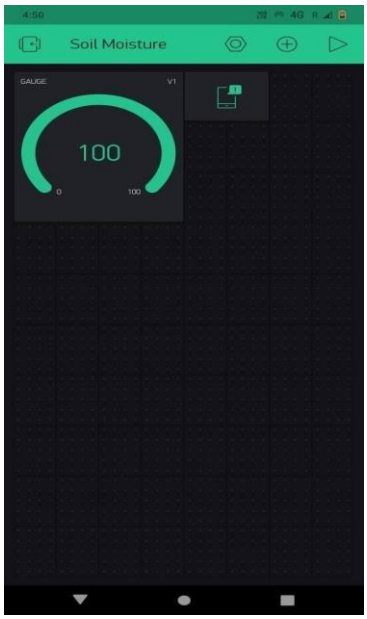
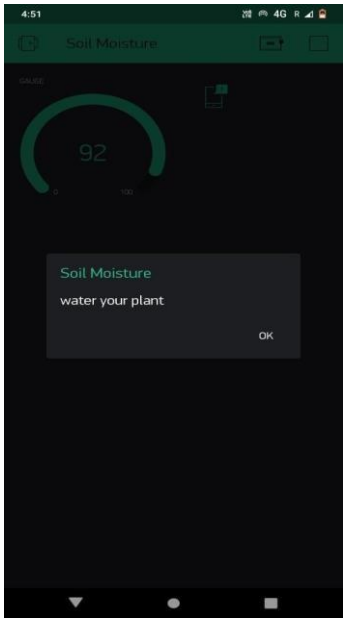



**FIG 4.1 Configuration of NodeMCU Board**

- Compile and upload the code to the board.
- Open the serial monitor, readings will update continuously with a delay of 1sec each.

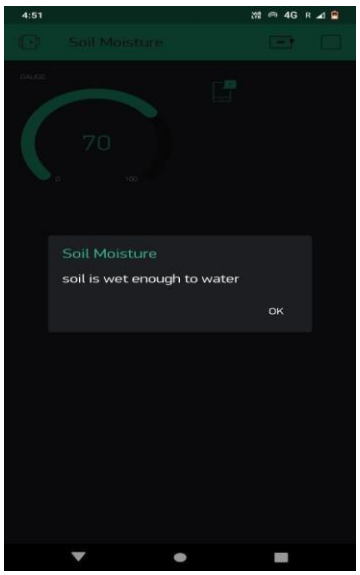
## Notification Screenshots:




This is where the notification is going to pop-up according to the water content level in the soil.

This is where the water is less in the soil so it gives us a notification about planting the water.




Once there is enough water this particular notification pops up

# CHAPTER 5

# CONCLUSION

Considerable progress has been made in the development of irrigation scheduling methods and there is a gradual increase in the adoption of irrigation scheduling tools by farmers. The technology level of the farm will determine the choice of the irrigation scheduling method. Industry farms and farms with high value cash crops are more likely to adopt and invest in sophisticated scheduling methods. The support and collaboration of the expert irrigation adviser will determine the rate of success in the adoption of the irrigation scheduling technology. Volumetric water control and distribution uniformity, particularly in surface irrigation, are essential factors in achieving accurate water applications. Performance of sprinkler and drip irrigation systems prove strongly dependent on the quality of design and materials selected. Inadequate management and variations in pressure are other main causes of low performance of these potentially efficient methods. Restrictions in flow deliveries in surface irrigation systems due to rotation, fixed deliveries and unknown discharges, are the main constraints in introducing accurate field applications and irrigation scheduling in those systems.

Field evaluation of field irrigation performance is an essential tool to improve management and introduction of irrigation scheduling methods. A better insight in yield-water functions is required including factors which effect yield and root behavior, especially under saline conditions. Biological stress indicators, such as sensitive crops, could be developed and introduced at farm level. Practical solutions need to be developed to overcome the difficulties raised by uneven water distribution and spatial variability of soil moisture which have a distinct effect under saline and deficit irrigation. New ideas and practical solutions need to be developed to enable the safe use of deficit irrigation. These include better timing and reliable supply and the development of a priority list of tolerant crops and irrigation systems suitable for deficit irrigation. For more efficient irrigation under variable and untimely rainfall, reliable methods are required to forecast both the frequency and amount of rainfall.

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# DESCRIPTION

The Smart Plant Monitoring System is an IoT-based solution designed to monitor and manage plant health efficiently. It uses sensors to track real-time data like soil moisture, temperature, humidity, and sunlight. Key features include automated watering, nutrient monitoring, remote control via a mobile app, and data-driven insights for proactive care.

This system promotes sustainability by optimizing water and resource usage, improves plant health through consistent monitoring, and offers convenience through automation and remote accessibility. Ideal for gardening enthusiasts, greenhouse management, and agricultural applications.