IoT-Meadow: A Smart Monitoring and Irrigation System

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project titled "**IoT-Meadow: A Smart Monitoring and Irrigation System**", submitted by Rudro Hasan, ID No: 181-15-1917 and Joy Ahmed, ID No: 181-15-1806 and KH. Mehedi Hasan, ID No: 181-15-1810 and Md. Zulhaz Uddin Joy, ID No: 181-15-2018 to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 31-10-2021.

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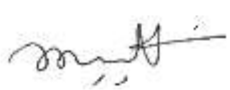

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We thus declare that we completed this research under the supervision of **Tajim Md. Niamat Ullah Akhund, Lecturer, Daffodil International University's Department of CSE**. We further certify that no component of this project, or any part of it, has been submitted to any other institution for the granting of a degree or certificate.

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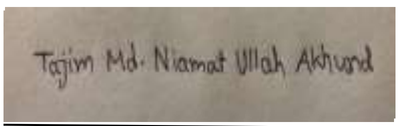

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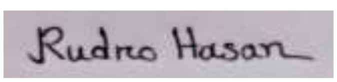

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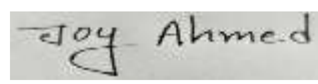

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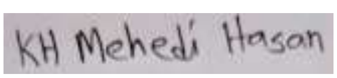

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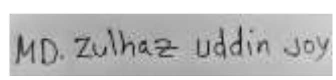

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ABSTRACT

Bangladesh is a land of agriculture. The agricultural sector of Bangladesh is crucial to the country's overall economic growth. But nowadays farmers are experiencing serious irrigation issues in the agricultural sector. Crops can be harmed as a result of over- and under-irrigation. Lack of proper monitoring with smart technologies in agro sector so for that our agro production decreasing day by day. As a result, we presented "An IoT-based Smart Monitoring and Irrigation System" in this study. which must be a solution to increase the agro production. To control irrigation from anywhere and at any time using a computer or smartphone. This project entails the development of an IoT platform based on Thingspeak cloud and NODEMCU that allows farmers to observed the field nature by using several types of sensors (soil moisture, water level, temperature & humidity). As well as also maximize the water usage. Using the soil moisture sensor data the motor (pump) will be turn on/off automatically. For further analysis all the sensed data will be saved in the ThingSpeak cloud database and periodically, notifications and observed data are delivered to mobile users (farmers).

Farmers may use a mobile phone application to check farm conditions from any location.

Keyword: IOT (internet of things), SIM Module, AM2 302, NODEMCU, Soil Moisture Sensor, Relay Module, Water Motor , Water Level Sensor, Cloud Database.

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CHAPTER 1

Introduction

1.1 Introduction

Agriculture is the economic power of Bangladesh. In a developing country, agriculture plays a vital role like backbone. Bangladesh's GDP grew at an annual pace of 8.3 percent in 2019, making it the world's sixth fastest-growing economy. Bangladesh's agriculture employs over 50 % of the population, with more than 70% of the country's land dedicated to agricultural production. In accordance with the growth of population, there is a need to increase the agro production. Irrigation is the most essential aspect of agriculture. The farmer's manual irrigation approach is not ideal for agriculture.

For increasing agro production, our farmers are to get in touched with the modern agro technologies. Traditional farming techniques must be modernized in order to increase production. While doing agriculture, two essential elements must be kept in mind: collect data on soil productivity and assess the amount of moisture available in the soil. There should be over-irrigation and under-irrigation, both of which are destructive to crop production. There is a need to preserve water due to the waste of water. As a result, we must create a smart irrigation and monitoring system. which will be the solution of all these problems like- over-irrigation and under irrigation, wastage of water and humidity and temperature.

Assumes all the aspects of Bangladesh, In the case of our country-based agriculture. We proposed a smart monitoring and irrigation system which is based on IoT. Our suggested system's major purpose is to improve our irrigation techniques in order to boost crops productivity while maintaining a low-cost and efficient approach. First, we gather different types of information from the soil using multiple sensors such as check the temperature & humidity using Am2 302, Measure the water content of the soil with a soil moisture sensor, and monitor the water level with a water level sensor. A relay module is also used to regulate the water pump. On Increasing and decreasing of water level the pump will turn on/off automatically. So all the sensors are connected with two Node

MCU with wired connection. After that, we used NODEMCU module to transmit the data collected into a cloud server. Then the data can be monitored by the farmers' phone/PC. And in the final step we used a GSM module to notify the farmer's via phone through SMS.

1.2 Motivation

Bangladesh is an agricultural country. The main source of food in our country is agriculture. So, we have to be more careful about agriculture. Climate changes, Population growth, lack of healthy seeds, Loss of Arable Land are the major challenges of agriculture. Over floating in the rainy season, no water in the dry season which affects about 12,72,151 farmers every year and it costs almost Tk1,323 crore. To reduce this loss, we have to focus on our productivity. This system will help to grow productivity by properly monitoring our land. This system will monitor soil moisture, temperature, humidity, and water level, with all data being stored in the cloud and notify farmers through the SMS. The main benefit of this system is farmers can monitor their field through mobile phones. Another limitation of our farmers is they don't have proper knowledge about the ideal amount of fertilizer, medicine, when and how to apply it. That is why we do not get desired production from our field. Here, our system will give proper guidance to farmers by sensing data from soil. That helps to increase our production.

1.3 Objective

i. To increase the crops productivity in agriculture.
ii. To decreased the agricultural cost and farmers effort.
iii. To easily monitor the field from anywhere.

1.4 Feature

i. It is a portable device.
ii. The system will continuously monitor field nature.
iii. It has the capability of measuring soil temperature, soil moisture, water level.

iv. To use Cloud Server for displaying real-time data.
v. It includes a NODE MCU module for transmitting data to a cloud server.
vi. It contains a GSM SIM module that sends a text message to the farmers.
vii. Regular sensed data helps us to increase productivity.
viii. We can control the whole system by Blynk App.

1.5 Expected Outcome

i. Agro Production will be increased.
ii. The expense of production cost has been reduced.
iii. Water utilization.
iv. The issue of real-time monitoring has been resolved easily.

1.6 Problem Statement

Bangladesh is an agricultural country. We fill most of the food demand from our agricultural sector. Not only had the food demand but also the economy of our country depended on agriculture. Bangladesh's population is steadily expanding. Food demand is also rising as a result of this. So sometimes we are getting out of our food stock. We needed to import food items from our neighbor country. The reason behind this is not growing the enough number of agricultural goods. The farmers of our country use the traditional ways to grow crops time changed, weather changed and the power of the soil growing crops naturally been lower than before. The farmers are not getting the enough output from the cultivation, due to not using the proper cultivating method and process. They are wasting their money and hard work without knowing the proper needs on their field like how much water, fertilizer they need to put in the field. They don’t know when their crops are getting damaged by many types of insects; they don’t know the proper time to serve fertilizer, the proper time to give water for their crops. So, day by day farmers are going to be demotivated about agriculture and this making our economy damaged, and we are facing problem like food stock shortage. This problem would be solved by using our proposed “IoT-Meadow: A Smart Monitoring and Irrigation System.” With our system we can get the maximum productivity using less resources and cost. And can access our system from anywhere and monitor and analyze the cloud server data.

1.7 Social Impact

IoT-Meadow: A Smart Monitoring and Irrigation System will help to increase production in agriculture. We already stated about barriers and problems in our agriculture. For that, day by day our production decreases. That also impacts our economy. The proposed IoT-Meadow: A Smart Monitoring and Irrigation System will help to reduce these problems and increase production. Our system will sense different condition of soil then suggest to farmers what actually needs to soil. Farmers easily maintain their fields with their mobile phone because our system will regularly notify farmers about their fields. It will save farmers effort, money and time. And farmers will get good production. Our farmers will get self-dependent if they get good production from their field. Our system helps to reduce corrosion damage in the agriculture field. If production is increased then it will help to grow our economy. There are still 21 million people in Bangladesh, that is, one out of every eight people does not have the capacity to get nutritious food. Our system will help reduce this problem. It will encourage our farmers to be more involved with farming.

1.8 Report Layout

Report layout: The project's visual presentation is comprised of a figure that clearly depicts the whole endeavor. The material, as well as additional information the material, and so much more. The project report is divided into 5 chapters. All chapters are explained in detail by a demographic depiction, which includes a short description.

Chapter 1: INTRODUCTION

Concerning this project, Motivations, Objectives, Features, Social Impact, Problem Statement.

Chapter 2: LITERATURE REVIEW

Review previous work

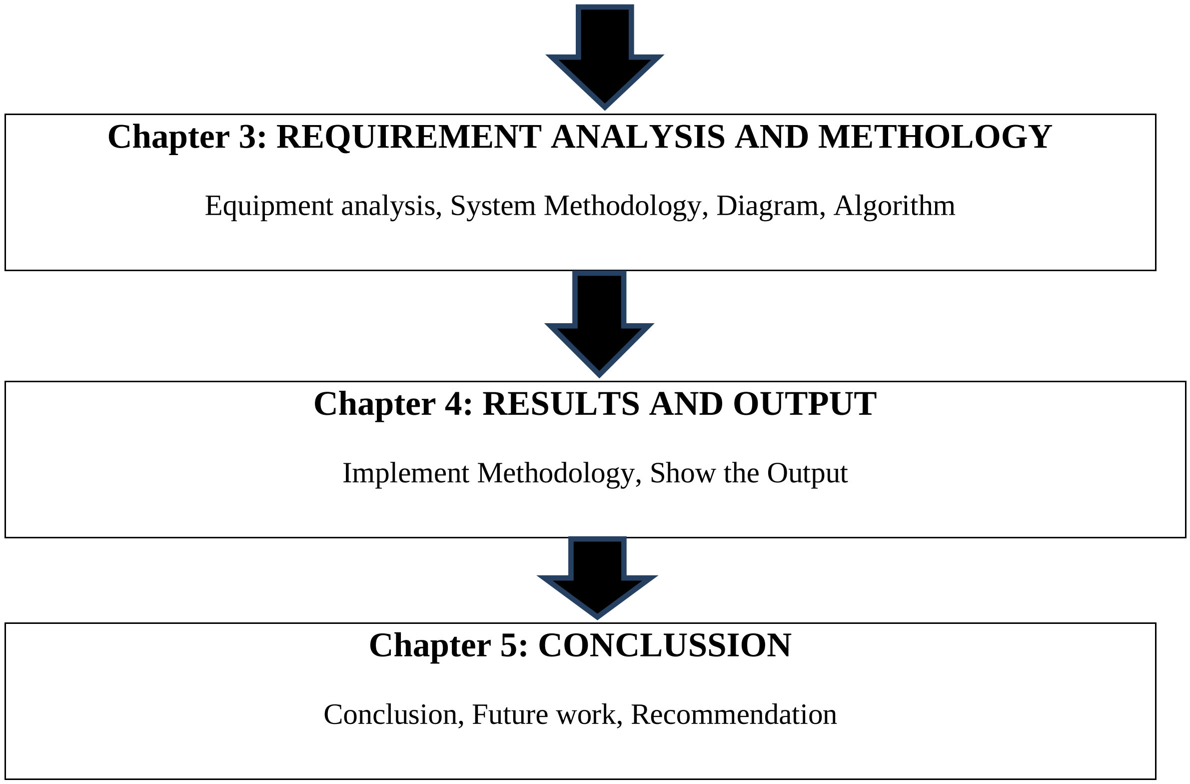

Figure 1.1: Report Layout

CHAPTER 2

Literature Review

The authors of [1] created an IOT-based Smart Irrigation System that provides water in the field based on soil moisture levels and monitors it. ATMEGA328P Arduino Uno is used to develop this platform and They employed two YL-69 soil moisture sensors in their experiment to sense data from the soil. Using a GSM-GPRS SIM900A modem, update sense data on a web page on a regular basis. PHP is used to create the web page, which senses data stored in a database. Basically, YL-69 sensors sense analog data from different places and pass it to the Arduino. This system's main goal is to automatically on/off based on the sensor data. If this system can sense the pH level of soil and also can sense gases. Then this system will be more accurate and it will increase productivity.

Authors of [2] have made an automated Arduino-based Smart Irrigation System for reducing the water waste. This system can save time, 80% of water and also can avoid some problems. There is a predefined range of soil moisture and soil temperature is set in their system. Soil Moisture Sensor, Temperature Sensor, Relay used here to sense data. Based on the predefined data and sense data the water pump will automatically on/off. The position of the water pump pipe is controlled by a servo motor. Sensors sense analog data and pass it to the Arduino, the Arduino converts it to digital data. This system is for an efficient irrigation system, maximum utilization of water, reducing the waste of water, and minimizing human effort. If this system could sense more data like different gas levels, the pH levels of soil and send those data to a cloud server then this system will be a more perfect and more smart system.

The authors of [3] suggest another smart irrigation system based on ThingSpeak and Arduino. The main purpose of this system is to reduce the farmers effort, optimize the use of water, and farmers can easily maintain their fields from any place via mobile phone or pc. Using the esp2866 Wi-Fi module, this system will transmit and receive data from the cloud. This technology can detect the quantity of water in a tank and obtain weather temperature data from websites. Time control is used to send tweets automatically. This basically sends tweets each hour. This system could be more accurate if they used more sensors like soil pH detecting sensors and soil gases directing sensors. Those sensors help them to develop a more perfect system and if the system gives some suggestions based on the sense data then it will more easier to the farmers.

A Low-Cost Smart Irrigation Control System is demonstrated in the study paper [4]. There are lots of traditional methods of irrigating like channel systems, sprinkler systems, drip systems are exits. But these are not effective for 12 months. This system tries to solve these barriers. Their main objective is automatic controlling an irrigation system and reduce the cost. This system senses the soil moisture and send alert message to the registered mobile phone by using RASPBERRY-Pi sensor thorough internet. Based on the sense data it will automatically on/off the water motor. The main advantage of this system is it can perform in remote areas. Arduino Uno, Soil Moisture sensor, Raspberry-pi, Electromagnetic valve these sensors are used to develop this system. This system can be more effective for the farmers if this system would sense soil pH level, would direct gases.

The authors of [5] suggest an IoT-based smart irrigation monitoring and control system. They develop a cloud-based wireless communication system to monitor and control a set of sensors that are used to determine the plant's water needs. Zigbee is used here for this communication. For real-time data management, A Java GUI was used on the web. Temperature, soil moisture, humidity, and agricultural field water levels may all be detected using this equipment. A filter sensor was used to minimize noise from sensors. All of the data collected is sent to a web server through GPRS over the cellular network. The main of motive of this system is to efficient use of water for farming. Farmers can easily observe their fields condition from a remote location.

IoT based smart crop-field monitoring and automation irrigation system was developed by the authors of [6]. This is used to remove old and traditional farming system. They made this system to reduce the water wastage. They used a temperature sensor (LM35) and a soil moisture sensor to monitor water availability in the soil and automatically turn on and off the engine as needed. They used some other sensor and component and made this system fully remote so that the farmer can check the filed condition from anywhere and can take action and analyze the data for more. Following this, all of their experimental testing reveal that the proposed approach is a complete answer to difficulties such as irrigation issues and field activities. Implementing such a system in our field can contribute in the improvement of our farm's crops as well as overall agro output. They can improve their project by adding some features like Sense the level of fertilizer, the number of insects is moving around the field these can save cost of production and the crops from the insects. So, the overall production can be improved

An IoT Instrumented Smart Agricultural Monitoring and Irrigation System was developed by the author of [7]. This irrigation system, which is a cloud-based smart irrigation system, is the most time-consuming in farming. And it can be control by a framer by using a Mobile/PC. They can also monitor the moisture and temperature parameter and then take a suitable action. The usefulness of this system is in this irrigation system we can save the crops damage from the over irrigation/under irrigation, We can monitoring anytime the moisture and temperature parameter and therefore we can optimize the use of water, We can boost crop yield while simultaneously reducing farmer workload with this technique. The main components of the system are (temperature and humidity sensors, soil moisture sensors, and PIR sensors). The soil moisture sensor measures the moisture content of the soil, the temperature and humidity sensor measures the surrounding temperature and humidity, and the PIR sensor detects motion in the field.

There is a value that is set as a threshold. When the sensor value exceeds the threshold value, the user will be notified. It has some drawbacks like in this irrigation system we cannot predict the weather forecast. We have no way of knowing how the system will behave. They can include weather forecasting into this method. In addition, applying a deep learning/machine learning technique to forecast the system's behavior and To improve the whole system, use a drone system for live monitoring.

Author [8] has also proposed a Fuzzy Logic-based Smart Irrigation System that uses the Internet of Things. This research is mostly focused on fuzzy logic in order to improve accuracy in irrigation water usage. And in this system we can also monitor the soil moisture, temperature parameter, surrounding environment and as well as use fuzzy logic to compute input parameter and produce the motor status. We can control this system through our android device. The usefulness of this system is this system will help farmers to water their agricultural field using GSM, The suggested fuzzy-based smart irrigation system sends out frequent acknowledgement messages regarding the job's statuses, such as soil humidity and temperature, and the usage of solar panels dramatically cuts power consumption.

As soon as the power source is turned on, the GSM modem is initialized. The GSM modem connects with Arduino using AT instructions. The LCD display is connected to Arduino, allowing data from sensors to be shown appropriately. The CPU first validates the availability of solar energy by using a Light Dependent Resistor (LDR) to detect sunlight. The soil moisture sensor measures the moisture in the soil. The temperature sensor detects the farm's ambient temperature. When the rain sensor detects heavy rain, the motor is turned off. GSM technology is used to communicate all of the data collected from sensors to the user. On this system has some drawbacks like Cannot predict surrounding behavior of the system. Cannot Live Real time data monitoring. They can improve by Adding more IOT technology to improve minimize waste and increase the productivity. Using drone to live real time data monitoring.

An IOT Based Smart Agricultural Field Monitoring and Irrigation System was developed by the authors of [9]. This system is mostly based on Internet of Things (IoT) (Internet of things). Its sensor detects data from the field, such as moisture levels, and sends it through IoT, with the result displayed on an LCD panel. The major usefulness of this system is this system help farmer to check the moisture level on the field and take appropriate action. When the soil moisture is less, then a certain value then it automatically operate the pump. Farmer can get the sensor data from anywhere by android device. They made this system by consist of the component ex: ESP-32 Wi-Fi Microcontroller, moisture sensor, 5v relay, 12v on/off valve, LCD panel, Inverter, water pump. ESP-32 is a chip microcontroller board integrated with Wi-Fi and Bluetooth techniques. This is the microcontroller board. Moisture soil sensor basically sense the moisture level and gives the output. 5V Relay control the 12V DC valve for switching on/off. 12V on/off use for pass and stop of water follow. LCD display use for to show the output result. And inverter basically control the speed of AC motors. Water pump use for transfer the water from one end to another. It has some drawbacks like cannot predict the weather forecast. And we cannot predict the behavior of the system. They can improve this system to adding weather forecast; they can get the weather behavior. Predict the system behavior by using some sensor. Use some machine learning approach to analyze the data.

An IOT-based Smart Irrigation System utilizing Soil Moisture and Weather Prediction was developed by the authors of [10]. A smart irrigation design using a machine learning technique to forecast soil moisture is suggested in this research. We can sense air temperature, air humidity, soil temperature, and weather forecasts using this device.

Predicting soil moisture using weather predicted data. And web application can monitor the irrigation of the system. Some usefulness of this system is 1. Farmers can monitor the whole farm using remote location by IOT, 2. Farmers can forecast soil moisture levels for the following days by using weather forecast data, 3. If the soil moisture level falls below a specified threshold, the pump will automatically start, and once enough water has been supplied, the pump will automatically stop. In the system soil moisture sensor is connected with Arduino which is obtain data and transmitted through wireless transmission. Analyze the data and compare the moisture, humidity, and temperature thresholds. Measurement of the soil moisture and then using microcontroller to control the pump. When the soil moisture level falls below a specific threshold, the microcontroller sends a signal to the relay module, which activates a pump to distribute water. Once enough water is deliver the pump stops. And web application continuously monitoring the irrigation through IOT. So this how they actually made this system.

This system has some drawbacks such as we cannot do live data monitoring, We are unable to do data analysis based on soil and environmental factors. They can add more features to improve this system such as Machine learning approach to analysis the data which will help to improve the performance, checking the color of leaves or plants using a camera, using drone to do live data monitoring.

Authors of [11] have made an IoT based machine learning approach to automate the farm irrigation system which would be the more cost-effective and valuable approach to the farm's necessities. A monitoring system with the primary goal of addressing excessive irrigation, soil erosion, and crop-specific irrigation while lowering water levels. Using various sensors all the sensed data will be sent to a server and for further analysis Use a machine learning system to forecast agricultural irrigation patterns and weather scenarios, and then take necessary action based on those predictions. Some major usefulness of this system is: it will be help to the farmer for monitor the field; this is the cheaper and more precious solution for farmer, Minimize the wastage of water. In this system they use two types of microcontroller raspberry pi 3 and Arduino mega. The microprocessor is linked to a variety of sensors, including a gas sensor, a water sensor, a temperature sensor, and a humidity sensor. The system's wireless sensor communicated with a central server through Wi-Fi. Using a Python script to automatically collect sensor data and transmit alerts. Weather data gathered from online web open source API. Weather data and all the sensor sensed data measures and processing all the values and control signal from the gateway node to the actuators to turn on/off the water pump automatically. This is how they actually made this. It has some drawbacks like Cannot possible automatic with predict with hyper parameter tuning, Cannot control it through mobile phone in every stage of farming. They can improve this system more by adding an approach of automation which will be dynamic and flexible. From planting seeds to harvesting crops, smartphones can assist farmers at every stage of the process.

The authors of [12] developed a smart irrigation and soil composition monitoring system based on IoT. This paper proposes a smart irrigation system with monitoring capabilities that can reduce water waste and soil deterioration. The benefit of this system is that the farmer can monitor the state of the plant/crops from any location. It also assists the farmer in irrigating in the most efficient manner possible, such as temperature and humidity, soil humidity, and environment. The suggested system is constructed with an Arduino uno (ATMEGA 328P) that is connected to several sensors such as soil moisture, temperature, and humidity, a light sensor, a relay that is used to perform a specific duty, and a water motor that turns on and off automatically when water is required. And a WIFI module for WIFI network access. It has some drawbacks like we cannot predict the weather. They can improve to add weather prediction for next few days analysis, and they can also use machine learning for better and accurate result.

The authors of [13] developed a Smart sensor for a paddy irrigation system that uses an autonomous drip irrigation system. Smart sensor-based drip irrigation is used in this suggested system. In which farmer can save the water and it will also increase the crop productivity. The suggested system uses a smart sensor that includes an ARM microprocessor, a smartphone, a GSM module, a sensor unit, and a motor control unit. Temperature sensor, humidity sensor, light sensor, and rain sensor make up the sensor unit, which is used to collect physical data such as light intensity, humidity, temperature, and rainfall in the agro field for environmental monitoring. An irrigation application that uses a smartphone photograph to determine the soil moisture level. GSM module use sending and receiving message between the microcontroller and smartphone. In this system some drawbacks like it usages an application for image processing to determine the wetness of the soil, which is highly cost effective, And we cannot monitor the data for future analysis of crop, Here they didn't use any cloud service for backup the data for future analysis which is important for crop productivity. To improve this system they can use cloud service for future analysis the data. They can also use a machine learning approach for better analysis.

Authors [14] have also proposed an IoT-based smart watering system. This proposed system is used for by the sense of soil moisture sensor value it will be turn on/off the water sprinkler and it will be help the farmer to prevent the crop damage from over/under irrigation. And they can monitor this system through online by a website. The system is made up of an Arduino UNO microcontroller and a soil moisture sensor that detects the moisture level in the soil. The IoT technology is utilized to keep the farmer informed about the state of the sprinklers. And all of the data from the sensor is updated on a daily basis on a webpage. Farmers may monitor the state of water sprinklers using a GSM-GPRS SIM900A modem sensor, and this sensor can also transfer data through Thing Speak to perform graph analysis. This system has some drawbacks like it usages a website to monitor the system. But making a website and hosting online which is costly. And we cannot directly control the water pump, we can just see the status of the sprinkler of water. They can add some changes on this system to improve this system like adding cloud based system instead of using website to store the sensor's data. Using machine learning approach to analyze the data more efficiently. And they can made it fully automatically opera table.

IoT Soil Moisture Monitoring and Irrigation System Development was developed by the authors of [15]. In which the system is help the farmer in visualization concept of power plant. It is mainly help the farmer in the process of irrigation system development. This system helps to monitor the moisture and properties of soil for plant . And measuring water level, the relay module will automatically turn on/off the motor pump when it is in need of water. In IoT architecture, this suggested system has three layers: perception layer, network layer, and application layer. A microprocessor, soil moisture sensors, and solenoid valves served as sensors, transducers, and actuators in the perception layer. The data transmission and receiving were done using wireless networking technology (Wi-Fi). Humidity and irrigation volume were gathered, recorded, and evaluated using the developed application, So this is how they made this system. This system has some drawbacks like it is a web based system which costly and hard to maintenance. And we cannot predict the behavior of the system. They can improve this system to adding a machine learning approach to analyze the data more preciously. And they can use weather prediction for future next 7 days environment behavior to take an appropriate action. Make this system fully-autonomous monitoring and irrigation.

According to the authors of [16], they suggested an Automated Irrigation System Using Weather Prediction for Efficient Water Resource Management. The major goal of this research is to make water consumption more efficient dependent on weather conditions. The key advantage of this technology is that it allows farmers to more efficiently use existing water resources by monitoring moisture levels in the soil and forecasting weather. This system detected data and sent it to the acquisition system using various sorts of sensors such as soil moisture, temperature, and humidity sensors. The data will then be processed with some code that improves in weather prediction, and the outcome will be sent to the microcontroller. The relay module will switch on the motor if the soil moisture sensor reading is less than a particular threshold. For the varies of weather prediction the pump and solenoid valves will be turn on/off till the set point value is reached by the moisture sensor. So this is how they made this system. It has some drawbacks like using this system we cannot properly monitor our system. And for this method slightly increase the photosynthesis just 2 % from the old method. Adding some features they can improve this system more like adding monitoring with phone/pc. And use cloud based system for data store and using machine approach they can get better result which will help for crop productivity.

Authors of [17] have made an IOT based Smart Irrigation System. They try to make automation in farm activities. They try to do higher agro production instead of less human supervision. They suggested in this research to create an automated irrigation system that can automatically monitor and maintain the needed soil moisture content. It is useful for automated irrigation system. It can be helpful for increasing agro production. Farmers are being helped with the automated irrigation system. They would be updated about the status of sprinklers. They would take any necessary steps depending on the sensed data. In their control unit they use Microcontroller ATMEGA 328P to implement this. In this, only Moisture Sensor is used to sense and the information is regularly updated on the webpage using GSM-GPRS SIM900A .Thus farmer could check the updated condition of water sprinklers. It could only sense the moisture and water in the land, but couldn't monitor. Without proper monitoring, human supervision couldn't be lesser. Only watering is not a specific work for a agro field. There are a lot of things to monitor. In this project more things could be included like more monitoring features, more sensors to sense more data to improve irrigation or cultivation and increase production without more human supervision.

The authors of [18] created a smart agriculture monitoring and control system based on IoT. This project is showing to all a method to solve common bad issues and provide a smart agricultural problem solution at an affordable cost to the farmers. This is made up of a framework for sensing soil moisture, temperature, and humidity, which allows for the prediction and monitoring of agro field irrigation needs. For increasing the productivity and environmental impact of agriculture this IoT based agriculture has great advantages over traditional agro farming. This IoT based project will help to increase productivity, less consumption of water, and reduces human supervision. This could be a system that gives a protection system for all agriculture with higher limit production and less human effort. The system's most fundamental feature is its user-friendly interface and ease of usage. This system is designed for both technical and non-technical background people so that no one can find it hard to use it. All the software part and reading interface of the system is also very easy to analyze and data processing of the system. How they made it: It is made in accordance with the basic methodology of the system. The system is based on IoT technology with different types of sensors and an automatic watering system. For getting smart performance, single use of microcontroller is not a wise suggestion as two (monitoring and irrigation) in together. It could be improved by adding more features like weather update, more automation, preventing insects.

The authors of [19] created a fuzzy logic-based Automated Irrigation System based on irrigation gates. It is particularly beneficial for decreasing incorrect scheduling, water waste, soil fertility loss, productivity loss, and electric power waste. This system will reduce only the wastage of water, soil fertilizer, not so much human supervision. This system could add more sensors to sense more specific data from the land and take more necessary steps to grow more production.

Several sensor nodes were deployed in the field using WSN techniques to collect soil moisture, temperature, and humidity data, which was then transferred to the Firebase Real-time Database. By analyzing gathered data against a fuzzy rule-base, fuzzy logic approaches have been utilized for decision-making. Smart gates calculate water quantity based on fuzzy judgments and supply water content according to the crop's demands. The mobile dashboard provides the farmer with real-time information and control. On a modest scale and in a MATLAB simulation, the system was put to the test. Estimating irrigation days has been done using the rate of moisture loss at various temperatures.

CHAPTER 3

Requirement Analysis and Methodology

3.1 Requirement Analysis

3.1.1 NODEMCU

NODEMCU is an open-source development board based on Lua firmware, designed specifically for Internet of Things (IoT) applications. In addition to software that operates on ESP8266 Wi-Fi, it also incorporates hardware that is built on the ESP-12 module. The ESP8266 Wi-Fi is comprised of many components, including a Central processing unit, Random Access Memory, Wi-Fi, and even a current OS (operating system) and Software Development Kit. The board is comprised of a 32-bit MCU and a Transceiver for Wi-Fi networks, as well as 11 GPIO pins and a corresponding analog input. It implies that we may program it the same way that we would any other Arduino or microcontroller. Additionally, we receive Wi-Fi communication, which allows us to attach to our Wi-Fi system, to connect our smartphone among other things. AT-Command firmware is included within this module that enables it to be utilized with any microcontroller through the COM port. CH340 family of chips is well-known for being a more economical replacement to the CP210x family of chips. The ESP8266 NodeMCU is equipped with 30 pins that allow it to communicate with the rest of the world.

Figure 3.1: NODE MCU ESP8266 Wi-Fi

Specifications & features:

- The input voltage range is 7V to 12V
- NODE MCU ESP8266 Voltage Required for Operation: 3.3V
- Tensilica 32-bit RISC CPU Xtensa LX106 was used as a microcontroller.
- It has an instruction RAM which size is 64 KB, and also a data RAM of 96 KB.
- The temperature range for the Node MCU was -40°C to +125°C, IEEE 802.11 b/g/n is the Wi-Fi network standard.
- 80 MHz is the clock frequency.
- Data transmission interfaces UART and GPIO are supported.

3.1.2 Water level sensor

Water level sensor is an easy-to-use, low-cost high-level/drop identification sensor that determines the water level by measuring droplets/water volume using a set of parallel wires exposed traces. To create the level warning effect, it is simple to convert water to analog signal and read the output analog values directly on the development board.

Figure 3.2: water level sensor

Specification & features:

- 4-20 mA or 0.5 to 2.5 VDC outputs
- Voltage range: 3.3 to 5 VDC
- 60 x 20 mm in size.

3.1.3 AM2 302 Temperatures and Humidity Sensor

AM2 302-Temperature & Humidity Sensor Module measures both temperature and humidity. The sensor comes with an easy-to-use 3-pin connecting wire. The sensor's JST Male port must be linked to the JST end of the cable, and the Arduino must be attached to the pins on the other end.

Specifications & features:

- Cost-effective
- A maximum current of 2.5mA and a voltage of 3 to 5V are employed during conversion (while requesting data)
- It measures humidity from 0 to 100 percent with a 2-5 percent accuracy.
- Temperatures are accurate to within 0.5°C from -40 to 80°C.
- The sampling rate must not exceed 0.5 Hz.
- Dimensions of the body: 27mm x 59mm x 13.5mm.
- length of three wires: 23cm.

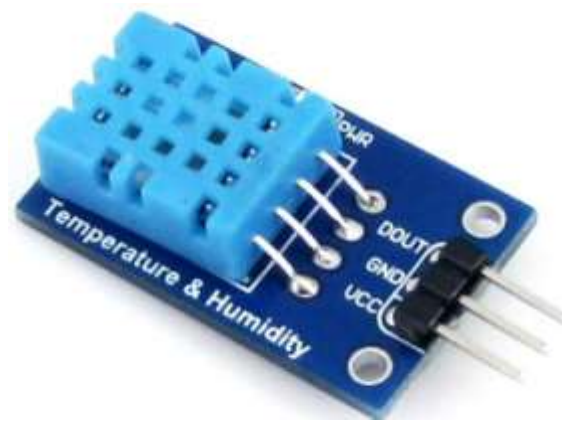

Figure 3.3: AM2 302 Temperature and Humidity Sensor Module

3.1.4 Connecting Wires

A wire is a metal strand that is flexible and generally cylindrical in form. Electrical conductivity is established between two devices in an electrical circuit using wires. They have a very low resistance to electricity passing through them. There are 3 types of connecting wires such as:

1. Male to male.

2. Female to female.
3. Male to female.

1. Male to male 2.Female to female 3.Female to male

Figure 3.4: Connecting wires

3.1.5 Relay Module

A relay module is an electromagnet-controlled electrical switch. To activate the magnets a power signal need from a micro controller. By turning on electromagnet it pulls on or off an electrical circuit.

Figure 3.5: Relay Module

Specification & features:

- Voltage range: 3.75V to 6V
- Current in standby mode: 2 mA

- When the relay is turned on, the current is around 70 milliamperes.
- Maximum contact voltage of the relay is 250 VAC or 30 VDC.
- Operating life: > 24 months.
- Relay maximum current – 10A

3.1.6 Water Pump

Water pumps are so widespread that you may find them at home, in fields, on farms, and wherever else. They are only used to remove water from the environment. Pumps for water use a variety of energy sources. There are three types of water pumps available: solar, electric, and engine.

Figure 3.6: Water Pump

3.1.7 Breadboard

The breadboard would be a quadrilateral plastic panel that has a slew of small holes drilled into it along its length. Breadboards are also used to develop prototypes of electrical circuits and may be applied for other applications in the future. The breadboard central half contains two columns, separately with 30 connection strips similar to the one on the breadboard that has been pushed out and to the side. These attach whatever that is strapped through from the forward-facing into single of the five holes to form a cohesive unit. Both borders of the breadboard have significantly longer portions of the clip that connect the columns of holes represented by red and blue lines on its exterior. Red lines are intended for 5V and Blue line are meant for ground (GND). The interior of a breadboard is constructed of small metal clips, it is possible that the leads will be accommodated by the board.

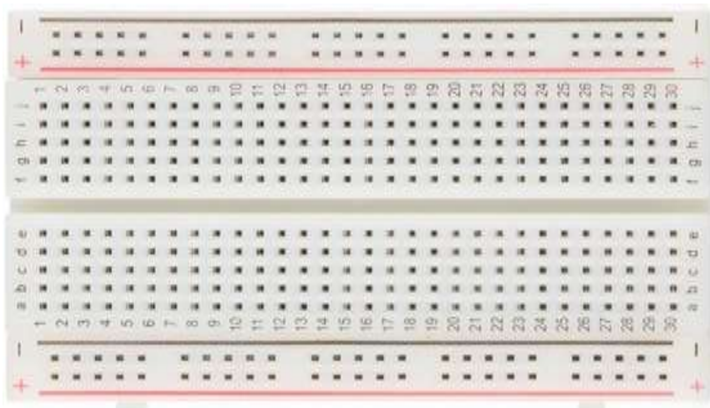

Figure 3.7: Breadboard

3.1.8 SIM800L Wireless GSM GPRS MODULE

SIM800L is a small module which can generate different type of actions such as send and receive GPRS data, send and receive SMS, and make and receive voice calls. The SIM800L uses a UART port to connect with the microcontroller and supports commands like as 3GPP TS 27.007, 27.005, and SIMCOM improved AT Commands. It also comes with built-in level translation, allowing it to function with microcontrollers that operate at greater voltages than the standard 2.8V.

Figure 3.8: SIM900A GSM/GPRS Module

Specification & features:

- SIM800L is a chip.
- The voltage should be between 3.7 and 4.2 volts.
- Dimensions of the module: 2.5cm x 2.3cm
- TTL serial port for serial port.
- The power module starts up automatically, and the homing network is established.
- All of the onboard signal lights are on. When there is a signal, it flashes slowly; when there isn't, it flashes swiftly.

3.2 Methodology

3.2.1 System Architecture

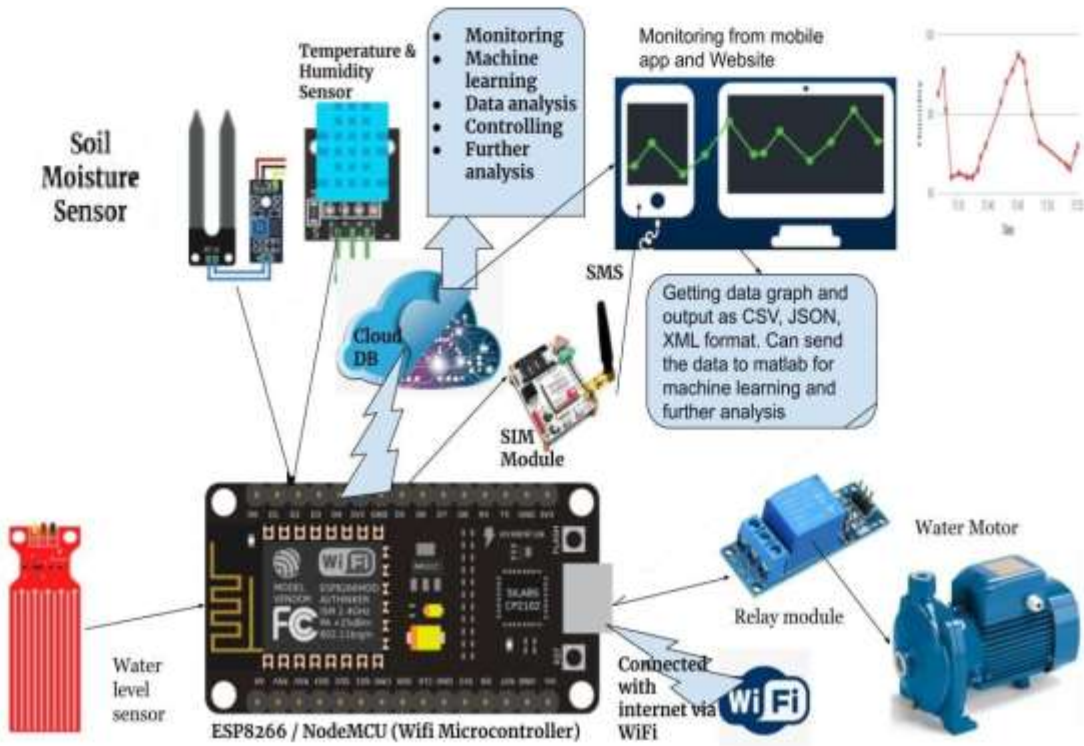

Figure 3.2.1: System Architecture

The system architecture of our proposed "IoT-Meadow: A Smart Monitoring and Irrigation System" is shown in the above diagram. Using a power bank, The system is charged up. Here, we use the NODEMCU module, which is developed with an open source framework on the ESP8266 that can link devices and allow data transmission via a Wi-Fi network. We also use several types of sensors like Soil Moisture sensor, Am2 302 temperature and humidity sensor, water level sensor, Sim module and Relay Module. Those sensors are connected to the NODEMCU module via connecting wires. There is also use Blynk app, which displays the Real-time data output that has been collected by sensors. Using mobile phone technology, a SIM module is utilized to create a cellular network with a distant network. If any of the sensed data changed, then a notification SMS is sent to the farmers' mobile phone through the SIM module. NODEMCU also sends real-time data from connected devices to the Thingspeak cloud storage for further analysis to use machine learning approach.

3.2.2 Flow Chart

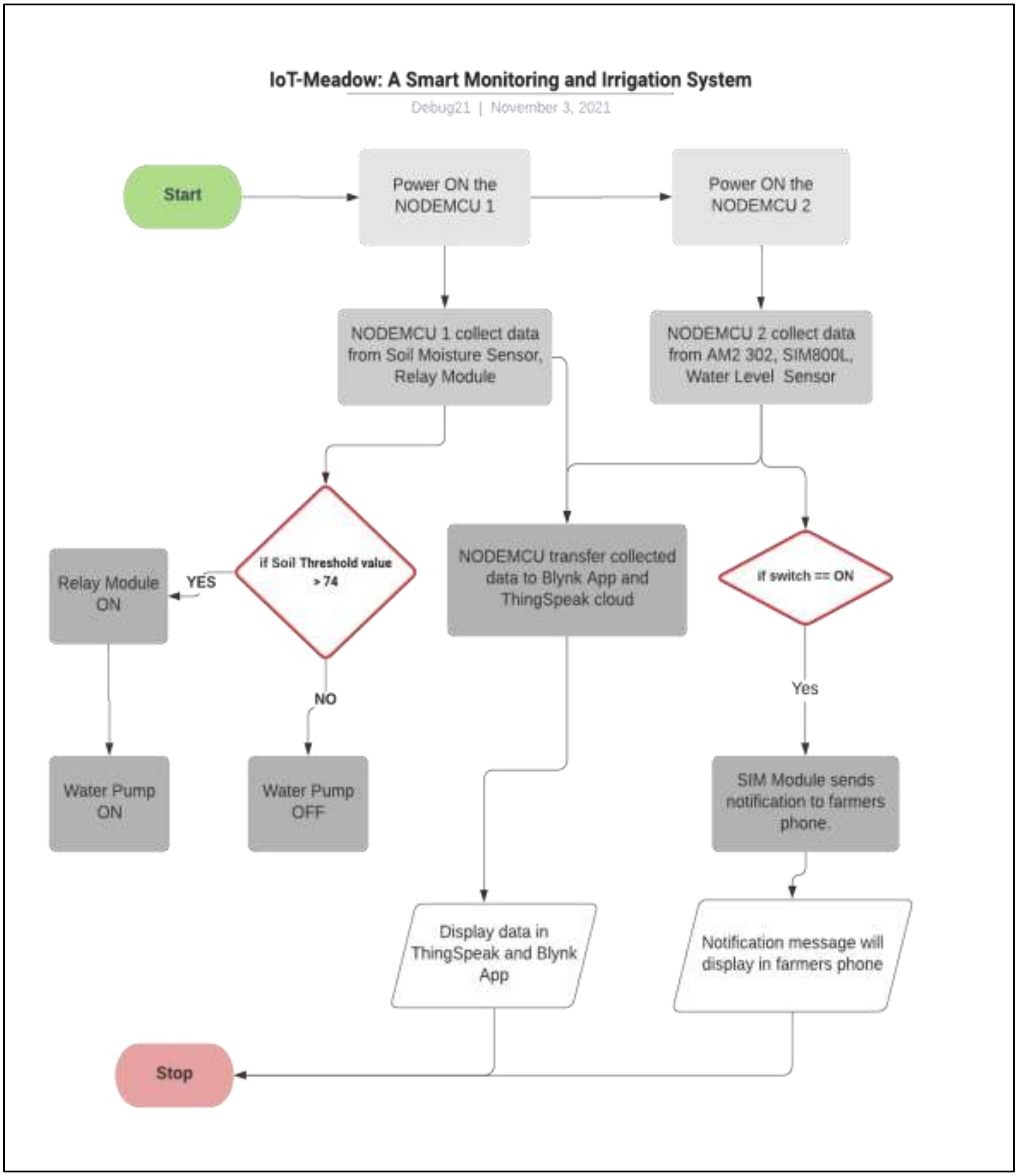

Figure 3.2.2: Flow Chart

3.2.3Algorithm

Step1 – Start.

Step2 – Power ON the NODEMCU-1 & NODEMCU-2.

Step3.1.1 – NODEMCU-1 collects the data from the Soil Moisture sensor and Relay Module.

Step3.1.2 – NODEMCU-2 collects the data from the AM2 302 sensor, SIM800L, and Water Level Sensor.

Step4.1.1 – if Soil_Threshold_value > 74 then Relay Module ON otherwise, Relay Module is OFF.

Step4.1.2 – if the Relay Module is ON then Water Pump will be ON otherwise Water Pump will remain OFF.

Step5.1.1 – NODEMCU transfer the collected data to Blynk app.

Step5.1.2 – NODEMCU transfer the collected data to the ThingSpeak cloud server.

Step6 – if switch == ON then SIM Module sends notification to the farmer's phone.

Step7 – Stop.

CHAPTER 4

4.1 Project Implementation

Here is the hardware implementation of our project. A breadboard, two NODEMCUs, an AM2-302 temperature and humidity sensor, a water level sensor, a soil moisture sensor, a SIM module, a relay module, and a water pump motor are among the tools we used. On the breadboard put two NODEMCU then the soil moisture sensor, relay module and a motor connect with one NODEMCU and also connect AM2-302 temperature and humidity sensor, water level sensor and SIM module with another NODEMCU.

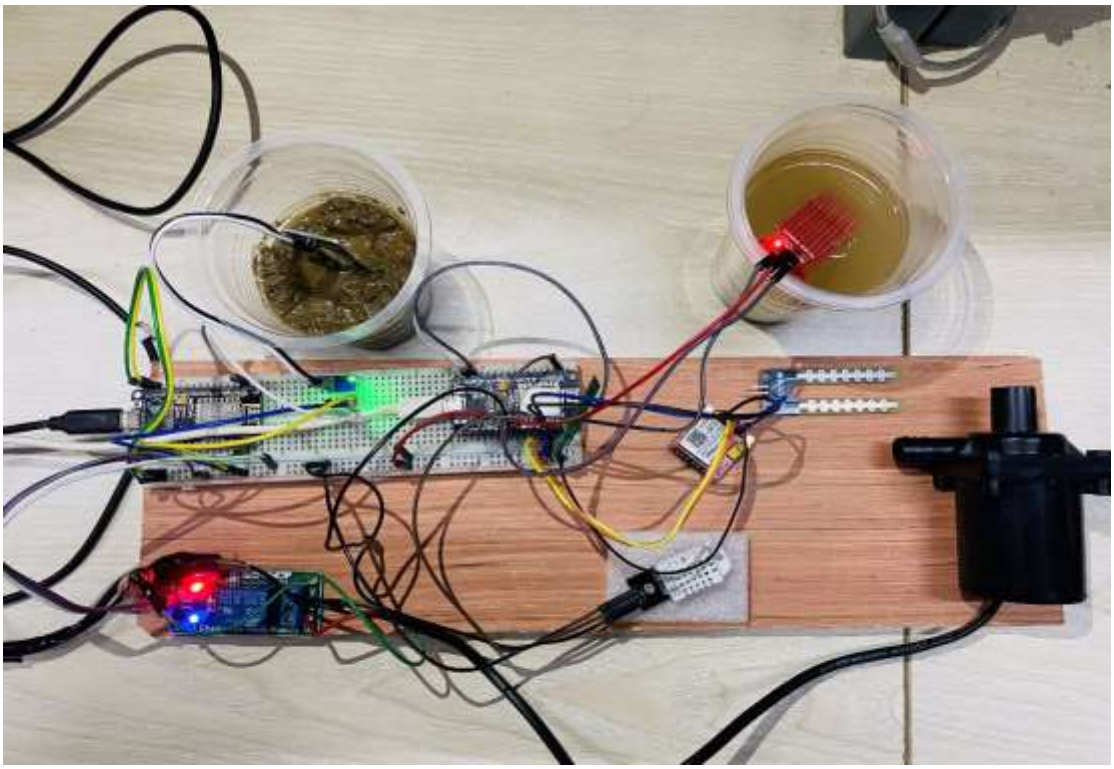

Figure 4.1.1: Project Implementation

In below we can see the live data in ThingSpeak cloud server that are shown our project. and also we can monitor this through using smartphone/PC.

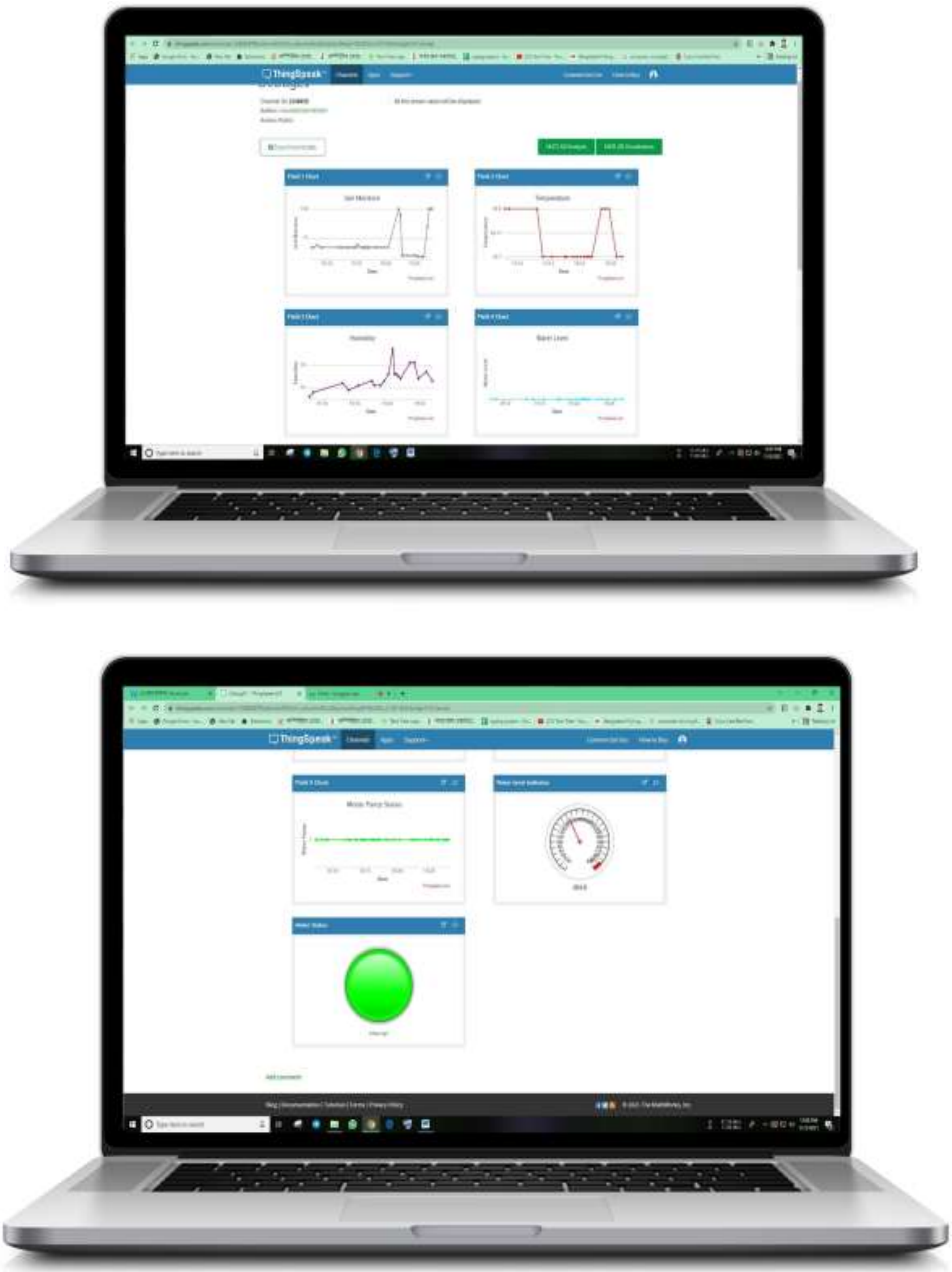

Figure 4.1.2: Live data in ThingSpeak Monitoring by PC

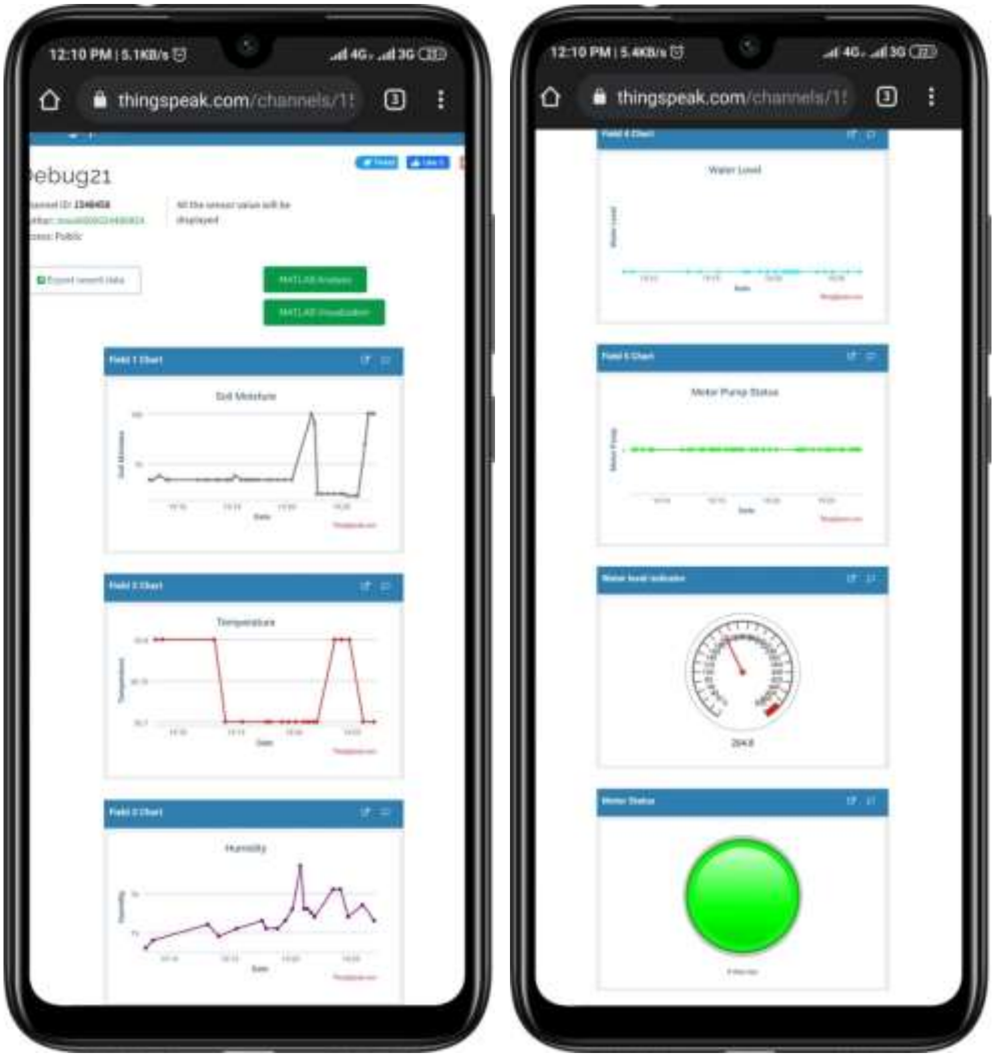

Figure 4.1.3: Live data in ThingSpeak Monitoring by Phone

Here in this figure it has been shown how the Soil Moisture, Humidity and temperature sensor sensing data from environment and sending to cloud server.

Figure 4.1.4: Real time data notify through SMS

In this figure the real time SMS (Temperature, Humidity and Water Level) of farmers' phone has been shown.

Figure 4.1.5: Live monitoring with Blynk

Here in this figure it has been shown how the Water Level, Humidity and temperature sensor sensing data from environment and sending to Blynk App Dashboard.

4.2 Accuracy of Measurement

The bar chart gives information about how much accurate our sensor provides in real-time data. Summaries the information by selecting and reporting the main features. First and foremost, there are the issues of soil moisture and temperature. It can measure temperatures with an accuracy of around 98% rather than 100% and soil moisture 94% rather than 100%. The humidity can then be measured with 96% accuracy rather than 100% precision. Furthermore, water level, relay module, SIM module and Cloud Database are detected 90%, 97%, 88% and 98% of accuracy respectively.

Features	**Outcome**
Soil Moisture	94%
Temperature	98%
Humidity	96%
Water Level	90%
Relay Module	97%
SIM Module	88%
Cloud Database	98%

Figure 4.1.6: Features and Outcome

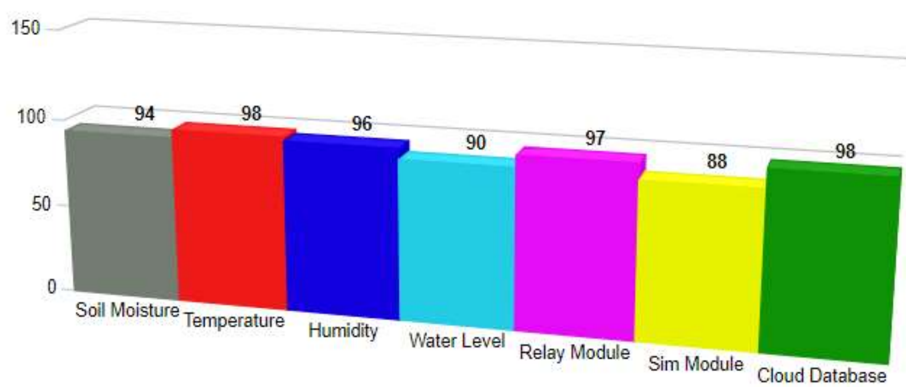

Figure 4.1.7: Accuracy of Measurement

4.3 Limitations

- Our system can’t sense gases from the field.
- This sytem is not water proof
- Without power source it can’t work properly.
- Without WiFi connection it can’t send the data to the server.
- It can’t send SMS to the farmers’ Phone without recharged money in the SIM.

CHAPTER 5

Future plan and Conclusions

5.1 Future works

In our future work, we will work to make it water proof. It will be affordable to send SMS in any condition. We are trying to make it affordable to run the system in another 24 hours power source. If it is run for 24 hours, it will be capable of sending data to the server continuously. We will apply the gas sensing method to our system. The cloud data will be used for further analysis to apply machine learning approach for increasing production.

5.2 Conclusions

Farmers in the modern period utilize a manual irrigation technique in which they water in the field at regular intervals. This procedure appears to use more water, resulting in water waste. Furthermore, irrigation becomes problematic in arid places with insufficient rainfall. As a result, To preciously monitor and regulate the water needs in the field, We have need an automated system. Installing our proposed a smart irrigation and monitoring system saves time while also ensuring that water is used efficiently. The system is sensed (soil moisture, AM2-302 temperature & humidity, Water level) sensor data and then we can monitor it through the Blynk app and ThingSpeak cloud server as well as send notification to the farmer's phone. The changes of soil moisture threshold value, Motor pump will turn on/off automatically. Furthermore, this architecture employs a microcontroller, which promises to extend the life of the device by lowering power consumption.

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