IoT BASED SMART IRRIGATION SYSTEM

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Declaration

This is to certify that this project is our original work. No part of this work has been submitted elsewhere partially or fully for the award of any other degree or diploma. Any material reproduced in this project has been properly acknowledged.

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ABSTRACT

Bangladesh is mostly a country that grows food. Farming is the most important job for a lot of people who live in rural areas. It is very important to the development of a country that grows food. The economy of Bangladesh is mostly based on agriculture, which makes up 26% of GDP and around 10% of exports. When you use irrigation, you can get a lot of water, but in some cases, there will be a lot of waste. So, to save water and time, we have proposed a project called an IoT-based automatic irrigation system. In this proposed system, we are using sensors like temperature, humidity, and soil moisture sensors to monitor the soil. Based on the soil moisture value, the motor can be turned on or off. These sensed parameters and the state of the motor will be shown on a user-friendly io dashboard. Insect repellent and other features have also been added to the system to make it better.

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Chapter 1

INTRODUCTION

1.1. Overture

Demands for agricultural water irrigation have recently risen because of the huge growth in the world's population. Agriculture now takes up about 64% of the available land. There will be 9.1 billion people on the planet by 2050, according to UN projections. This means that food production will have to go up by one third to feed the extra one-third of people. And, the agriculture industry is a big part of meeting people's needs for food, energy, and shelter. It's true that traditional farming methods have a lot of problems, such as a lot of water wasted when watering the field, a lot of time, money, and people to use. The only way to solve all of these problems is to modernize farming, which some farmers have already done. Next-generation farming fields would use data from sensors to grow crops. Around 80% of the water we have is used for farming, according to some estimates. In the near future, as the population grows, freshwater bodies will be depleted, which will have a big impact on farming, which is one of the most important ways to ensure food security [1]. Keeping food secure would require a lot of agricultural monitoring and mapping. Water management from afar is also a difficult job, especially when there is not enough water to keep the crop healthy.

They still use traditional water canals that are fed by rivers or streams to water their farms in most parts of the world that are rich. There doesn't seem to be a lot of control or feedback on how much water the farms need. This method seems to take a lot of water from the water sources. So, we came up with a way to solve these problems by introducing a Smart Irrigation and Monitoring System that can be used to control the

irrigation process wirelessly, monitor the farm, water sources, and the whole system in real time.

Irrigation is a process. This method would find new ways to get the most out of farming and get rid of all the problems that stop the crop from growing [2].

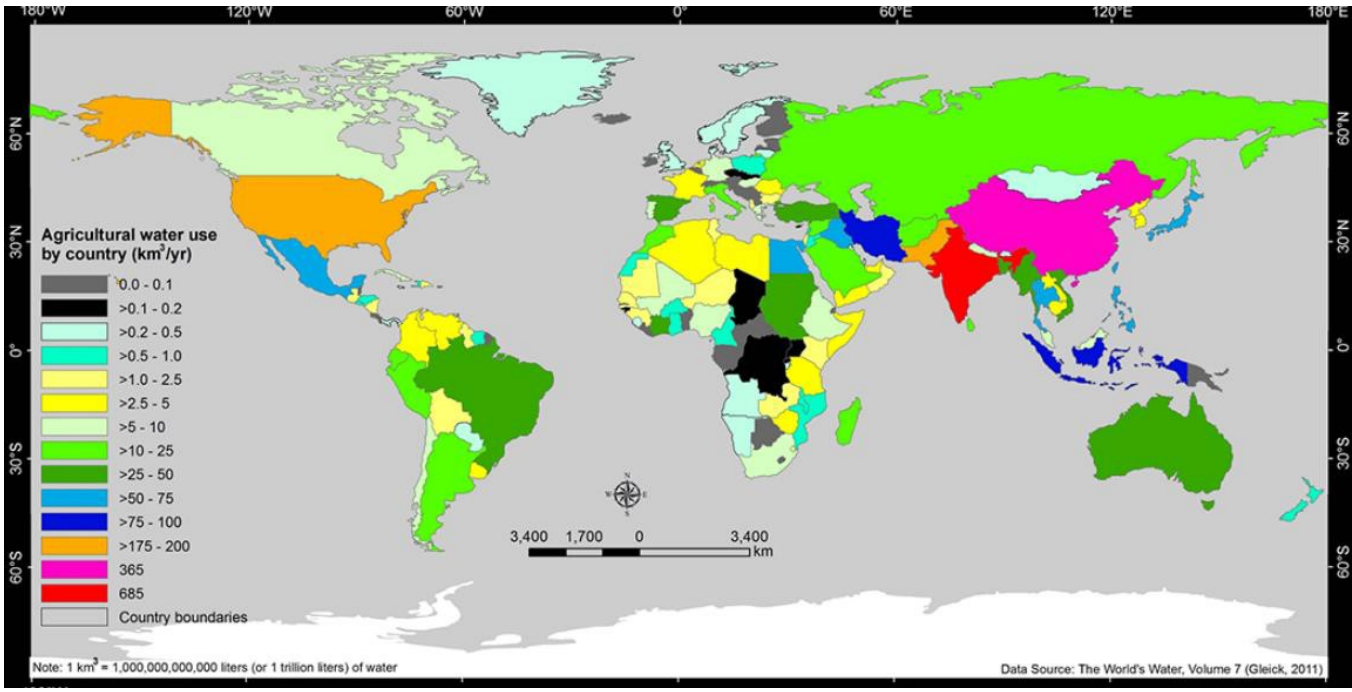


Figure 1.1: Water Usage in agriculture by country

1.2. Significance of the Project

There are many sensors that are used in agriculture, such as humidity sensors, temperature sensors, and soil-moisture sensors. Agriculture is a growing field, so there are many sensors used in this field. If the sensors used are connected to the Node MCU, then the data is gathered. In the regulatory section, the data is checked against a threshold standard [3].

When the humidity level drops, the Node MCU starts the pump of water to get water to the system. If the system detects enough humidity in the ground, the cloud server tells the end-user through the IoT section that the graph level is going down, and this is shown

through the IoT section. These factors include if there are pests that could be killed with a light that draws them in and kills them. The irrigation mechanism could be used to control water and pesticides on farms and fields at night.

Sensors are used to measure things like humidity, temperature, and moisture. An electric motor-pump and a light are used to keep pesticides and water from getting out. Adafruit io is thought of as a system that uses a dashboard to control the Node MCU that runs the electronic hardware. Irrigation will be done by robots at a certain time. The project itself is simple and easy to install using the available and open-source Arduino. Electrical components such as high Wattage motors can be controlled using relays [4]. This in return can save energy and resources which can be utilized later in proper way and amount. People who work on farms or nurseries would be able to spread the right amount of water at the right time if they made the irrigation systems run according to the given instruction. Avoiding irrigation at the wrong time of day will cut down on surface water from overwatering saturated soils, which will help crops grow better. Relays are used to turn the motor on and off in an automated irrigation system. Motors can be automated easily by using controllers and no need of physical labor to turn ON or OFF. At night an insect attracted light would be used to protect the farm without human involvement. The IoT can accurately measure the soil, temperature, pH, etc. It can be used in more sensitive vegetables or crops that are cultivated in greenhouse. This project saves time and eliminate human error by adjusting the soil moisture levels.

1.3. Objective of this Work

The purpose of this project is to use the IoT to monitor the temperature and moisture level of the soil without any human interaction. This system is utilized to monitor from a remote location using internet. The sensors take the data reading from the soil and using

cloud io send it to a password protected server. Where the data is stored for further use. In these farms, traditional irrigation systems still use a lot of water from the surface. Many irrigation systems don't work very well. They lose about 60% of the water that they transport through evaporation, leaks, and farmers illegally shifting irrigation channels to their farms [5].



Figure 1.2: Traditional irrigation system

The ways of using real-time monitoring and remote controlling the farm is crucial for water management. The farmers or user himself can watch the state their farm is in. It can be utilized in greenhouse where every component decides how the crops will turn out. If the automatic system is shut down due to some technical problem a manual switch is also included in the io dashboard which can be pressed to turn ON the motor. The irrigation is controlled by a motor and the whole system is smaller in size due to using the MCU module. The Wi-Fi which has low latency and can be accessed easily is the best point of using Node MCU. Along with the soil moisture and temperature a sensor was used to also monitor the surround temperature and moisture in the air. In case of rain the irrigation is stopped otherwise the crops will be submerged in water resulting in damage to the field.

There are where the temperature is high and surface water tends to dry up fast, this irrigation system is necessary to improve the cultivation of those areas. The resultant production would be better and more profitable due to implementing this system. The crops that need more waters will grow more and healthy which will bring happiness to the farmers. The natural quality will also be maintained as there will not be any use of pesticides, chemicals, etc.

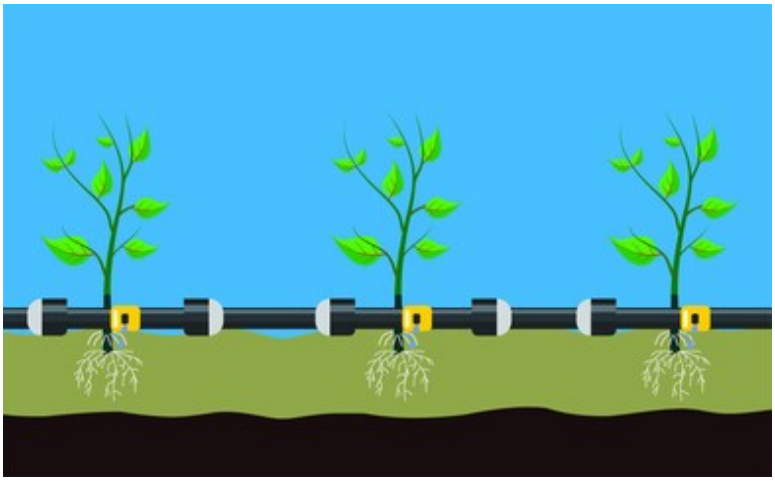


Figure 1.3: Automatic irrigation system using a relay-controlled motor

It takes a lot fresher water for irrigation to support more crops on farms. Currently, agriculture is responsible for 83% of the water used in India.

When you don't think about how much water you're going to use, you waste water. This shows that there is an urgent need to come up with ways to keep water from being wasted without putting pressure on farmers.

During the last 15 years, farmers have started using computers and software systems to keep track of their finances, keep track of their transactions with third parties, and also keep an eye on their crops. If you live in the age of the Internet, where people value information, agriculture is quickly becoming very data-intensive. Farmers need to collect

and a analyses a lot of information from a lot of different devices (sensors, tractors, etc.) to become more efficient at producing and communicating the right information.

With the help of open-source Arduino boards and cheap moisture sensors, it is now possible to make devices that can monitor soil moisture levels and, if necessary, water fields or landscapes when they need it. IOT and microcontroller ATMEGA328P are used in a system that lets farmers check the status of sprinklers on their farms from afar. This makes their jobs easier because they can do other things on the farm while the sprinklers are working [6].

Chapter 2

LITERATURE REVIEW

2.1. Introduction

IoT is changing farming and giving farmers the tools, they need to fight the huge problems they face. Agriculture has to deal with growing water shortages, limited land availability, and a growing world population's need for food, all while meeting these needs. In the future, new IoT applications will be able to solve these problems and make farming more efficient, more sustainable, and more profitable. Agriculture is one of the main sources of income for the Bangladeshi economy. We see a lot of rapid growth in the world's population today, which makes agriculture more important to meet the needs of the human race. However, agriculture needs irrigation, and with more water used than rain, it's important for growers to find ways to save water while still getting the best yield. But in the modern era, farmers have been using a technique called manual irrigation, in which they irrigate their land at regular intervals by putting water on the land with their own hands [7].

According to statistics, agriculture uses 85 percent of the world's freshwater resources, and this percentage will keep growing because of more people and more food needs. There is an urgent need to use science and technology to come up with ways to use water more sustainably, including technical, agronomic, managerial, and institutional changes. People who use internet technology in agriculture use rules to make sure crops get the amount of water they need to grow. In order to keep water from being wasted and to use the best scientific methods for irrigation, we can use the Internet and sensor network technology. Thus, it can greatly improve how much water is used and how productive it is

When a mobile device is connected to a device, it can be used to keep an eye on how it works. This is called the "Internet of Things." The Internet of Things (IoT) is about connecting things that can talk to each other even if they are in different places that could be far away from each other. The Internet of Things (IoT) is a type of network technology that senses information from different sensors and makes anything that can connect to the Internet share information with each other. To change the state of the device, it can also be used.

2.2. Related Research Works

In this paper, soil moisture sensors, temperature and humidity sensors are placed in the root zone of the plant and send data to Adafruit io. The threshold value of the soil moisture sensor that was used to control how much water was used. On the Android app, you can see the temperature, humidity, and soil moisture levels [8].

This paper, "Automatic Irrigation System on Sensing Soil Moisture Content," is about how to make an automatic irrigation mechanism that turns the pumping motor on and off when the soil is wet. In this paper, only soil moisture values are looked at, but the proposed project added temperature and humidity values to this project.

Using Wireless Sensors and Short Message Service, you can keep an eye on your agricultural greenhouse from afar (SMS).

Data is sent in this paper by text message. The proposed system sends the values to a mobile app.

An Arduino-based irrigation system for an agricultural plantation has been proposed in this paper [9]. The system is set up at a remote location and sends water to the plantation when the soil humidity drops below a certain level. But we didn't know about the soil

moisture level, so the proposed system added soil moisture value and temperature value to the farmer's mobile app to make up for this flaw.

Android and GSM were used to make an irrigation control system that used less water and electricity. To avoid this, the system used an Arduino Yun board that already had a WIFI module built in.

It's called "a Microcontroller-Based Irrigation System for Plantation." In this paper, an older microcontroller with less memory is used to control the system. The proposed system, on the other hand, used an Arduino board that is easy to use and makes it easy to dump the programmers [10].

In this paper, "a wireless application of drip irrigation automation that is supported by soil moisture sensors" is being discussed. In this paper, irrigation is done using soil moisture values, but this proposed system also shows temperature and humidity values.

According to the papers above, there aren't any systems that have all of the features that the proposed system has. It shows temperature, humidity, and soil moisture values, and it switches the motor on and off based on soil moisture values.

2.3. Earlier Research

A research paper suggests a system that will help a farmer make decisions based on real-time information about the field and the crops that grow there. Multiple cropping practices boost productivity in farming, especially in areas with a small area of operation. Multi-cropping helps the farmer be more efficient by limiting the use of resources and also by providing crops with help from companion crops [11]. The Penman-Monteith and Pan Evaporation Methods have been used to figure out how much water each crop needs at different stages of growth. A sensor network can be used to control irrigation in the

field so that the crop yield is as high as possible and the amount of water used is kept to a minimum [12].

Researchers have shown that when an automated irrigation system that uses soil moisture as a parameter is used, water use is cut down. A sensor-based system can be used to cut down on both the amount of power used and the amount of money spent during the irrigation process. Researcher showed how wireless communication can be used to make smart irrigation and a sensor system that can make farming smarter. To build this system, a microcontroller board called Arduino is used. This board has been shown to be both power efficient and small. GSM is used to run an irrigation control system that saves water and electricity [13]. But GSM can only send so much data at a time, so it needs a Wi-Fi module to move data around the system. People who made the system used a wireless sensor network and a GPRS module to make it work. A sensor-based system for a smart irrigation system can be easily expanded without having to change its main structure. For automatic irrigation in rural areas, robotic systems are set up in the fields to do the work.

In the past, research on automated irrigation with modern technology had a lot of problems that kept it from working well in the Indian agricultural landscape [14].

2.4. Validity and Accuracy of Existing Solution

The suggested method has been developed to reduce the amount of water that flows into agricultural regions without being used. By employing temperature, moisture, and humidity sensors, continuous temperature, moisture, and humidity measurements can be taken and sent to the IP address that has been designated. The Android application continuously collects data from the IP address that has been assigned to it. When the soil moisture values surpass a certain limit, the relay, which is coupled to the Arduino

microcontroller, activates and controls the motor to reverse the direction of the soil moisture values [15]. The android application is a straightforward menu-driven application with only four options to choose from. There are also values for the motor's status, as well as moisture, temperature, and humidity. The present status of the pump is indicated by the motor status indicator. The prior research publications were unable to provide a definitive solution. Due to a lack of funds and skills, only the implementation phase was completed. In addition, the insecticide was not included in the proposed system. In our project, we were able to control the entire soil qualities, which included things like water level [16]. When there is a change in temperature and humidity, the irrigation will start. This is what was said in Sensor based Automated Irrigation System with IOT. A solenoid valve is used to control the flow of water in the bathroom. In order for a valve to open and close, a signal is sent through the microcontroller. The water is delivered to the roots of the plant one drop at a time with a rain gun [17]. When the moisture level is back to normal, a sensor senses this and sends a signal to the microcontroller. The valve is then closed.

Advantages:

- Monitoring the entire system from any location
- Providing remote control of every sensor and piece of hardware in a system to increase greenhouse security
- When faced with an emergency situation, quick action can be performed.

2.5. Summary

The project itself is automated and manual each control exists. Previously researched material lacks either one or another component. This system also communicates with the cloud network using Wi-Fi through Node MCU. Environmental state was also considered

as only by measuring the soil moisture can be an illogical decision. While raining the duration of rain can be short or longer. As the water goes deep over time crops may not be able to feed sufficient water thus surrounding temperature and moisture was a plus point of this project. Because Internet of Things sensors are equipped to provide information about their gardening fields, splendid development is a rising concept. The paper focuses on the application of pushing innovations, such as Internet of Things (IoT) and intelligent horticulture (using motorization). The Wireless Sensors Network (WSN) is now being utilized extensively to gather decision-making information from genuinely stable businesses in order to resolve a wide range of difficulties in real time. Precision farming is one of the most exciting industries to work in because of the increased demand for decision-making organizations that are genuinely stable (PA). This study argues that using WSN to deal with rural concerns such as resource development, dynamic aid, and land checking is the most effective method of dealing with these difficulties [18]. This technique provides farmers with continuous information about their fields and crops, allowing them to make informed decisions. A major source of worry in many management systems in semiarid and fully dry regions is the availability of potable water. Sensitive water framework structures that have been passed on in the field provide a fair answer for help site-express water framework the board, which allows producers to increase their value while conserving resources. It depicts the subtleties of the configuration and instrumentation of a variable rate water framework, a remote sensor association, and programming for continuous in-field recognizing and control of a site-express precision direct move water framework system, among other things.

Chapter 3

METHODOLOGY

3.1. Introduction

Automation of farm activities has the potential to alter the agricultural domain from one that is manual and static to one that is intelligent and dynamic, resulting in higher output with less human supervision. This study offers an automated irrigation system that uses automatic watering to monitor and maintain the appropriate soil moisture content. The control unit is implemented using a microcontroller or Node MCU based on the Arduino platform. The system employs soil moisture sensors to determine the exact moisture level in the soil. This value allows the system to use an adequate amount of water, avoiding over/under irrigation. The Internet of Things (IOT) is utilized to keep farmers informed on the status of irrigation. The sensors' data is routinely updated on a webpage utilizing Wi-Fi technology, allowing the farmer to see whether the motor is on or off at any particular time [19]. Additionally, sensor readings are transmitted to Adafruit io for storage and generation of graphs for study. Ranchers use their labour to determine their harvest's development level, which is accomplished through the use of a manual technique for checking the borders. The actual ranchers inspect the limits of each crop field to ensure that they are correct. It is possible that they will use only the sensor and not the high level of notice, which will result in the loss of additional time and a large amount of labour. It is quite difficult to maintain constant observation of the harvests and assistance. It is impossible to obtain exact results. It is tough to be in the harvest field and to break down the temperature, humidity, and security for the yields, as these factors may not be exact and fully met and satisfied. It is possible that agricultural productivity will be

reduced as a result of a lack of labour and observation in this situation [20]. The Internet of Things (IoT) plays a critical role in the production of high-quality agricultural products.

3.2. Block Diagram and Working Principle

The block diagram of the system represents each and every component involvement. This below Fig 3.1 is a overall block diagram of Arduino based Node MCU irrigation system which consists of three sensor and are connected to controller. The sensors measure the values and sent them via Wi-Fi and through internet to the cloud server.

3.2.1. Block Diagram

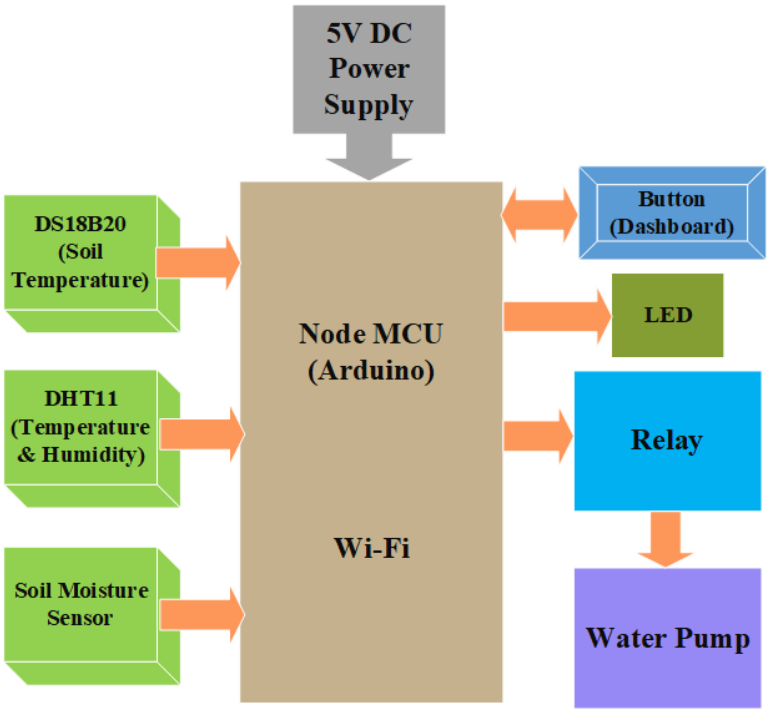


Figure 3.1: Block Diagram of SMART irrigation System

A smart irrigation system with IoT is shown in Fig 3.1. With the help of automation, farmers can use a system to keep an eye on things like temperature, humidity, and soil moisture. This can help farmers get a better yield. This project includes an embedded

system that can be used to control irrigation automatically. This project has a wireless sensor network that can see what is going on with an irrigation system in real time. Three sensors are placed in the harvest; information will be gathered from these sensors in the form of simple qualities, so that simple worth is changed over computerized values; advanced qualities are offered contribution to Arduino; this information is sent off the data set by utilizing Wi-Fi; and the sensors are aligned so that the base wet condition is maintained. The limit voltage is adjusted in accordance with the varying yield fields encountered during the year and throughout the seasons. When the information from the Sensors is that value is contrasted and microcontroller [21], when the value is not exactly ordinary value so that the field is dry conditions at that point signal ship off the engine on, when the value is more noteworthy than typical value so that the field is wet conditions at that point signal ship off the engine on is additionally positioned on that. If you want the sign ship off the engine to be turned off, then you should use a ringer to indicate that the engine is turning off when it should be turned on and vice versa when it should be turned on. By utilizing the Wi-Fi module, the information has been stored in the cloud information. The framework has been completely automated, and the current state of the framework can be determined by sending a money order to his cell phone. It has been created an Android application, so that these data can be used to determine whether or not a condition has changed, and in the microcontroller, cycle using Arduino code, it creates an IP address for every one of the sensors information that is accessible around there, as well as the engine condition, and at any point open the application by utilizing a portable, the information will appear on our device [7]. This system makes sure that the water level on the farm is always the same and that there is no waste of water. When the moisture level in the soil falls below a certain level, the system turns on the motor. When the water level is at the right level, the motor automatically turns off. Users will be able to see the

motor's sensed parameters and current state on their Android apps. AT night the user can also turn on the LED to keep the crops away from harmful insects.

3.2.2. Flow Chart

A flowchart is a picture of a logic sequence, a work or manufacturing process, an organization chart, or another formalized structure. The flowchart is a way to show how data moves through an information processing system in a way that can be seen. Sensor data from soil moisture, temperature, and rainfall is sent to the computer [10]. These are data that can be used to make decisions about the crop. In this case, the valve will open if there is not enough soil moisture for the crop. It will depend on the temperature whether or not you can water with a sprinkler. When it rains, you can't water your plants. It is possible to open the valve or not do anything at all based on the values that the sensors send out.

To keep track of the types of crops, sensors, and statistics, a database is needed. In Fig. 2, you can see how the database that was used works. There are many ways to store information about crops and their cycles. This structure makes it easy to keep track of this information. In addition, the data is kept on the sections that are being monitored and the sensors that are linked to them. A field called "Irrigation Type Crop Cycle" lets you link the type of irrigation that will be used to each crop for each cycle and the amount of liquid that will be used [11].

In order to show the results in a way that makes sense, the administrator should be able to keep an eye on the state of the variables (the data from the sensors) and the irrigation of the crops. Each type of crop can have its own irrigation setting in the part of the app that shows and interacts with users. This is called "configuration." If it isn't possible, each crop can be set up in a certain way.

TEMPERATURE & HUMIDITY SENSOR:

This below Fig 3.2 shows the sensed values of temperature and humidity.

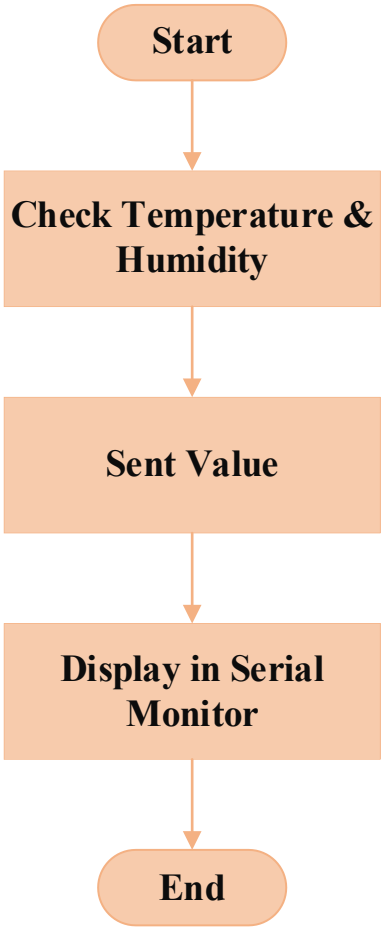


Figure 3.2: Flowchart of Temperature & Humidity Sensor

The DHT11 is a simple temperature and humidity sensor that is digital. It has a capacitive humidity sensor and a thermistor that measure the air in the room. It sends a digital signal on the data pin (no analogue pins needed). It's easy to use, but you have to be very careful when you want to get data. Humidity sensors are used to figure out how much moisture there is in the air [4]. Then, the microcontroller sends the current temperature and humidity values to it. The values will show up in the Android app of the person who is using it.

SOIL MOISTURE SENSOR:

This below Fig 3.3 shows the procedure of displaying soil moisture value.

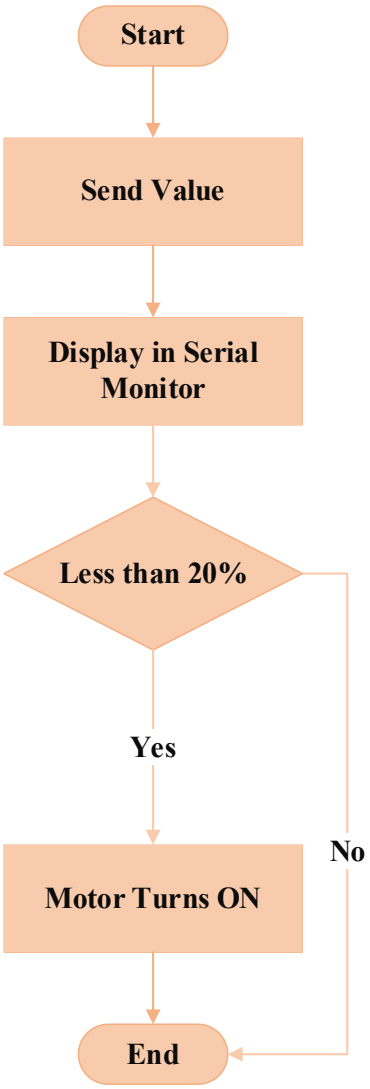


Figure 3.3: Flowchart of soil moisture sensor

Soil moisture sensors measure how much water is in the soil. Moisture in the soil is an important part of the water cycle in the sky. When the soil is dry, the sensor module gives off a lot of resistance. It has both digital and analogue outputs, so it can be used with both. Digital output is easy to use, but it isn't as accurate as analogue output, which is based on moisture level. The motor is turned on and off automatically when there is enough moisture.

There is one more condition which was not included in the flow chart as they are manually controlled by the user any given time. The LED and the motor can be turned ON/OFF with a button in the dashboard if the farmer wants [5].

3.2.3. Working Principle

DHT11 Temperature & Moisture Sensor:

DHT11 is a cheap digital sensor that can tell you how hot and humid it is. This sensor can be easily connected to any microcontroller, like an Arduino or Raspberry Pi, so it can measure humidity and temperature right away.

The DHT11 sensor can be bought as a sensor or as a module. The pull-up resistor and a power-on LED are the only things that make this sensor and module different from the one you already have. DHT11 is a sensor that tells how humid it is. This sensor uses a thermistor and a capacitive humidity sensor to figure out how much air is in the room.

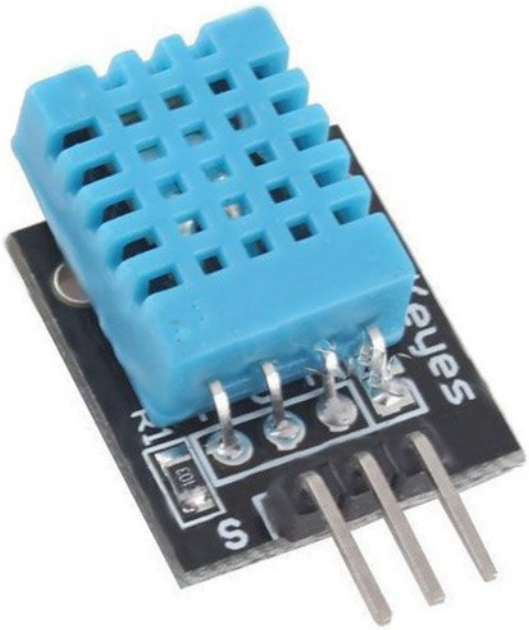


Figure 3.4: DHT11 Sensor

The DHT11 sensor has two parts: a capacitive humidity sensor and a thermistor for measuring temperature. This is how the humidity sensor works: It has two electrodes and a moisture-holding substrate as a dielectric in between them. The capacitance value changes when there is a change in humidity. The IC reads, processes, and converts this changed resistance value into digital form with the help of a chip.

This sensor uses a Negative Temperature coefficient thermistor to measure temperature. As the temperature rises, the resistance value of the thermistor goes down. This sensor is usually made of semiconductor ceramics or polymers so that it can get a bigger resistance value even if the temperature changes by a very small amount [7].

There is a 2-degree difference between what the temperature is at DHT11 and what it is at other places. This sensor can measure humidity from 20% to 80% with a 5% level of accuracy. One reading is taken every second by this sensor. DHT11 is small and has a voltage range of 3 to 5 volts, which makes it easy to use. It takes 2.5mA to measure the maximum amount of current.

The DHT11 sensor has four pins: VCC, GND, Data Pin, and a pin that isn't wired up. A pull-up resistor of 5k to 10k ohms is used to communicate between the sensor and the microcontroller.

Soil Moisture Sensor:

The soil moisture sensor is one type of sensor that can be used to figure out how much water there is in the soil. As the straight gravimetric dimension of soil moisture needs to be removed, dried, and weighed, so does the soil moisture. These sensors don't measure volumetric water content directly. Instead, they use other rules of soil, like dielectric constant, electrical resistance, or neutrons, to figure out how much water is in the soil.

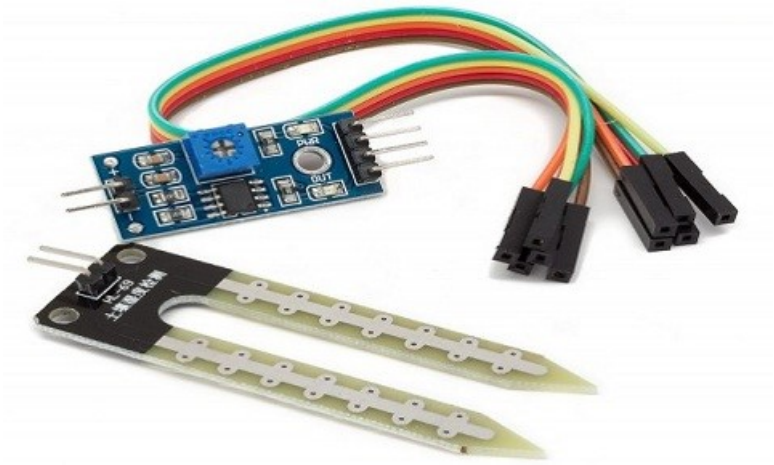


Figure 3.5: Soil Moisture Sensor Module

The relationship between the calculated property and the amount of moisture in the soil needs to be changed and may change based on things like temperature, type of soil, or electric conductivity. The amount of moisture in the soil can change the microwave emission that is reflected. This is mostly used in agriculture and remote sensing in hydrology. The volumetric water content of soil is usually checked with these sensors. Another group of sensors calculates a new type of moisture in the soil known as water potential. These sensors are called soil water potential sensors because they have gypsum blocks and a tensiometer in them [3].

This sensor mostly uses capacitance to figure out how much water is in the soil (dielectric permittivity). By inserting this sensor into the ground, you can use this sensor to see how much water is in the soil. You can then see how much water is in the soil as a percentage.

This sensor is great for experiments in environmental science, agricultural science, biology, soil science, botany, and horticulture, as well as other science classes.

DS18B20 Temperature Sensor:

When you use the DS18B20, you get 9-bit to 12-bit readings of the temperature. These numbers show the temperature of a certain thing. The communication of this sensor can be done through a one-wire bus protocol. This protocol uses only one data line to communicate with an internal microprocessor inside the sensor. This sensor also gets its power from the data line, so there is no need for an external power source. The DS18B20 temperature sensor can be used in industrial systems, consumer products, systems that are very sensitive to heat, thermostatic controls, and thermometers.

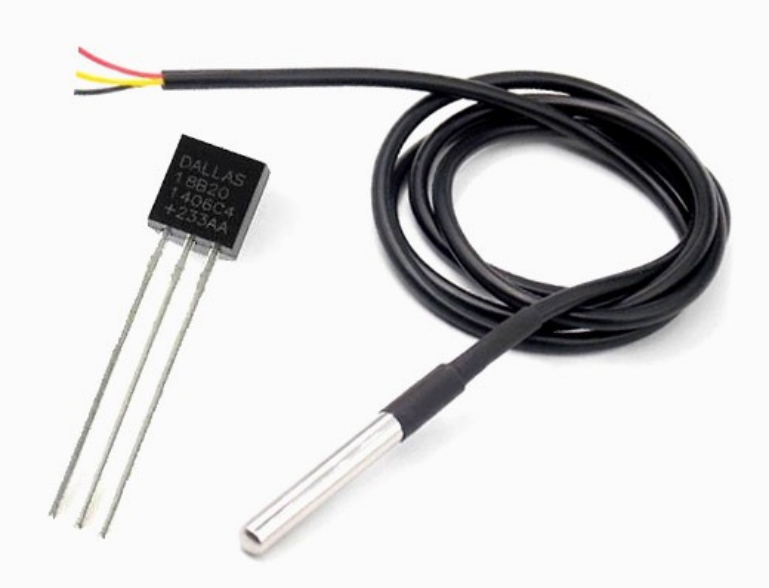


Figure 3.6: Soil Temperature Sensor

The DS18B20 temperature sensor works in the same way as a temperature sensor. How many bits does this sensor have? It can go from 9-bits to 12-bits. In fact, the default resolution that is used to start up is 12-bits. This sensor gets power when it is in a low-power, inactive state. convert-T is a command that can be used to measure the temperature, as well as convert A to D. The temperature data can be stored in a 2-byte register in the sensor. After that, the sensor goes back to being inactive.

Sensors that need power from outside sources can have read time slots next to commands like Convert T, if the master can set them up. Even though the temperature change is going to get better, the sensor will respond by giving out 0. When the temperature change is done, the sensor will respond by giving out 1.

5V Relay Module:

A relay is a type of electro-mechanical part that acts as a switch. In order for contact switches to be opened or closed, the relay coil is energized by a source of DC. This is what you'll find in most single-channel 5V relay modules: a coil, two contacts, like "normally open" (NO) and "normally closed," and a power source (NC). This article gives

an overview of the 5V relay module and how it works. Before we talk about what the relay module is, we need to know what a relay is and how its pins work.

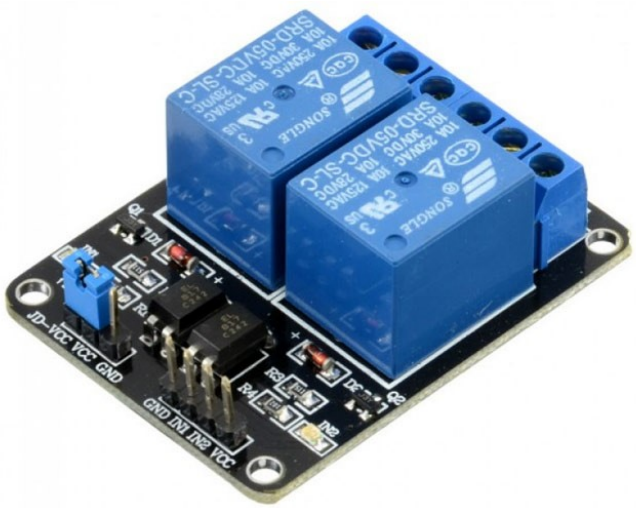


Figure 3.7: Dual Channel 5V Relay Module

The relay uses the electricity it gets from the power source to open or close switch contacts. Usually, this is done with a coil that magnetizes the switch contacts and pulls them together when the switch is turned on. When the coil isn't strong, a spring drives them both at the same time.

By using this system, there are two main advantages. The first one is that the current needed to activate the relay is less than the current needed to switch the relay contacts. As a bonus, there is no electrical connection between the contacts and the coil.

12V Submersible Pump:

The pump is a machine that moves water from a low level to a high (or) low-pressure area to a high-pressure area. People use pumps to move liquids with a lot of power. The energy from the liquid will be used to raise the pressure. It has become very popular because these pumps are mostly used on farms, so people like them a lot.

These pumps are placed in the water. Other types of water pumps, like the ones we talked about, have a wide range of types. Each type of pump has a different use. They can be used to pump water from wells and concrete water tanks on farms. When submersible

pumps are used as part of a water distribution system, there are both good and bad things about them.

The one used in this project is a 12V DC 1Amp submersible pump. It has a flow rate of 2.64 Gallons per minute. The temperature of the water can not be more than 40 Degree Celsius. It is small in size compared to the other submersible pump. The power is also sufficient to work enough for a small project like this.



Figure 3.8: 12V Submersible Pump

NodeMCU ESP 8266:

The NodeMCU ESP8266 development board comes with the ESP-12E module, which has the ESP8266 chip and a 32-bit LX106 RISC microprocessor. This microprocessor can run RTOS and has a clock frequency that can go from 80MHz to 160MHz. To store data and programms, the NodeMCU has 128KB RAM and 4MB of Flash memory, which can be used to store data or programmes. You can use it for projects that use IoT because it has a lot of power. It also has built-in Wi-Fi and Bluetooth and can go into "deep sleep mode." [14]

Micro USB and VIN pins can be used to power NodeMCU (External Supply Pin). It has a UART, SPI, and I2C interface.

ESP8266 can run on a voltage range of 3V to 3.6V. The board comes with an LDO voltage regulator to keep the voltage at 3.3V, which is what the ESP8266 can run on. Because ESP8266 can draw up to 80mA during RF transmissions, this should be enough power for it. On one side of the board, the regulator's output is also broken out. It's marked 3V3. This pin can be used to give power to other things. It is a small and perfect board to work with at IoT related project.

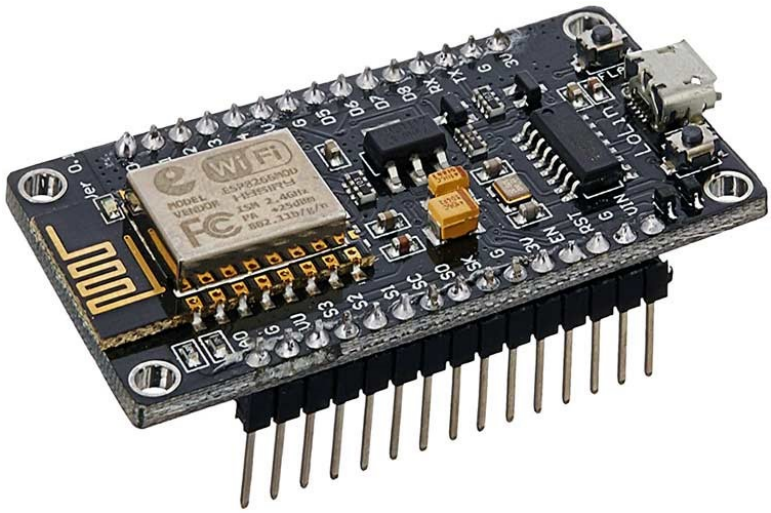


Figure 3.9: Controller Unit NodeMCU ESP8266

3.3. Implemented Model

The 2D modeling of the proposed prototype shown in Fig 3.10 the structure of an IoT based smart irrigation system. The proposed architecture is modular and gives and overview of how the various modules interact with each other.

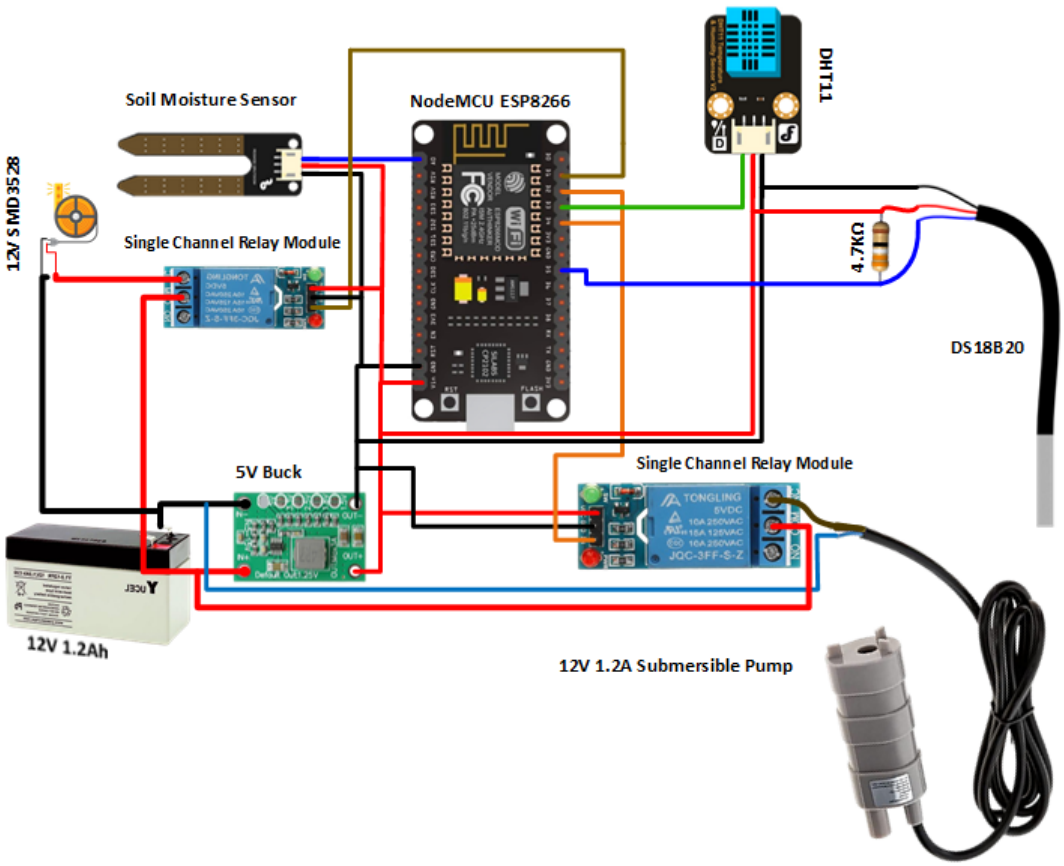


Figure 3.10: 2D design with proper architecture of the proposed model

The hardware modules are described as follows:

- **Sensors:** In the farm, three sensors of different model are used. One is to measure the surrounding temperature, moisture in the air and the other is to measure data from the soil itself. The sensors are set to measure the optimal value from the sources.
- **Microcontroller:** The microcontroller is an ESP module with built in Wi-Fi. The microcontroller receives data and compare the data with threshold value, depending on it controls the irrigation. The collected data transfers though Wi-Fi to the could Adafruit server to be stored and for further discretion.
- **Cloud Server:** Adafruit io is a free cloud-based server for the related ESP module so that it can be used to store and analyze the data. The data collected from the sensors are shown

in the dashboard with interfaces such as graph, button, pie chart, etc. These graphical representation makes the stored data easy to analyzed.

- **Interaction:** The data can be accessed through any web browser using internet. The web page can be load in mobile or pc both platforms.
- **Actuators:** The actuators directly involve with farm environment system. Based on the data collected from the microcontroller the instructions are provided to the actuator to control the devices such as motors, light, etc.

  In open irrigation systems, there is a main canal, as well as farm distribution canals of different levels. Each farm or corporation has its own main canals that bring water from a river, reservoir, well, or some other source to the farm distribution canals. The intrafirm distribution canals bring water to fields in the rotation or irrigation sectors of the farm. In some cases, the supply network doesn't have all the canals it needs to move goods [19]. The irrigation canals are arranged in a way that reduces both the cost of building and operating them, as well as the amount of water that can be delivered at the right time and in the right quantity. The canal efficiency ratio is the ratio of water discharge at the end of the canal to discharge at the beginning. Other goals are to use as much land as possible in the areas that are irrigated and to make the canals and structures there run smoothly. The main canal must have more water than the canals below it, and the higher-ranking canals must be higher than the lower-ranking canals so that the water moves by gravity. This is a very important part of how an irrigation network works.

Hardware Model (Physical):

The hardware model is the prototype that will be implemented in real life scenarios. The figure below shows the physical model.

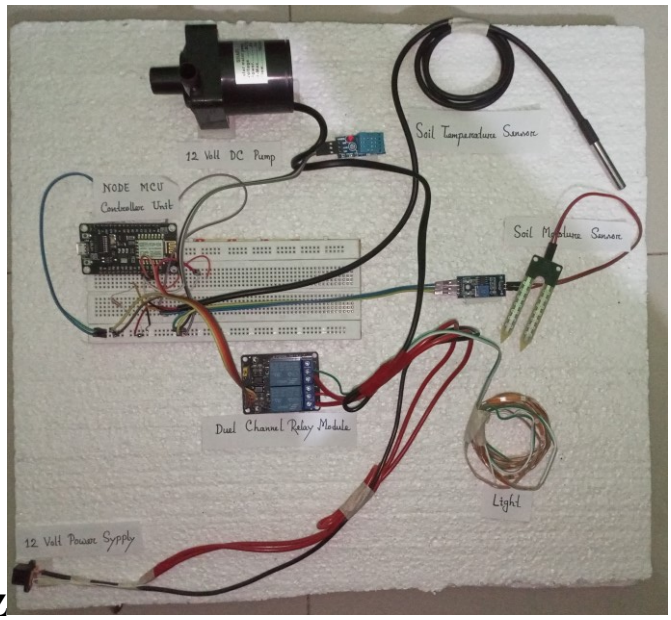
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Figure 3.11: Physical model of the prototype

3.4. Required Code

The MCU is coded using Arduino IDE, an open-source platform. A working access point has to be present near 100 feet of the controller. As built in Wi-Fi module is present at first Adafruit library has to be included in the code along with Temperature, Moisture and ESP module library.

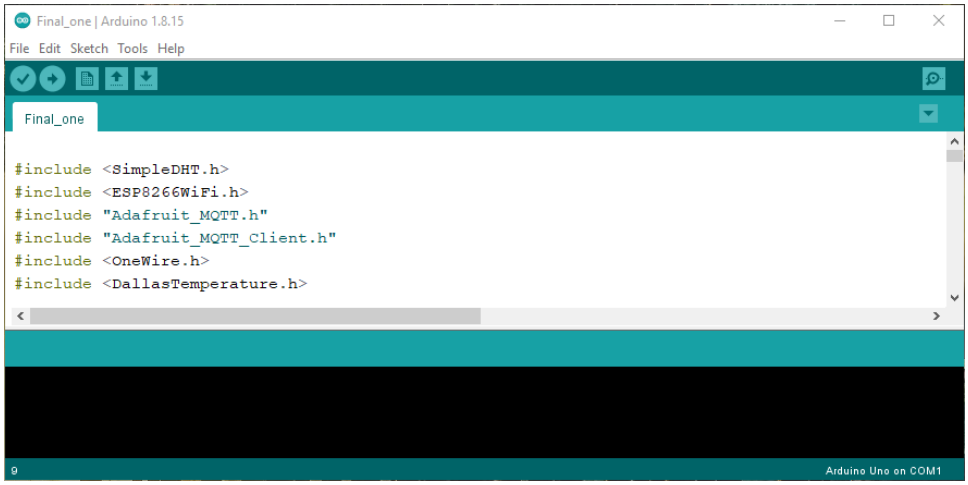


Figure 3.12: Calling the necessary library to the code

After calling the necessary function the io server is established using the 1883 port and a username and key. The user's name and key are found in the Adafruit server. The function used in the example above is very simple, so it won't be easy to see all of the benefits of functions right away. They don't have to write the same code over and over again in a sketch, which saves money and time. The same code is used over and over again. A function only needs to be changed once. The changes will be made every time the function is called in a sketch. The statements in a sketch that are used to do a certain thing would have to be found and changed if a function was not used. There are functions that can be used to break up a sketch into smaller parts. This makes the sketch more modular and easier to follow and understand. When you make a new sketch, you can use the same functions.

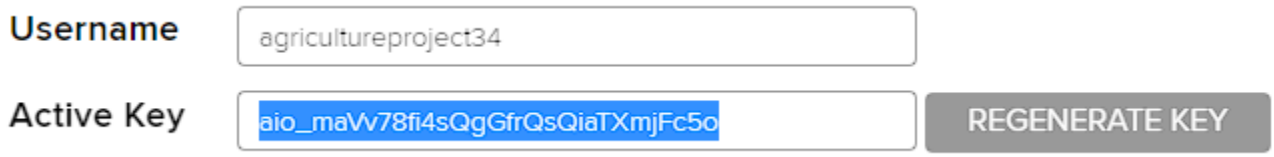


Figure 3.13: Adafruit user name and key



Figure 3.14: Adding the username & key into the code

The rest of the code is written according to the user needs. Adafruit dashboard looks like in the figure below. Electrodes in the ground send a current through the soil, and the soil's

resistance to the current tells how much water is in the soil. In this case, the soil will be able to hold more water, which means more current will pass through. When there isn't enough moisture in the soil, the sensor module gives off a high level of resistance, on the other hand. These outputs can be both digital and analogue with this sensor. There are two types of output: analogue and digital. Analogue output is easier to use and more accurate than digital output. Analog input pin: Because the ESP8266 microcontroller used in the Node MCU has an onboard A/D converter, Arduino can read and write binary numbers from 0 to 1023 that are being sent from the sensor to the analogue input pin. The more output there is, the less moisture there is.

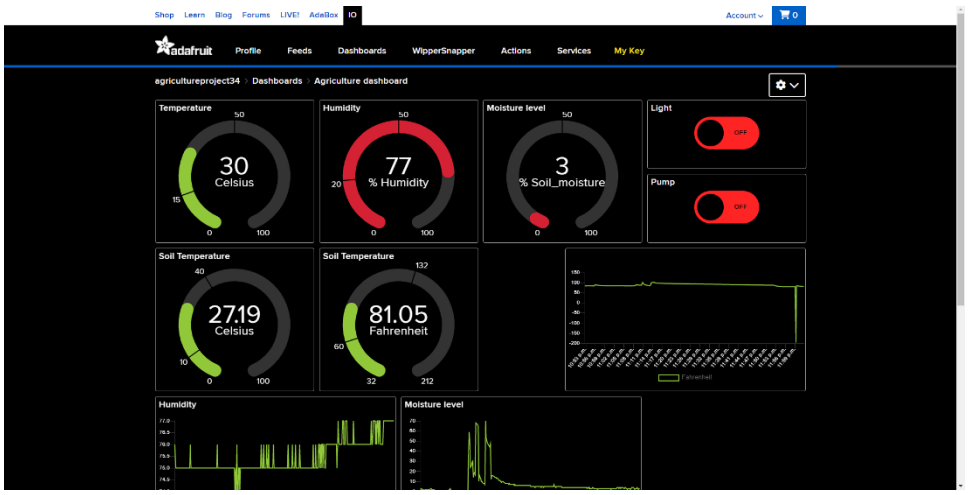


Figure 3.15: Dashboard of the Irrigation system

From the dashboard the live data is presented in graphical form. There are also two virtual buttons than is pressed when the user needs to turn ON the motor manually as well as the lights.

3.5. Establishing Connection

The components are connected to the microcontroller and are powered by microcontroller too. Each sensor module needs 3.3 to 5V each. Thus, both microcontroller and a separate 5V source is equivalent.

Soil Moisture Sensor:

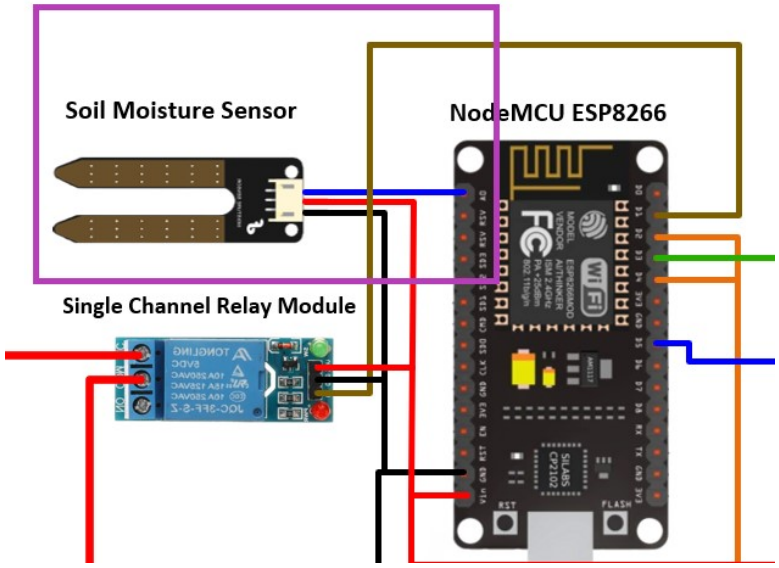


Figure 3.16: Soil Moisture Sensor connection

The soil moisture sensor can be found with or without the serial converter. The i2c is connected with one in the Analog port named A0 pin or ADC0. Analog to digital converter. The soil moisture is the only sensor connected to the analog pin. It provides analog value which is basically a resistance value. If the value is high then there is enough soil moisture. It is small and compact. It can be placed on every plant as it is cheap. In the figure a separate 5V is connected to it but in the microcontroller a 3.3V is also present which can run the sensor too.

Surrounding Temperature & Humidity:

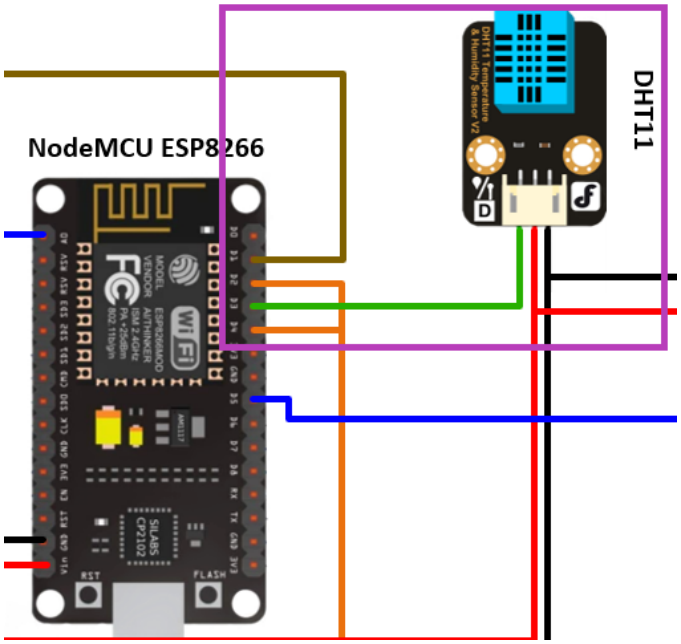


Figure 3.17: Temperature and Humidity sensor connection

The temperature and humidity sensor collects data from the surroundings of the crops. It measures the temperature from air thus it can be placed away from dirt and water. The data port is connected to the MCU D3 pin or GPIO0 channel. The resultant data is already been converted to digital signal. In the dash board the temperature is shown in Celsius and the Humidity is shown in percentage.

LED:

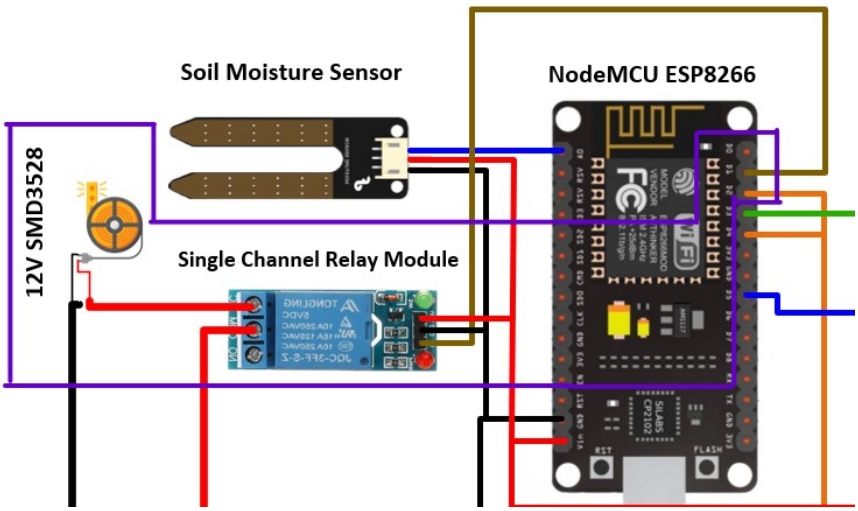


Figure 3.18: 12V LED connection

The LEDs are SMD and the strip is powered by 12V external sources. The sensors can be powered by 3.3V thus they were either connected to the microcontroller or a 5V source. But in this case the LED is connected tot a battery or a adapter which provides 12V. This LED power on/off is controlled via a single or dual channel relay module. The relay module is connected to the Arduino and powered by 5V DC. The LED positive terminal is connected to NC (Normally Close) port. This means if the relay is turned on The LED will illuminate otherwise it will be turned off always. The relay data port is connected to the D1 of the microcontroller or GPIO5 pin. The digital "1" & "0" is all need to turn on/off the LED. Normally the timer is set as to turn on the light when there is dark outside. It can be manually turned on via dashboard with a virtual button.

Soil Temperature:

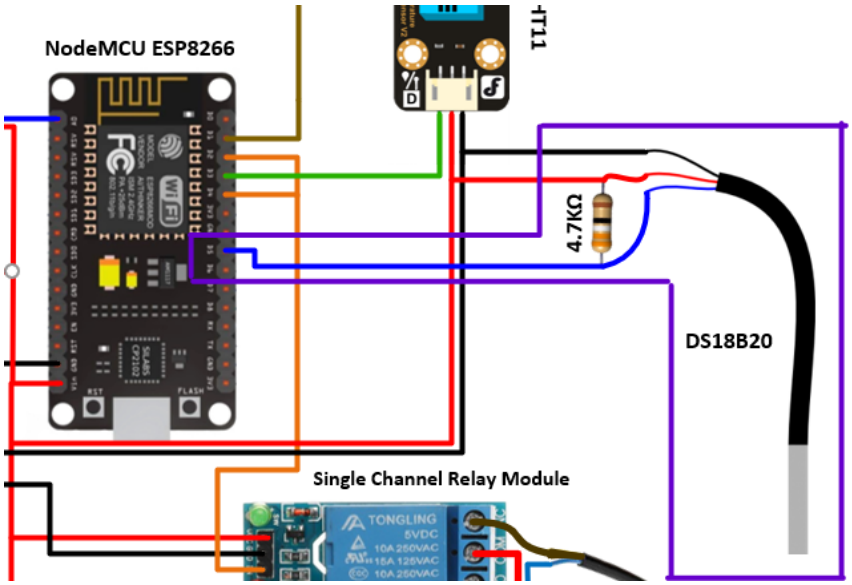


Figure 3.19: Soil Temperature sensor connection module

The temperature of the soil is also important as it depends on the irrigation. The temperature of the soil if increased, the reason is that the water level has decreased. To measure the temperature of the soil in this project DS18B20 was used. This sensor is protected by a cover which protects the semiconductor from water. So, it also works when the moister level is high. It is connected to the D5 pin or GPIO14 port. There is a 4.67KΩ

resistor added as the required voltage is lower. To make the only semiconductor of the sensor work, low voltage is enough. The output of the sensor is calculated in the microcontroller as Celsius and Fahrenheit.

Motor:

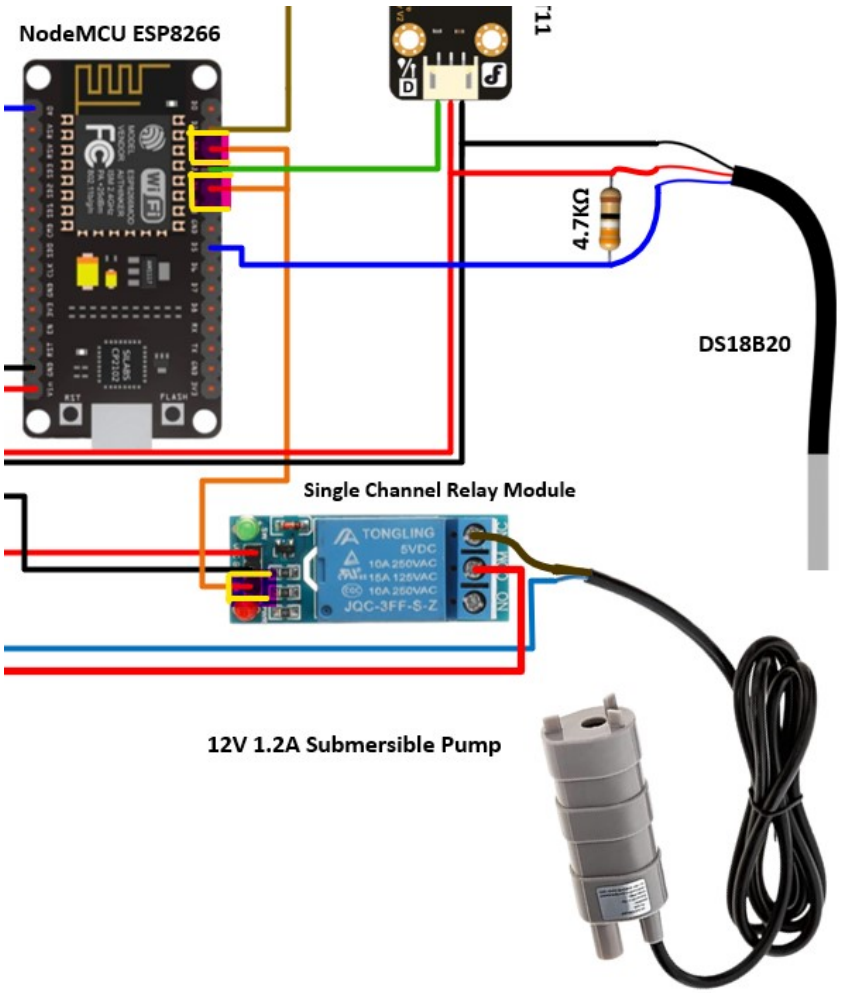


Figure 3.20: Submersible Motor Connection with MCU

A 12V motor is connected to the relay where positive terminal is connected to NC and the negative is to the power source or the battery. In the microcontroller the data pin is connected to both D2 and D4 pin or

GPIO4 & GPIO2. D2 pin works according to the instruction given in the code. It depends on the soil moisture level. If the level is <20% then the D2 will be positive and the motor will turn on. On the other hand, D4 is for manual override. It is controlled directly from

the Adafruit dashboard. The virtual slide switch if it is ON the D4 will be positive and the motor will run.

3.6. Summary

In this chapter, the overall implementation of the project has been shown step by step. The whole system contains three parts those are the data-collectors, the cloud data transfer, and the automation system using the relay. The system works perfectly. The light also turns on with the command. But due to the size of the sensor it was hard to detect the level of the water deep into the roots. The surrounding temperature was showing correctly. Soil temperature is also working as it is. Due to differentiating the value in Celsius and Fahrenheit, the irrigation will be easier as different crops and plants needs a certain temperature to grow.

Chapter 4

RESULTS ANALYSIS

4.1. Introduction

Many different devices can be automated and their data can be analyzed in real time thanks to the Internet of things, which is a new technology. Because of its ability to collect more data, the integration of the system and its accuracy have a big boost. It uses a lot of different sensors to get data. Through the use of Data science, it is possible to look at the data that has been collected. Use predictive and prescriptive analysis to get useful information out of data in data science, which is the way to do this It takes a quantitative approach to make sure that decisions and results are both correct and precise.

A proposed system uses the Internet of Things to get data from each field module about what is going on in the field (using sensors installed). This data is then sent to the cloud through the master router. When you use a cloud system, data is collected and merged together to make the on-field data set. This data set is then compared to other data sets in the cloud. Data Science concepts are used to figure out the best time for each field to be irrigated with water. There is a database where these values are kept. The MCU then sends these values to the digital pump and a relay through this database. The relay is told how much water to give to the field in the real world. This is how it works: The MCU works with the relay to turn them on and off so the fields get the right amount of water. The resultant data is stored and used for further improvement. It increases the motor lifespan as well as the water wastes [21].

4.2. Results Analysis

Smart systems use methods and models that can automate tasks related to the parameters being monitored and also find and fix problems that may arise from both inside and outside the system itself. Factors that could be inside the smart system include things like faulty hardware or inaccurate measurements, as well as how easy and efficient it is to meet the main goal of the system in an efficient and convenient way. An outside factor could be hardware or components being stolen or not having enough resources to be monitored or to meet the smart system's goal, so it doesn't work well. In this project, simple Arduino code was used to get a lot of work done quickly and to achieve the overall idea of automation. 12V dc is used to power the circuit, which has a forward voltage safety diode to keep it safe and a 4.7kΩ resistance to separate it from the 12V. The voltage controller makes sure that the 5V dc supply comes out exactly the way you want it to. The Microcontroller, the sequential port, and the IR transmitters and sensors all get 5V dc power from the same source. Most strange of all, these gadgets should be found in a specific place. Devices in a Network need to have unique IP addresses in order to be shown in a unique way. The majority of IoT gadgets use IPv6 to plan their routes. It doesn't matter if these devices have IP addresses that are fixed or that cover a whole network. They all have IP addresses that are v6. One of a kind IP makes IoT devices easy to find in the web as a free hub. This is the most important thing to know about IoT. As a rule, the electromagnet is used to move an armature that can move a lot more force with a small amount of force, like from a small dashboard switch or a low-power electronic circuit. This is called a transfer. With 5 volts and 50 milliamps, you could make the electromagnet work. You could also use 120V AC and 2 milliamps for the armature (240 watts). They happen all the time when there is an electronic control that turns on

something, such as an engine or lights. Besides, they are also very common in cars, where the 12V battery voltage means that pretty much everything needs a lot of power to work. Manufacturers have started putting transfer boards into the circuit box of later cars to make it easier to support them [1].

4.2.1. Hardware Result

In the hardware part the sensors and the actuator both worked as instructed. When there was no manual intervention the prototype measured the soil moisture, temperature, surrounding temperature, and humidity. After sensing the moisture of the soil, the microcontroller does not take action until it crosses the threshold value. When the value is less than 20% of the standard value the actuator turns on the motor. The motor supplies the water until it crosses 21%. If it crosses the value the motor will turn off by itself.

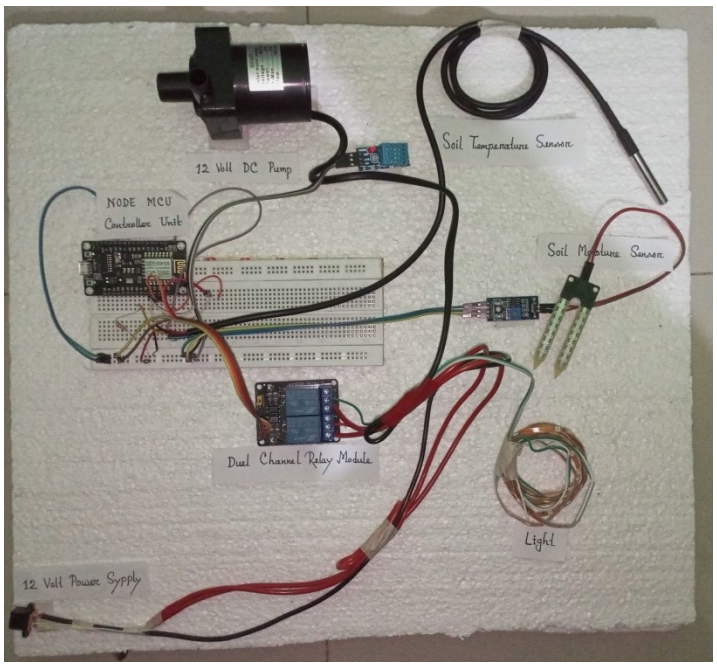


Figure 4.1: Hardware Automated Action

The sensor used in this project are fragile and can be sensitive. If there is any malfunction with the sensor or any related module. The user can turn on/off the irrigation by himself using io dashboard. The goal of this research project was to show how new agricultural

monitoring systems have been developed that solve problems with previous systems, such as cost, coverage, and outdoor usability. A simple, low-cost, precision agriculture monitoring system that can be used outside, is self-powered to cut down on the need for long power lines, and has extra features that make farming easier and make more money was made.

It's hard for small farmers and marginal farmers (who have land between 4 and 6 hectares) in semi-arid areas to use power irrigation. Seasonal precipitation is the main thing that keeps them going most of the time. The data acquisition unit, which had sensors and a microcontroller, was able to get information about things like temperature, humidity, light intensity, and soil moisture content. IoT technology was used to send the information from the sensors wirelessly to the cloud server, where it could be seen by people who had an internet-enabled device. These field managers can use this information to distribute resources, make predictions about how crops will grow, and make farming equipment easier to use. The virtual switch is remotely controlled and it will only take one command. At the time of night when the insect harm the crops or plants, a LED is turn on to attract the insects away from the plant.

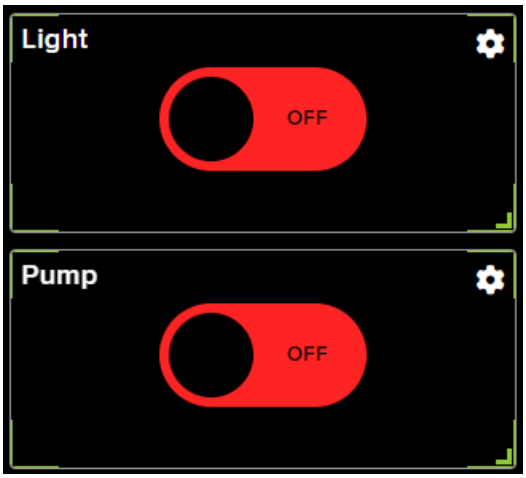


Figure 4.2: Manual Turn ON/OFF Motor & LED

4.2.2. Cloud Data Analysis

The prototype collects the data and transfer the data through the NodeMCU using Wi-Fi technology. The data is sent to the cloud server. Using the interfaces of the server to understand the situation, graphical analysis is mandatory. In the server all the data are shown separately and a graph shows the average line of the value for a long period of time. Communication is done through the cloud. Each Arduino has an ESP8266 Wi-Fi Module that connects to the cloud and sends the solution to a database. There is a Web Service (WS) instead of a direct connection because the database isn't safe. The WS puts sensor data into the database. The Wi-Fi module sends two fields: an ID and the value of the sensor. The ID is made by taking the IP address of the Wi-Fi module and a unique number for each sensor type. This value is important because it tells you where the information came from, which makes it more useful. Interpretation takes place during the processing of the data. When irrigation needs to be done, a WS is changed to show that. A Wi-Fi module is used to control the electronic valve in the irrigation system. An Arduino is used to control the valve and it is linked to the module. A cloud service can't send an order to your Wi-Fi Module because it doesn't have a public IP address. This means it can't be identified from the cloud. It's like a solution: The Wi-Fi module always asks the web service for help. When the WS adds a power-on time, the valve opens. Each Wi-Fi module has a fixed IP address and connects to a gateway that lets you get to the Internet. The database information is used to make the visualisation of the data so that you can keep an eye on the data. In this case study, a web application has been used to show the data. However, there are other ways to show the data.

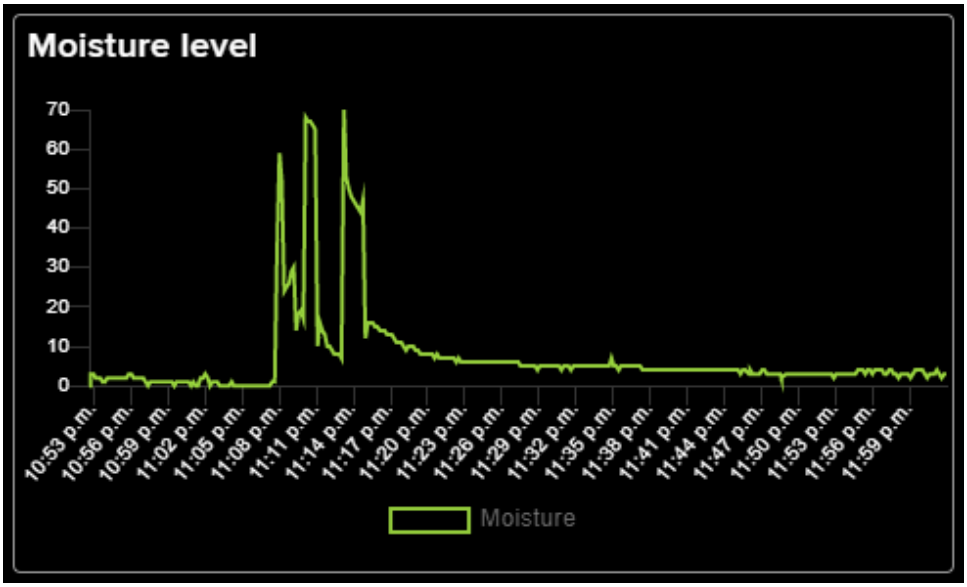


Figure 4.3: Historical data of the Soil Moisture level

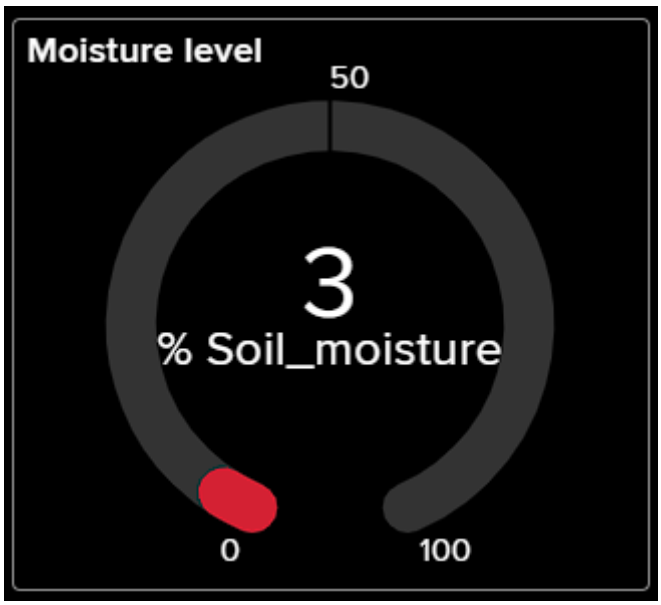


Figure 4.4: Live/last updated Soil Moisture level

Using the virtual key to switch on/off the LED is also shown in the figure below. They turn RED when the command is not recognized. They turn GREEN as soon as the command is accepted and in the prototype the motor starts running due to the relay. This leads to more efficient agricultural operations and use of resources, less running costs and work, and more productive crops. The WSN system that was made in this study has a better range of monitoring, and the weather-resistant, solar-powered data acquisition unit

was found to be good for long outdoor use. Furthermore, the monitoring system test found out how accurate the data acquisition unit was. The automation of the control system through monitoring of environmental parameters was found to be reliable at keeping the small-scale greenhouse at the right temperature and humidity for the plants to grow at their best. So, an IOT module can be used to monitor things like moisture, humidity, temperature, a leaf's growth, water-spraying with pesticides through a motor-pump, and so on. This mechanism reduces the number of people and the amount of manual labour. This was done with an MCU, a soil moisture sensor, a humidity and temperature sensor, and an IoT module.

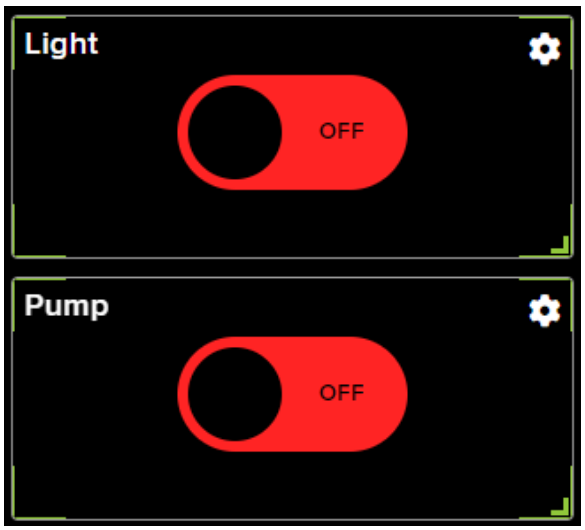


Figure 4.5: The Virtual Control Key

In the Feed section of the cloud server any history up to Two years can be viewed and downloaded. Automatic response graph is created to better understand the situation. Every data has a range which if crossed a RED sign appears. It indicates the instruction to turn on the motor.

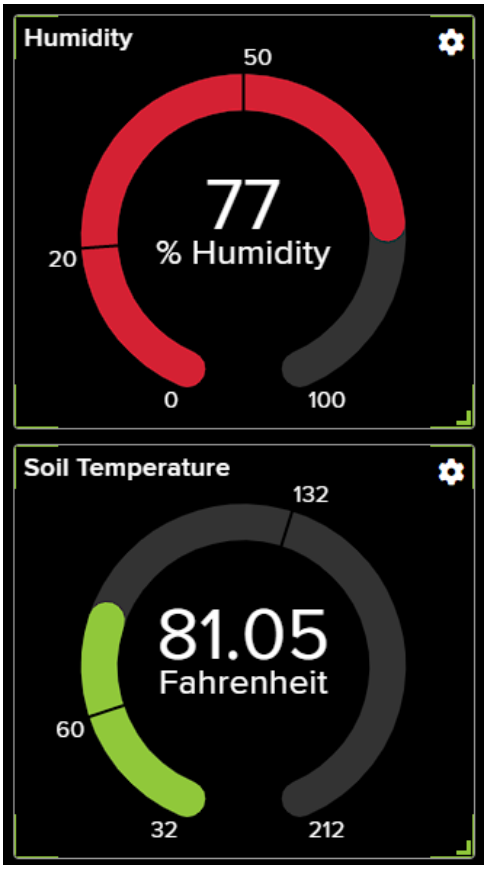


Figure 4.6: Within Threshold value and above Threshold value

The RED bar indicates that it has exceeded the threshold level thus the motor should be turned ON. Among all the sensors only with the soil moisture sensor the motor is connected. This is due to the nature of the soil. If the motor activities were controlled by all of the sensors, then a conflict in the could have happened. For all the other sensors a threshold value is given and depending on the states the user has to manually turn on the virtual key to start actuator.

4.3. Comparison of Results

The data collected from both hardware and cloud shows the compatibility of implementing IoT in farming. Experiment was performed to have the best result obtained from the prototype. The data is stored in the cloud server and was used to determine the weather of the place of cultivation.

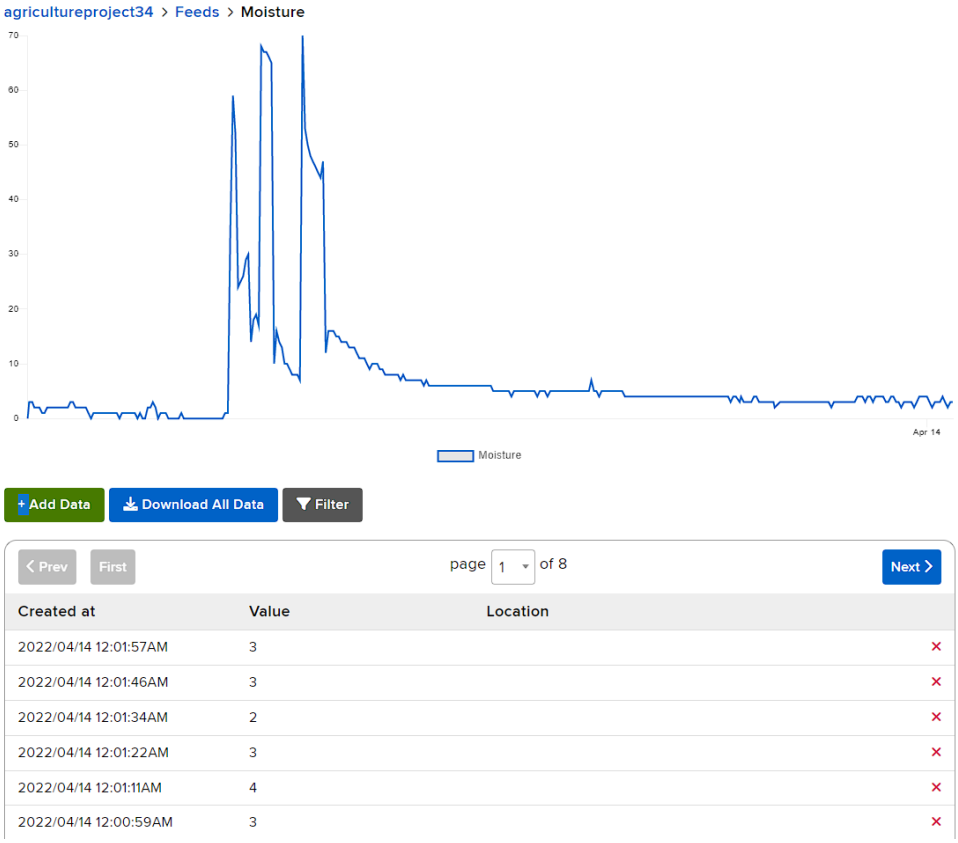


Figure 4.7: Historical data with line graph

The data acquisition system has the ability to accurately measure the ambient conditions on a farm field. In order to do an assessment of a field, three sensors were used. These sensors, which measure air temperature and humidity, as well as light intensity and soil moisture content, were used to measure three environmental factors, such as temperature, humidity. The system is also very flexible, which means that extra sensors, such as a pH sensor to measure soil acidity, a UV sensor to measure ultraviolet light intensity, carbon dioxide and oxygen sensors to monitor the air, a rain sensor to detect rainy weather, and a water level sensor to detect flooding in the field, can be added to the system based on the user's needs. Use a microcontroller, which is a computer that has a lot of built-in functions. The microcontroller reads, processes, and sends data to the cloud server wirelessly over a network.

4.4. Summary

This is how the cloud server worked: It took live data from all agriculture fields and stored it there. People who want to get to the data stored in the cloud server can use a browser on a computer with an internet connection or a mobile app to get to it. Use this field data to help field managers direct resources to where they're needed the most, which leads to more efficient agriculture and sensor-based irrigation operations, less pollution, lower costs, and more profit. This is how it works: Another way to use the field information is to use it as input data to run sensor-based irrigation on the field. The irrigation monitoring system used in this study is cost-effective, multifunctional, and can be moved easily to any agricultural field thanks to the "plug-and-play" method, which makes it easy to move to any field. This system is also powered by solar energy, which makes each data actuation unit wireless and portable. This means that there is no need for cabling for power and data transmission, which means that the costs of installing, maintaining, and moving the system will be lower.

Chapter 5

CONCLUSION

5.1. Summary of Findings

A system to keep an eye on how much moisture is in the soil was made, and the project gave people a chance to look at the systems that were already in place and see what they had to offer. The proposed system can be used to turn on and off the water sprinkler based on soil moisture levels, which is one of the most time-consuming tasks in farming. Agriculture is one of the things that uses the most water. The system uses information from soil moisture sensors to water the soil. This helps to avoid over or under watering the soil, which can damage crops. The owner of the farm can keep an eye on the process through a website. Through this project, it can be found that there can be a lot of growth in farming with the help of IOT and automation. Thus, the system may be able to help solve some of the problems with the current manual and time-consuming process of irrigation by making the best use of water resources. This paper talks about how to make a Cloud IOT system that can keep an eye on a greenhouse. In the last few years, there have been a lot of new ways to grow food even in cities. In this case, the Cloud IOT makes farming more efficient. There will be a big change in how we live our lives and what information is kept about us when the Internet of Things comes out. People can use this cloud computing as long as their computer is connected to the Internet. They can use it any time and any place. These monitoring systems use sensors, GSM, and the cloud to keep track of different things in the greenhouse. The new system can be profitable because it will make the most of the resources in the greenhouse. The whole module is cheap and runs on very little power, so it's easy for everyone to get their hands on. This

paper gives a general idea of the research done on greenhouses, but there is still a lot more that can be done technologically.

5.2. Novelty of the work

Use of agriculture networking technology is important because it shows how far agriculture has come and how far it will go in the future. It is also a sign of how far agriculture has come. When you use the internet of things to make sure that water is used efficiently and that agricultural production is safe and efficient, it has a big impact on how much water is used and how well and how long it lasts. The system shown in this document is already in use, and it meets its goal of taking data from different sensors and figuring out how much water a certain type of crop needs. The communication between the Arduino module and the cloud environment met all of the rules.

The goal of this research project was to show how new agricultural monitoring systems have been developed that solve problems with previous systems, such as cost, coverage, and outdoor usability. A simple, low-cost, precision agriculture monitoring system that can be used outside, is self-powered to cut down on the need for long power lines, and has extra features that make farming easier and make more money was made.

5.3. Proposed Professional Engineering Solution

The idea for an automated irrigation system has been shown. Here, it is thought that the field has several parts where different crops can be grown. Each part of the field has a sensor module, which is a group of sensors that measure things like soil moisture and temperature in that part of the field. It then goes to the cloud system through a master router to form a dataset. Another dataset comes from previous research, and it includes information about the stage of a crop and how much water it needs at that stage. From

time to time, more information comes from the meteorological center. A process called "data science" is then used to analyses all of the datasets, putting them through the same thing. This data is then sent to Arduino Uno through the master router, which tells the digital pump how much water is needed in the field. When releasing water, real-time comparisons of the field conditions are made in order to decide whether or not to keep going. When the water needs are met, the automated valves are turned off, and the digital pump is turned off as well. Thus, this method is a good fit for Bangladesh's agricultural needs because it meets the needs of today's irrigation in an efficient way.

5.4. Limitations of the Work & Future Scopes

In agriculture, pesticides and fertilizers can be used for different things. If these are used too much, they can harm the soil, crops and the environment. Thus, controlled amounts of these could be used in the right way. There could also be more work done in the field of how to manage nutrients in the soil, as well. Moisture and temperature aren't the only things that can make a system more efficient. Other factors can also be taken into account. Farmers can be given information about the best crop combinations for multiple cropping scenarios so that they can keep costs down and get more food out of their land.

In order to make the system more efficient and effective, the following ideas can be taken into account.

The farmer can be given the ability to control the water pump so that he can start and stop the irrigation process without having to be at the farm to do so.

Farmer: The farmer can stop the growth of his crops, or bad weather could cause the crops to get hurt. Farmer may need to stop the system from afar. People who work in farming can use the idea of using IOT for irrigation to help with things like fire detection

and controlling the temperature of the land. This would cut down on the amount of work humans have to do in farming.

5.5. Conclusion

It is being watched and controlled by an io at the client's end. The ESP8266 is the device at the field end that gets messages from the company and controls it, and it will do what the message says. Once the messages are sent, they will be sent to the network quickly, and so they will be sent to the people (client end). People who make IoT projects should use an ESP8266, which is the best thing to use. Because it is small, lightweight, easily programmable, and can be easily installed. It also has enough GPIO pins to use them. Low-tech hardware is used to build the framework of an agriculture water system. The circuit has two sensors that work well together to get the correct data to the framework. These sensors are the temperature and moisture of the soil. Each of the three Nodes has two sensors and microcontrollers that work well with the sensors and microcontrollers of the other Nodes. All of the opinions and tests show that the proposal is a good way to deal with activities and water system problems. Executing a framework like this in the field can help improve the field of harvests and general creation.

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