LOW COST IOT SYSTEM FOR MONITORING THE MOISTURE LEVEL ON VEGETABLE FARMS IN TONO IN THE UPPER EAST REGION.

A PROJECT REPORT

Submitted by

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DECLARATION

I hereby declare that the work presented is my best of knowledge, except for reference to the work of others which have been duly acknowledged and that no part of the work has been presented for another degree in this university or elsewhere.

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FMS/0086/17

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Signature Date

CERTIFICATION

I certified that this project report **"A LOW COST IOT SYSTEM FOR MONITORING THE MOISTURE LEVEL ON VEGETABLE FARMS IN TONO IN THE UPPER EAST REGION"** is the bona fide work of **"LAKYIERE ALICE BAGYIEREYELE"** who carried out the project work under my supervision and which has been approved as meeting the requirements of the Department of Computer Science. .

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DEDICATION

I dedicated this project work to Almighty God for its successful completion. And also to my lovely parents, Mr and Mrs Lakyiere, my adorable siblings for all their support.

ABSTRACT

The one cycle rainfall system and the dry natural nature of the upper east region has resulted in the importances of a smart irrigation system for plant farming. This project centers its importance on an automated irrigation system with the use of Arduino microcontroller,soil moisture sensor and water flow management. The humidity and temperature sensor is connected to the arduino board which sends analog inputs to the Arduino board over a wireless network using WiFi. Based on digital values recorded from the board by an android app application which serves as the server web for reading display and decision making. At a threshold value set to compare to sensord reading, the water pump is turned ON when conditions are not meant and OFF when the conditions are meant. This irrigation system will reduce the hardship of farmers, save time and enhance accuracy and effectiveness at relatively minimal cost.

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LIST OF ABBREVIATIONS

GDP	Good Documentation Practices
FAO	Food and Agriculture Organisation
MOFA	Ministry of Food and Agriculture
IoT	Internet of Things
IT	Information Technology
GPS	Global Positioning System
RFID	Radio-Frequency Identification
SaaS	Software as a Service
PaaS	Platform as a Service
IaaS	Infrastructure as a Service
IDEs	Integrated Development Environments
UAV	Unmanned Aerial Vehicles
GIS	Ghana Immigration Service
SDI	Subsurface Drip Irrigation
GSM	Global System for Mobile

DTMF	Dual Tone Multi Frequency
SMS	Short Message Service
GPRS	General Packet Radio Service
WSU	Wireless Sensor Unit
WIU	Wireless Information Unit
WSN	Wireless Sensor Network
pH	Potential Hydrogen
BSD	Berkeley Software Distribution
DHT	Digital High Technology
USB	Universal Serial Bus
MCU	Microcontroller Unit
VCC	Voltage Common Collector
GND	Ground
DC	Direct Current
WiFi	Wireless Fidelity
PCB	Printed Circuit Board
LED	Light Emitting Diode

CHAPTER ONE

1.1 INTRODUCTION

Ghana is mainly an agricultural country. Agriculture is the most important occupation for most of the Ghanian families. In Ghana, Agriculture contributes 54% of Ghana’s GDP, and accounts for over 40% of export earnings(FAO,2018) with sixty - eight percent of Ghana's population. Agriculture provides 90% of the country's food needs. In 2019, 33.5% of the labor force in Ghana was absorbed by the agriculture sector. Agriculture is the second largest employer in the economy but the smallest sector in comparison to services and industry. Ghana aids other African countries with agricultural products such as Cocoa Beans, Rice, Coffee, Maize, Shea nuts, Cashew nuts, Fruits (Banana, Pineapple and Oranges) and many others. The ecological and climate advantages in Ghana makes it an attractive investment in agriculture.

Tono in Kassena-Nankana District of Upper East Region, Northern Ghana has made a count in Ghana's agriculture and the economy as a whole. Agriculture remains the dominant in the economic activities employing 80% of the population. The region is known for its major crop commodities in Millet, Guinea-corn, Maize, Groundnut, Beans, Sorghum, dry season tomatoes and onions. It has been ranked 9th position due to its largely improvement in the performance of agriculture (MOFA, 2010). Agriculture is highly challenged by the one cycle rainfall between a 5 to 6 months growing season which is between April/May and September/October and 6 to 7 long dry seasons from October to April. The region records the highest Temperature and relative humidity at 45 degrees and 80% respectively which contributes to the stagnant growth of plants (MOFA, 2010).

With the one cycle raining season, high records readings of Temperature and relative humidity and other relative soil insufficiency, which has standyly reduced production rate in agriculture over the years. There is a need to employ an automated water irrigation system for proper plant growth. Water aids the transpiration process of the plant, maintaining the absorption of nutrients from the soil is an essential process and regulates the temperature and cools the plant. Real Time temperature and humidity monitoring of soil can correctly guide agricultural production and improve crop yield. Water regulation, temperature and humidity plays vital roles in the speedy growth and improved crop yield. The above calls for an advanced technology to cater for over irrigation and under irrigation. An occurrence of over irrigation is caused by bad distribution of water and chemicals which leads to water pollution. Upper irrigation leads to the increase of soil salinity which builds up toxic salts on the soil surface in regions with high evaporation. To surcharge these problems and to minimize the use of manpower, a smart irrigation system has been utilized. An irrigation process is useful to reduce water use for agricultural crops which is a much required process .

The full notion of the automated water irrigation system is a typical use of the traditional techniques of sprinkler or surface irrigation which requires half of water sources. The project employs the study of Internet of Things (IoT). The IoT connects parameters to the internet for communication and with the sensing devices with suitable protocols and exchanging data with each other by using wireless sensor networks. The functionality of the project is brought to reality with the recorded parameters from the temperature, humidity and water sensors as analog values and converted to digital values by the arduino microcontroller to the computer programmed by a software programme (simplified C++). The web server displays reading for decision making by the user. Based on a set threshold value, the water pump is regulated ON/OFF if conditions are satisfied.

1.2 PROBLEM STATEMENT

Traditional irrigation system gives little attention to water saving techniques. Plants irrigation is an essential process which requires farmers' attention and participation. It is usually a time-consuming activity which requires a large amount of human resources since all steps are executed by humans. It is a doubtful moment for farmers to know exactly the time to perform an irrigation activity and the exact quantity of water to apply for excellent soil condition in a session of irrigation activity. Also, It is the farmers' worry when he is far away from home to properly irrigate plants.These problems can be appropriately rectified if an automated type of plant irrigation system is used. This project therefore seeks to use an automated IoT irrigation system to automate the irrigation system for farmers in Tono in the Upper East Region.

1.3 JUSTIFICATION OF STUDY

i. The framework will robotize the way toward checking soil conditions for the plants just as redressing them in case need be.
ii. The framework will convey activities and occasions to the client through the android application, accordingly wiping out the need for the client's actual presence.
iii. The framework will reduce work expenses.

iv. The framework will advance conditions for plant development along these lines expanding creation.
v. The framework will cut on wastage of water. The sensors will assist with controlling the measure of water needed to water the plants.

1.4 OBJECTIVES OF THE STUDY

1.4.1 General Objective

The general objective of the project is to develop a prototype device for Automated Irrigation System to deal with systematic watering activities, whence retain the soil on good moisture and display and update data conditions to the user.

1.4.2 Specific Objectives

The automated irrigation system aims at saving energy and resources, so that it can be utilized in a proper way and It is time saving, the human error elimination in adjusting available soil moisture. The following are the objectives of the project:

i. To design, build and test an automated irrigation system which will be economical, efficient and effort reducing for the farmer.
ii. To detect water level and manage the water supply for proper cultivation of plants.
iii. To enable farmers to smear the right amount of water at the right time by automating farm or nursery irrigation.

iv. To implement a functional IoT system with the combination of soil moisture sensor, temperature and humidity sensor and solenoid valve to properly irrigate plants with enough water.

1.5 EXPECTED OUTCOME AND IMPACT

This project places much focus on helping the people living in and around Tono in the Upper East region. The automated system aims at releasing stress of farmers on their farms as it is automatically controlled from everywhere in the world. It will improve the economic status of farmers as it reduces the intake of laborers on the farm. This automated system enriches and maintains soil nutrient balance since over irrigation and under irrigation is properly controlled. Finally, this project give the farmer complete control over the farm

1.6 SCOPE OF THE STUDY

The scope of this project is to automatically monitor the soil moisture, temperature and humidity parameters. Its scope is to pump water through water pipes for irrigation over a threshold value and conditions set by the user.

1.7 LIMITATIONS

This application centers its concentration on proper irrigation of plants and is accessible by only the people of Tono and its surroundings.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Automated irrigation systems are estimated on a larger scale to have averagely decreased the amount of water usage by 73% compared to the standard watering systems. Just as every sector has benefited from the impact of technology, so has agriculture. Information Technology (IT) is highly demanded by farmers. IT has changed farmers' way of managing their crops and livestocks. The E-Agriculture Programme covers models of improving the communication and learning process in the agricultural value chain and it is here to stay. There is a dramatic change in farming processes and food production.

2. 2 TECHNOLOGIES IN AGRICULTURE

As predicted by FAO that by 2050, there will be 9.6 billion people on our planet and therefore requires a 70% in agricultural growth, regardless of suitable land and fresh water scarcity (FAO. 2009). It is every farmer's ideal position to locally harness technology with the aim of reducing water consumption, improving crop yield and increasing profits.

Agricultural Technology is very different from how farms and agricultural operations were operated decades ago. Most technological advancements include sensors, equipment, machinery, and information technology. Today, agriculture uses advanced technologies such as robots, temperature and humidity sensors, aerial imaging and GPS technology. These advanced modern equipment have enriched the breeding farm and the robot system Business Model. These advanced equipment, precise agricultural and robotic systems enable the businesses to make greater profits, more efficient, safer and more environmentally friendly.

2.2.1 IMPORTANCES OF AGRICULTURAL TECHNOLOGY

Farmers are greatly assisted as they no longer have to apply water, fertilizer and other pesticides uniformly across the entire field. Instead, they can automatically apply minimum quantities of resources to plants on target. Some benefits include:

i. Higher crop productivity
ii. The use of water, fertilizer and pesticides decreased
iii. Reduction of impart on natural ecosystem
iv. Enrichment of soil nutrients
v. Ensure increase in Workers safety

In addition, robotic technologies are deployed in creative and innovative applications in agriculture. It allows more reliable control and monitoring of resources, such as air and water quality and other soil parameters.. It also offers manufacturers more control over plant and animal production, processing, distribution and storage, which results into:

i. Greater efficiencies and lower prices
ii. Environmental and ecological impact reduction
iii. safer foods and Safer growing conditions

2.2.2 TOP TECHNOLOGIES WHICH AIDS AGRICULTURE

Agricultural Technology is widely controlled worldwide by the following technologies: Cloud Computing for Farm Management, Big Data, Analytics, and Smart Farming, RFID and Security Technologies, Mobile Technology of which each is briefly explanted and their impact on agriculture.

(a) CLOUD COMPUTING FOR FARM MANAGEMENT

Cloud Computing is defined as an information technology paradigm that allows users to access a shared collection of configurable system resources on the Internet. It is an emerging technology today as a commercial infrastructure with the objective of eliminating expensive computing hardware, software, Information technology, staff, infrastructure, and resources. It is a network-based environment which concentrates on computational information and serves as a data bank. Cloud Computing plays roles in eliminating farmer's limitations to access technical knowledge & resources in agriculture. It serves as a promoter to agriculture product circulation and services in wider fields. It manages all related data to land, location, area, soil and land characteristics through centralized decision support systems.

Cloud computing offers three different service models which uniquely satisfy a set of business requirements. These models are Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS).

Software as a Service (SaaS) Model : This model delivery services gives end users direct access to the software application services over network on an on-demand basis without the company's management.

Platform as a Service (PaaS) Model : It is a model which grants users access to a cloud based environment where users can build and deliver applications without necessarily installing and working with IDEs (integrated Development Environments). PaaS providers offer applications such as Microsoft Azure (also IaaS), Google App Engine, and Apache Stratos.

Infrastructure as a Service (IaaS) Model :IaaS model offers to users a standardized way of acquiring computing capabilities (storage facilities, networks, processing power, and virtual private servers) on demand and over the web. Users are charged under a “pay as you go” model, where users are billed on certain conditions such as the hardware storage used or the consumption rate of processing power over a timespan.

(b) BIG DATA, ANALYTICS, AND SMART FARMING

Big data is a field that deals with large and complex data sets both structured and unstructured that are difficult to handle with comparasism to the traditional data-processing application software. The act of retrieving , accessing and storing complex data for analytical purposes has been in existence for a long time but the concept of big data gained the name when Doug Laney, an industrial analyst in the early 2000s mainstreamed the definition of big data as the three V’s.

Volume : It is an accessible storage area with a single file system where organisations retrieve data from. Data sources include business transactions , smart (IoT) devices, videos, social media and more.

Velocity : The development of information and its amazing benefits have changed the way we view information. It was a time when we did not realize the importance of information in the

Collaborate world, but with the change of handling data, we have come to appreciate its existence and rely on it daily. Velocity measures the flow of data.

Variety : Data is available in all forms, from structured data in traditional databases to unstructured text files, e-mail, video, audio, data, inventory data and financial transactions.

THE OPPORTUNITIES OF BIG DATA ON AGRICULTURE

i. **Massive increase in agricultural productivity.** It can be testified that big data analytics has already yielded great results in agriculture with improvement in the weather forecasting and crop yield.

ii. **Improvement in Farming operations.** Smart systems and other technologies have contributed to reduced consumption of resources like water and electricity.

iii. **Attract greater investments in AgriTech.** One of the fastest growing technological advancements reshaping Agritech is Big data. The achievement of big data in smart farming ratifies investing in technologies like sensors and cloud computing.

(c). SMART FARMING

Present day technologies such as sensors (water, light, soil, humidity and temperature management), software, conductivity, location, robotics, data analytics have advanced agriculture to an attractive investment.

Smart Farming is an emerging concept in agriculture that refers to managing farms with technologies like IoT, drones, robotics and AI on our farms with the ultimate goal of increasing the quantity and quality of products while optimizing the human labor required with modern information and communication Technology.

SMART FARMING CYCLE ON OUR FARMS

The concept of IoT is the data drawn from things (T) and transmitted over the internet (I). For the farm process optimizations, smart devices installed on a farm collect and process data in a recursive cycle that activates the farmer’s reaction to emerging issues and changes in ambient conditions. Smart farming follows a cycle below:

i. Observation : Sensors installed over the farm record, process and transmit data about sil, air, moisture, humidity, temperature and light.

ii. Diagnostics : It is a stage where recorded values are fed to a cloud-hosted IoT platform with predefined rules and models to establish some predictions and identify any necessity.

iii. Decision : Based on problems from the previous analysis, the user or a machine learning driven system decides on necessary advancement to predicted problems.

iv. Action : from the previous step, deduced solutions are being implemented such as enriching soil nutrient, checking over and under irrigation and many others and the whole cycle gets to start again.

APPLICATION OF SMART FARMING

i. Precision Farming : Traditional farming concentrates on acres of farms, making decisions based on historical records or experiences. These decisions could be centered on irrigation, pesticides, fertilizer and harvesting. With smart farming and precision farming, they employ sensors , GPS, data analytics and mapping to provide accurate results and real insight to explicit decision making and investment for greater earnings. Smart agriculture visualizes visibility, control and insight concerning the farm which translates into improved decision making, time management and other practical plant application such as irrigation, fertilizer and many others yielding in healthier crops, high crop yields and resources conservation. Precision farming goals at higher revenues, reduced cost and less work.

ii. Agriculture Drones : One of the most encouraging advancement in agritech is the use of agricultural drones in smart farming. Agricultural drones are known as Unmanned Aerial Vehicles (UAV) used for crop health assessment, irrigation, crop monitoring, crop spraying, planting, and soil and field analysis. Based on strategies and planning on real time data collection. Some drones operate on deforestation by planting trees in deforested areas. And a sense fly agriculture drones uses multispectral image analysis to evaluate crop health and the costs involved. Records from the drone gives farmers insight in decision making concerning plant counting and prediction, plant health measurement, drainage mapping, chlorophyll measurement, under irrigation and over irrigation, and many others. Drones have benefited farmers in integrated GIS mapping, crop health imaging, ease to use,time saving and the potential of yield increment.

iii. Greenhouse Automation : Greenhouse environment is a manual intervention by farmers to control environmental parameters. The use of IoT sensors which is designed intelligently to give accurate real time information and for monitoring greenhouse conditions such as lighting, humidity, temperature, soil conditions and irrigation. Automated sensors control the actuator automatically by responding to plant deficiency immediately. Greenhouse automation has benefited farmers by maintaining a controlled temperature, keeping plants healthy and prosperous with automated sensors, optimizing manpower and increase in quality and yields.

INTERNET OF THINGS (IOT)

Internet of Things (IoT) refers to an interconnected system, which is an Internet-connected device that can record and transmit data over a wireless network without human intervention. It is basically an embedded system with sensors, softwares and other technologies with the aim of connecting and exchanging data with other devices over the internet. IoT is essential in agriculture as it plays major roles in water management, crop monitoring, soil management, control of insecticides and pesticides and improving time efficiency in a form called smart farming.

2.3 AGRICULTURAL IRRIGATION

Plants are moisturized by two ways namely the rain-fed farming and irrigation. The rain-fed farming is a natural application of rain water to the soil for plants' agricultural growth. It is the main source of much food consumption by poor countries in developing countries. It Accounts for over 95% of sub-Saharan Africa farmlands, 90% in Latin American, 75% in the Near East and North Africa, 65% in East Asia and 60% in South Asia (International Water Management Institute, 2010). Relying on rainfall results in less contamination of crops but at risk to partial or complete crop failure due to prolonged water breaks.

One the other hand, irrigation is an artificial application of controlled amounts of water to plants through various systems of tudes, pumps and sprays to assist production in crops. It is practiced when unfavoured conditions such as irregular or dry times or drought is experienced. There are various types of irrigation systems, in which proportional amounts of water is applied to the entire farm uniformly. Irrigation water is sourced from surface water, river, lakes or reservoirs, groundwater or other sources such as desalinated water. There are many practiced irrigation systems currently used today and are included in the fore main categories of Flood, Sprinkler, drip and micro irrigation.

2..3.1 TRADITIONAL IRRIGATION METHODS

(a) FLOOD IRRIGATION

Flood irrigation also known as the surface irrigation is believed to be an ancient method of irrigation and most likely the first form of irrigation for crop cultivation and still commonly used in our recent times. It is a method of irrigation where water is distributed to the soil of plants by gravity. It describes the process where water is uncontrolled and therefore inherently inefficient. It requires low investment for equipment. This farming irrigation method fails to take advantage of the capillary flow of water through the soil which results in more water loss from evaporation, infiltration and runoff. Floor irrigation comes in three major types namely; level basin, furrow, and border strip.

Basin Irrigation

It is a type of irrigation which waters the ground by surrounding it with a dike to create a basin and flood it with water. This class of surface irrigation is advantageous at saving time. Water reaches other plants automatically when the system is opened. Less economic investment and the most suitable method for more trees. It is a method that falls short as it is not suitable for all crops, rapid spread of diseases and wastage of water are some disadvantages of this irrigation method.

Furrow Irrigation

Furrow irrigation is a class of irrigation made of miniature trenches between crop rows in a field. Water applied at each furrow flows down the field under the influence of gravity. It is a time and resource saving method of irrigation and results in higher crop yields with proper furrow irrigation practices. This farming practice is not suitable for sandy soil, salts are accumulated in ridges of soil between the furrow and not the most suitable method for some crops.

Border Strip Irrigation

It is a type of surface irrigation where the field is divided into a number of bays or strips which are separated by raised earth borders. It is the best method of surface irrigation as it uniformly distributes and at high application of water to crops. Labour requirement is less and it is a simple and easy form of operation. It is disadvantageous at the high demand of labour for leveling of the field. It requires supervision over bridge repairs during irrigation.

2.3.2 MODERN IRRIGATION METHOD

(a) SPRINKLER IRRIGATION

Sprinkler irrigation/sprinkler irrigation is a method of controlling water supply, similar to rainwater. Water is distributed through a network, which can consist of pumps, valves, pipes, and sprinklers. Sprinklers can be used for residential, industrial and agricultural purposes. Sprinklers are often used for residential, industrial, and agricultural purposes. They are used on uneven terrain and sandy soils where there is not enough water. A vertical pipe with a rotating nozzle on the top is regularly connected to the pipe. When water is supplied, water is pumped through the main pipe and it protrudes from the rotating nozzle. It is sprayed through a culture gun.

There are four types of sprinkler irrigation namely; Traditional Spray Systems, Drip Systems ,Soaker Hoses and Rotor Systems.

Traditional Spray System

As we all know, traditional spray systems include pop-up nozzles and floor nozzles that spray water in a semicircle, full circle, or quarter circle to achieve a wide range of water coverage. To spray water to the surrounding area, this type of sprinkler system uses pop-up sprinklers, which are not as efficient as other types. In reality, this system sprays too much water, so the soil cannot absorb it fast enough, which also results in wasted water.

Drip System

The drip system is one of the best options for environmental activists, using some of the water to slowly supply it to the soil and absorb it at its rate. This system is Water-efficient. In windy conditions, this sprinkler irrigation system also works well and the wind does not affect its effectiveness as the water is distributed directly into the soil rather than being sprayed into the air.

Soaker Hoses

Soaker hoses are a kind of irrigation system, although technically not sprinklers, which homeowners need to consider before making a final decision. A quenching hose is laid throughout the landscaping to release water over the entire length of the hose. For homeowners with difficult dense landscapes that water using one of the traditional sprinkler irrigation systems, grilled hoses are a wise choice.

Rotor System

In the garden, the rotor can cover a wider area and is more efficient. The rotor also discharges water at a slower rate, so in many energy-efficient and larger yards like the drip system, this system was used alone. With most rotor sprays, you can adjust the nozzle to change the distance the water is sprayed and the amount of water radiated, so you have full control over changes in landscaping conditions all year round.

(b) DRIP IRRIGATION SYSTEM

It is a kind of micro-irrigation system that allows irrigation water to be buried above or below the soil surface and drip slowly onto the roots of plants, saving water and nutrients. The goal is to place the water directly on the root area and minimize evaporation. It distributes water through irrigation systems, valves, pipes, tubes, and emitter networks. Depending on the degree of irrigation system design, installation, maintenance, and operation, it is more efficient than other types of irrigation systems, including surface irrigation and sprinkler irrigation. This system of farming allows farmers to run their farms in an efficient and simple way, it utilizes the efficient use of fertilizers and crop protection and no leaching. There are two types of drip irrigation, Subsurface drip irrigation and Surface drip irrigation.

Subsurface Drip Irrigation

SDI (Sub-surface irrigation) is a more sophisticated, expensive, and unusual method than using a narrow plastic tube with a diameter of about 2 cm. They are buried in soil 20-50 cm deep enough to not interfere with normal cultivation and passage. The tubes are generally porous or are equipped with emitters or perforations at regular intervals. If porous, the tube drains water along its entire length. If the emitter is mounted, it will only emit water at certain points. The released water spreads and diffuses into the soil. The wetting pattern depends on the characteristics of the surrounding soil and the spacing and release rate between adjacent emitters. A potential problem with this technology is that the narrow holes in the emitter can be blocked by roots, particles, birds, and sediment salts.

Surface Drip Irrigation

Surface drip irrigation is much more common and uses a very wide drip irrigation device. The line on the side supplied by the field main is placed on the surface. Generally, it is 10 to 25 mm in diameter and is equipped with a sky or a special emitter. The latter was designed to drop water into the soil at a controlled rate of 1-10 liters per hour per release group. The operating water pressure is generally in the range of 0.5 to 2.5 atmospheres. Because this pressure is dispersed by the friction of the flow through the emitter's narrow passage or orifice, the water appears in the form of droplets rather than jets and sprays at atmospheric pressure. Emitters or dulipos are devices used to control the outflow of water to plants from the sides. They are generally more than a meter away from one or more emitters used in a single plant such as a tree. The basis of the design is to manufacture an emitter that does not change significantly in response to changes in pressure and provides a specified constant discharge that is not easily blocked.

Micro Irrigation

The term "micro-irrigation" describes a family of irrigation systems that supply water through a small device. These devices transfer water directly to the root area of the plant under the soil plane or soil surface very close to the plant. Growers, and gardeners have tailored the micro-irrigation system to meet the needs of precision water applications. Micro-irrigation systems are very popular not only in dry areas and urban environments but also in areas with limited water supply or high humidity and high humidity. Irrigation In agriculture, fine irrigation is widely used for rows of crops, mulching crops, orchards, gardens, greenhouses, and orchards. micro-irrigation of the city landscape is widely used along with decorative plants.

2.4 SIMILAR SYSTEMS

2.4.1 Sensor based Automated Irrigation System with IOT

Mentioned the use of sensor-based irrigation, where IoT is irrigated whenever there is a change in ambient temperature and humidity in a sensor-based automatic irrigation system. The flow of water is controlled by a solenoid valve. Valves are opened and closed when signals are transmitted through the microcontroller. The water to the roots of the plant is dropped drop by drop using a stormwater gun, and when the water level is normal again, the sensor detects this and sends a signal to the microcontroller to close the value. Two mobiles are connected using GSM. GSM and microcontroller are connected using MAX232. When the soil moisture becomes low moisture, the sensor detects it and sends a signal to the microcontroller, and the microcontroller sends a signal to the mobile to trigger the buzzer. This buzzer indicates that the valve should be opened by pressing the button of the called function. The signal is sent to the microcontroller. The microcontroller you use can extend the life of your system and reduce power consumption. The system there is limited to the automation of the irrigation system and lacks special normal functions.

2.4.2 Wireless Sensor Network based Remote Irrigation Control System and Automation using DTMF Code

Remote irrigation control system based on wireless sensor network and automation using DTMF code mentioned about using an automatic irrigation system to realize appropriate yield and remote processing for the safety of farmers. Technology-based on embedded wireless sensor networks and Dual Tone Multiple Frequency (DTMF) signals to control streams of sectorized sprinkler or drip section irrigation. Circuit-switched instead of packet-switched used in SMS control devices currently on the market. Farmers can dial and send DTMF commands over the GSM network, and use their cell phone or landline phone to initiate and control irrigation and pesticide spraying. This system is very economical in terms of hardware cost, power, and phone bills. Farmers need to control (on / off) the valve frequently (and at night), which is very inconvenient if we have to call it every time we turn the valve on or off, so operating costs Increase. Farmers cannot know the power status in the fields.

2.4.3 Automated Irrigation System Using a Wireless Sensor Network and GPRS Module

Use of an automatic irrigation system that is connected to a radio transceiver that allows soil movement with an automatic irrigation system using a wireless sensor network and GPRS module, and is irrigated by a wireless sensor device (WSD) and a wireless information device (WID). Mentioned. Moisture and temperature data implement WSN using ZigBee technology. Sensors are used to measure temperature and moisture, which are controlled by a microcontroller. WIU also has a GPRS module that sends data to a web server over a public mobile network. Information can be remotely monitored online via a graphics application via an internet access device. This irrigation system is a viable system that can be cultivated where water is scarce, improving sustainability. However, due to the Zigbee protocol, this system will cost more.

2.4.4 Automated drip Irrigation system

It mentions the use of a fully automated drip irrigation system to control and monitor using an ARM9 processor in a Smart Drip irrigation system for sustainable agriculture, soil PH, and nitrogen content. Frequently monitor. A GSM module is implemented for monitoring and control. The system automatically turns the valve on and off depending on the water requirements of the plant. The system notifies the user via SMS via the GSM module of reduced moisture and increased temperature, as well as the same anomalous conditions as CO2 concentration. The moisture sensor output helps determine whether to irrigate the land according to its moisture content. While irrigating the land with the moisture sensor, the output of the temperature sensor can also be considered. Irrigation of plants with very low soil moisture content and very high temperatures are required, but the amount of time irrigation is provided depends on the temperature range. When applied in moderation, a small amount of water is lost to deep penetration and the ARM processor is not binary compatible with x86. This means that you are not running through the window right away. However, there are some Unix operating systems that can run on Linux, and ARM like BSD.

2.4.5 Wireless Sensor Network Based Automated Irrigation And Crop Field

Mentioned the use of wireless sensor network-based automatic irrigation and crop monitoring systems to optimize water use for agricultural purposes. The system consists of a soil moisture distribution wireless sensor network and a temperature sensor installed on the crop. The Zigbee protocol and irrigation system microcontrollers used to process sensor information use algorithms with sensor thresholds to control quantity programming. The system continuously displays the abnormality of the land (soil moisture, temperature level). A GSM modem with GPRS capability provides information to the fan and interfaces with the PIC 18F77 A microcontroller. Irrigation systems are automatic and manual mode. This system can increase the crop field, improve the quality of crops and increase energy to reduce nonpoint source pollution. PIC microprocessors have longer programs using RISC (35 instructions).

2. 5 HOW THE SYSTEM WORKS

The control system should be started to act on the irrigation system when the ground moisture sensor is injected into the ground (Sprinkler in this case). Our agricultural soil (earth) is one of the actors when we achieve input values to trigger irrigation. The humidity sensor works between its samples by detecting its resistance. Values were taken using a multimeter and recorded. The figures were when the ground is dry and the ground is saturated. This gave us a threshold to write our software to identify if the soil is dry and wet. The system switches on the irrigation system when the soil is dry. The mechanism shuts the irrigation system off when the soil is wet enough. Recorded digital responses are communicated and displayed on the smartphone of the farmer.

CHAPTER THREE

METHODOLOGY FOR THE DESIGN OF THE IOT IRRIGATION SYSTEM

3.1 INTRODUCTION

This section investigates the equipment and programming prerequisites, examination and plans needed to think of the last venture model. Our answer to the exploration issue can be additionally explained by displaying every one of the thoughts behind it. Examination and plan of the framework can feature the theoretical perspective on the heading taken in critical thinking. A legitimate investigation of the current frameworks has prompted an appropriate plan being made of the framework. This is done to deliver a framework which is important in tackling the issue.

3.2 System Design

The equipment segments of the framework model comprise of:

i. Soil Moisture sensor
ii. DHT11 Temperature and Humidity sensor
iii. ESP32 nodemcu
iv. Water Pump
v. Jumper Wires
vi. Relay Module
vii. Breadboard
viii. Smart Phone

The Software requirements include:

i. Proteus Design Suite for simulation
ii. Arduino IDE for programming via USB

The accomplishment of the undertaking is generally secured on the capacity to interface together the equipment given previously. An inside and out investigation and portrayal of the framework model is outlined.A used square outlines, flowcharts, and schematic drawings to represent the proposed framework.

The proposed system block diagram is shown in Figure 3.1

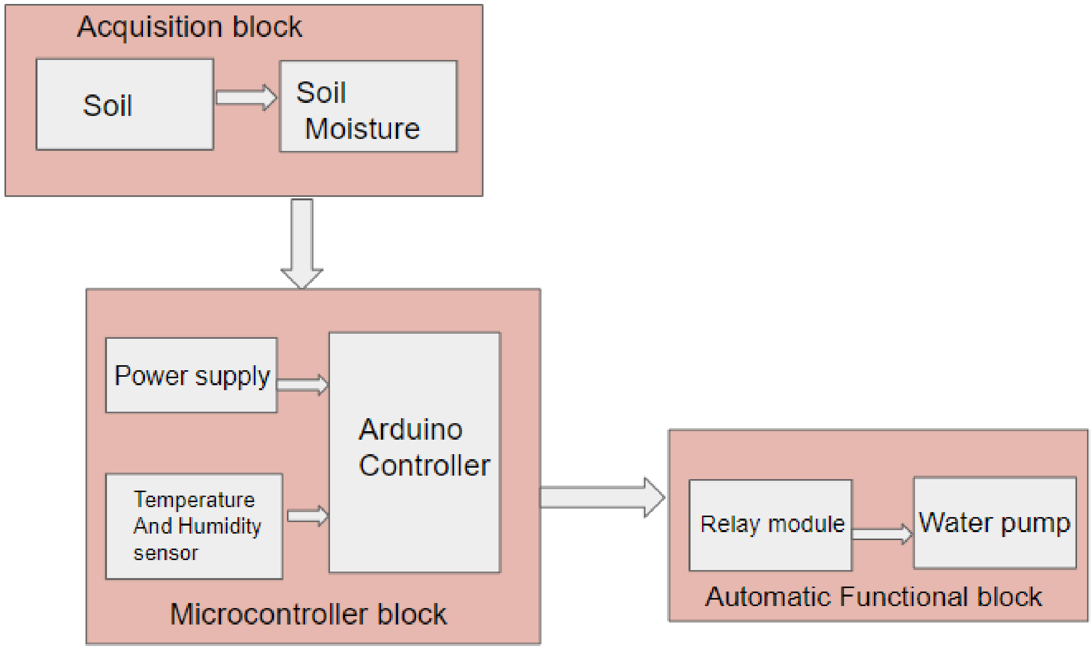

Fig 3.1 System Block Diagram

3.3 Hardware

3.3.1 Soil Moisture Sensor

Soil moisture sensors monitor the amount of water in the soil. Multiple soil moisture sensors make up a soil moisture probe. When liquid or moisture is detected between two wire leads, an active High output is generated. Because the exposed wire can absorb liquids, it permits water vapors to pass through to the sensor. These exposed parts are lightly engineered. As a result, the sensor reacts quickly to changes in applied moisture, both when the process is being dried and when it is called into action if moisture intrusion occurs. Because there is an indirect, the crop field may now interact with the microcontroller, feeding input into the MCU.

Nevertheless, good accuracy and precision can be attained under appropriate conditions and some sensor types have become extensively utilized for scientific activity. In general, conversions from raw sensor readings to volumetric moisture content or water potential utilizing secondary or tertiary approaches tend to be sensor or soil specific, influenced or prevented at high saline levels and dependent on temperature.

The soil moisture sensor is straightforward to line up and operate. The sensor's two huge exposed pads serve as probes, and combined they work as a variable resistor. The more water within the soil, the higher the conductivity between the pads is going to be , and therefore the lower the resistance is going to be . Figure 3.2 shows an example of a soil moisture sensor.

Figure 3.2 Soil Moisture Sensor

The Moisture Sensor is connected in the following manner:
VCC pin - Arduino’s 5V Output
GND pin - Arduino’s GND
DATA pin - Arduino’s Analogue A0

Features & Specifications

i. Supports 3-Pin Sensor interface
ii. Analog output
iii. Operating Voltage: DC 3.3-5.5V
iv. Output Voltage: DC 0-3.0V
v. Interface: PH2.0-3P
vi. Size: 99x16mm/3.9x0.63″

3.3.2 Temperature and Humidity Sensor

The DHT11 is a basic digital temperature and humidity sensor with a modest price tag. It measures the ambient air with a capacitive humidity sensor and a thermistor. On the data pin, it gives out a digital signal.
It's simple to use, but data collection necessitates careful timing. The only major disadvantage of this sensor is that it only provides new data every 2 seconds. As a result, sensor data can be up to

2 seconds outdated when utilizing the library. This sensor will be used to measure the air temperature and humidity in this project. . Figure 3.3 shows an example of a Temperature and Humidity Sensor

Figure 3.3 Temperature and Humidity Sensor

3.3.3 NodeMCU ESP8266

NodeMCU is an open-source Lua-based firmware for Espressif's ESP32 and ESP8266 WiFi SOCs that uses the SPIFFS file system on the on-module flash. The Espressif ESP-IDF is placed on top of NodeMCU, which is written in C.
Initially, the firmware was developed and supported by the popular NodeMCU developers based on ESP8266, but the project now supports the community and now the firmware can be used on any ESP module. Figure 3.4 shows an example of a NodeMCU ESP8266

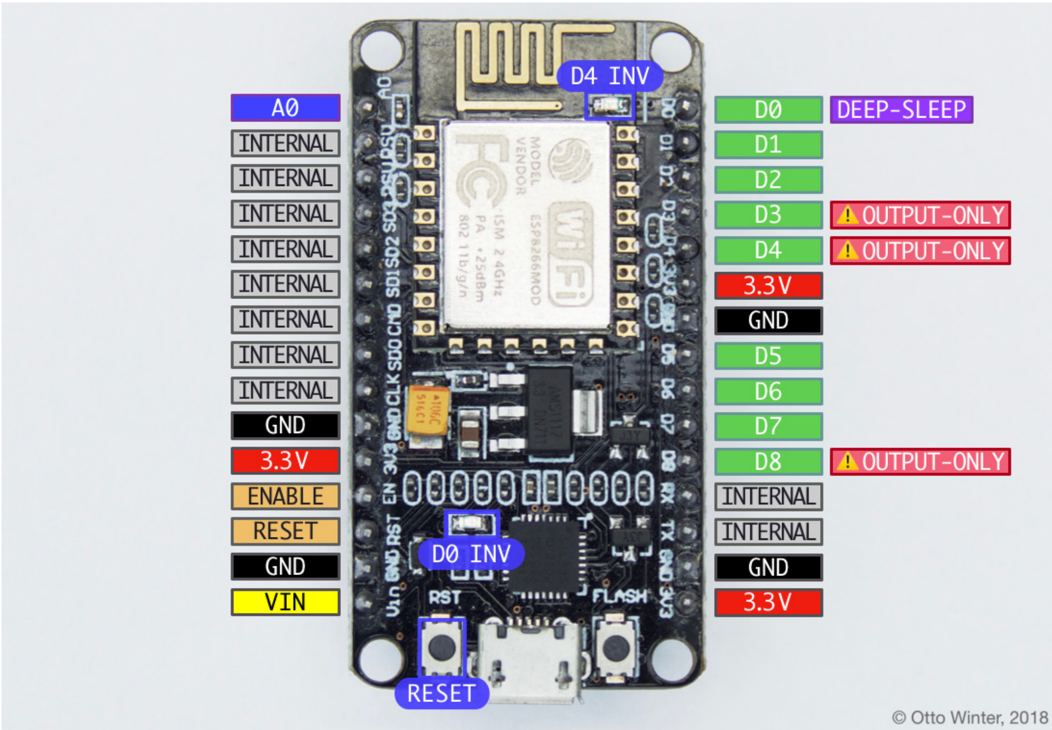

Figure 3.4 Pins on the NodeMCU ESP8266 development board

The pin numbers for the NodeMCU are different from the internal pin numbering as seen on the board (D0 etc pins). For instance, the GPIO0 internal pin maps the D3 pin number. Luckily, ESPHome knows about mapping the internal pin numbers from the on-board pin numbers, but you must prefix D to make that automatic mapping happen.
In general, the only way to avoid confusion is by using the D0, D1 ... pin numbering.
Please note that you can use the INTERNAL marked pins in the picture above under some conditions.If the pin connects the RESET pin, D0 can also be used to wake the device from deeper sleep. D0 is connected to the L in addition.

3.3.4. Submersible Mini Water Pump

A low-cost, small-size Submersible Pump motor is the DC 3-6 V Mini Submersible Water Pump. The power supply is 2.5 ~ 6V. With a very low current consumption of 220mA, it can take up to 120 liters per hour. Just connect the pipe to the engine outlet, submerge and power it in water.
Figure 3.5 shows an example of a Submersible Mini Water Pump

Figure 3.5 Submersible Water Pump

Features & Specifications

i. Operating Voltage : 2.5 ~ 6V
ii. Operating Current : 130 ~ 220mA
iii. Flow Rate : 80 ~ 120 L/H
iv. Maximum Lift : 40 ~ 110 mm
v. Outlet Outside Diameter: 7.5 mm
vi. Outlet Inside Diameter: 5 mm

3.3.5 Jumper wires

Jumper wires can simply be used to connect two points without soldering with connector pins on each end. Typically jumpers are used with breadboards and other prototyping tools to facilitate the change of the circuit. Whilst a variety of colors are used with jumper wires, the colors mean nothing. This means that technically a red jumper wire is the same as a black one. However, colors can be used for your benefit so that connections such as ground or power are differentiated from each other. For this project, Male to Male and Female were used for two types of jumper wires. Figure 3.6 shows an example of a Jumper Wires

Figure 3.6 Jumper Wires

3.3.5 Relay Module

An electrical switch is an electromagnet power relay module... Held in the spring, when the relay is degenerated the armature leaves a gap in the magnetic circuit. One of the two contacts is closed in this position while the other is open.

A simple relay consists of a wire coil wrapped around a soft iron or solenoid, an iron yoke that provides the magnetic flux with a low reluctance, moving iron brackets, and a set of contacts. The moving armature is linked to one or more moving contacts and hinged to the yokes. The armature, held in place by a spring, leaves a gap in the magnet when the relay is decompressed. Figure 3.7 shows an example of a Relay module

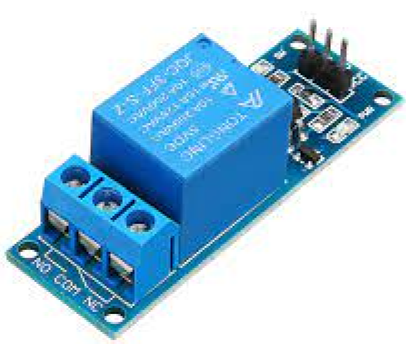

Figure 3.7 Relay Module

3.3.6 Breadboard

A breadboard is a solderless device with electronics and circuit designs for temporary prototypes. By inserting their pipes or terminals into the holes, most electronic components in electronic circuits can be linked up and connected via wires where appropriate. The panel has metal strips under the board and connects the trousers on the top of the board. A breadboard is cheap hardware that is easy to use for electrical circuits to be wired. They are similar in shape to the boards used for cutting unsliced bread and have taken up their name. Figure 3.8 shows an example of a Breadboard

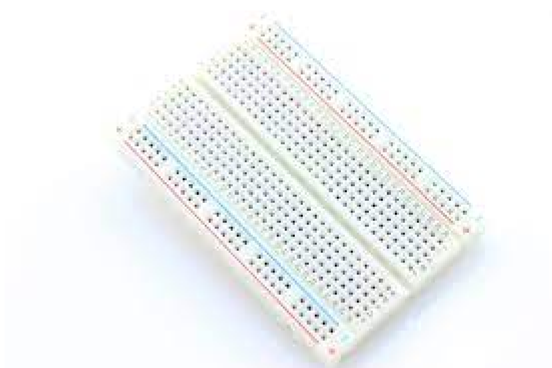

Figure 3.8 Breadboard

3.4 Major Software Requirement

3.4.1 Proteus Software

Proteus is a microprocessor simulation software, schematic capture and printed circuit board(PCB) design.The circuit diagrams and simulations were developed using Proteus. Some of them have to be improvised. The water pump and the sprinkler with LEDs had, for example, to be improvised by the use of buttons. Figure 3.9 shows a Proteus Software

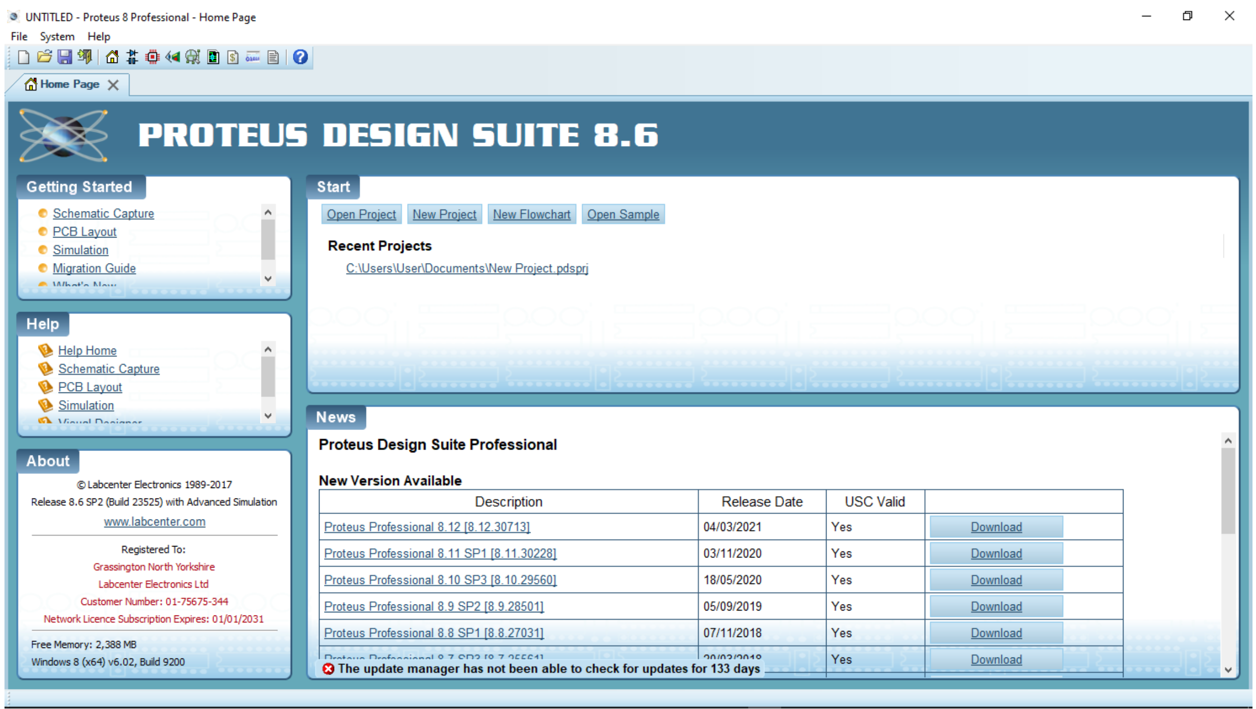

Figure 3.9 Proteus Application Software

3.4.2 Arduino Integrated Development Environment (IDE)

Arduino is an open source, software-based prototype platform. A text editor for code authoring, a messages area and a text terminal, a button bar for common functions and a series of menus may be found in the Arduino integrated development environment (IDE). It links to the hardware of Arduino and Genuino for the uploading and communication of programs. Sketches are called programs written using Arduino Software (IDE). These drawings will be written in the text editor and saved with the ino file extension. The publisher provides cut/paste and search/place text features. Feedback during storing and exporting and faults are also displayed in the message box. The console shows a full error message and other information in the text Output of the arduino software (IDE). On the right bottom of the window the board and serial port are displayed. You may check and upload programs, generate, open, and save sketches and open the serial monitor using the toolbar buttons. Check for incorrect compilation to verify your code. Upload Compile and upload your code to the board configured (Sravya, 2018). Figure 3.10 shows an Arduino Integrated Development Environment (IDE) Software

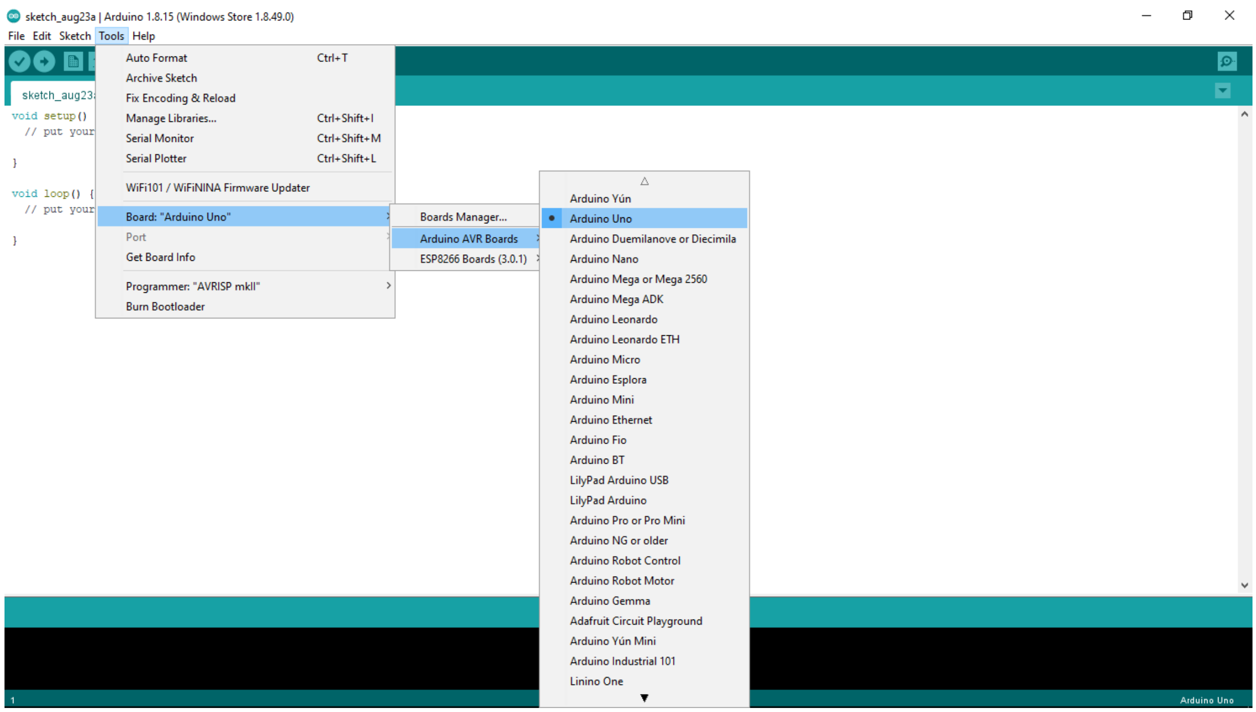

Figure 3.10 Screenshots of Arduino application

3.4.2 System Flowchart Diagram

The proposed system Flowchart diagram is shown in Figure 3.11

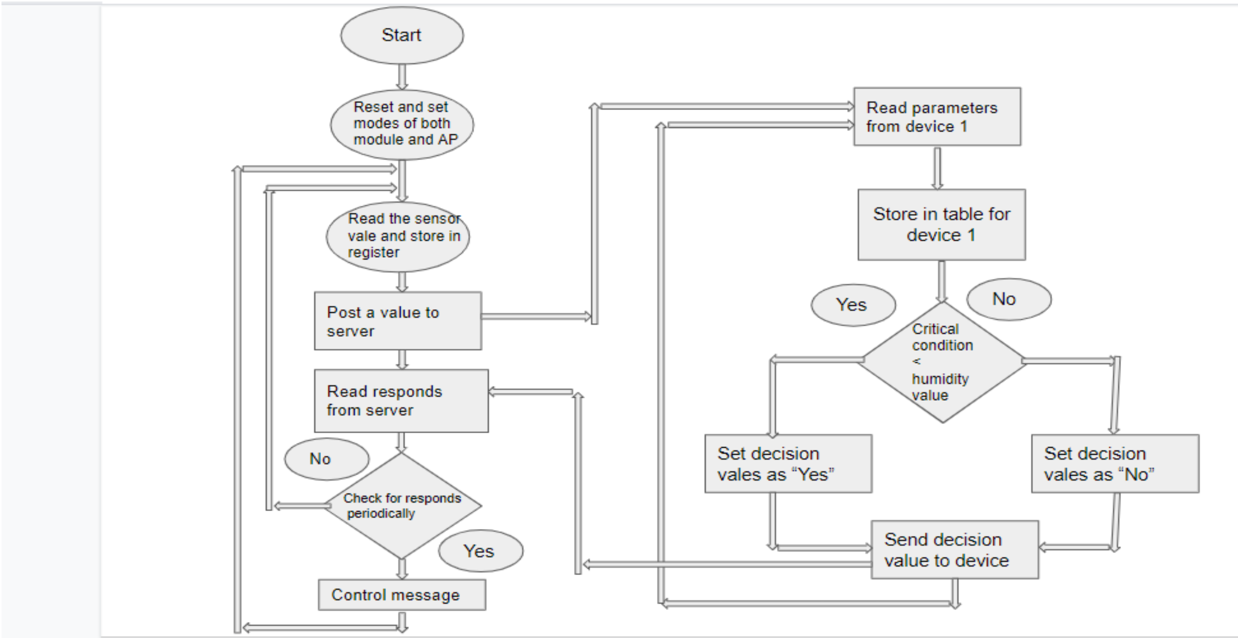

Figure 3.11 Flowchart of the system

CHAPTER FOUR

IOT AUTOMATED IRRIGATION SYSTEM IMPLEMENTATION

4.1 INTRODUCTION

This chapter includes data gathered and analyzed and designed for the project. Data are displayed as photos and screenshots.

4.2 DEVELOPMENT OF THE AUTOMATED IRRIGATION SYSTEM

A successful development and connection of an automated irrigation system. The system built includes a microcontroller, a sensor of humidity content, a temperature and humidity sensor, a relay module, a water pump, jumper wires, and a power supply. Arranged on the prototype watering system. Figure (4.1) shows the automated system wireless circuit constructed while Figure (4.2) shows the prototype of the Moisture sensor not submerged in water. Figure (4.3) displays the reading of the moisture sensor not in water. Figure (4.4) shows the submersible water sensor in water The displayed reading of the water sensor in water is represented in Figure 4.5, Figure 4.6 shows the Humidity value and a live graphical report and Figure 4.7 represent C++ code of the system

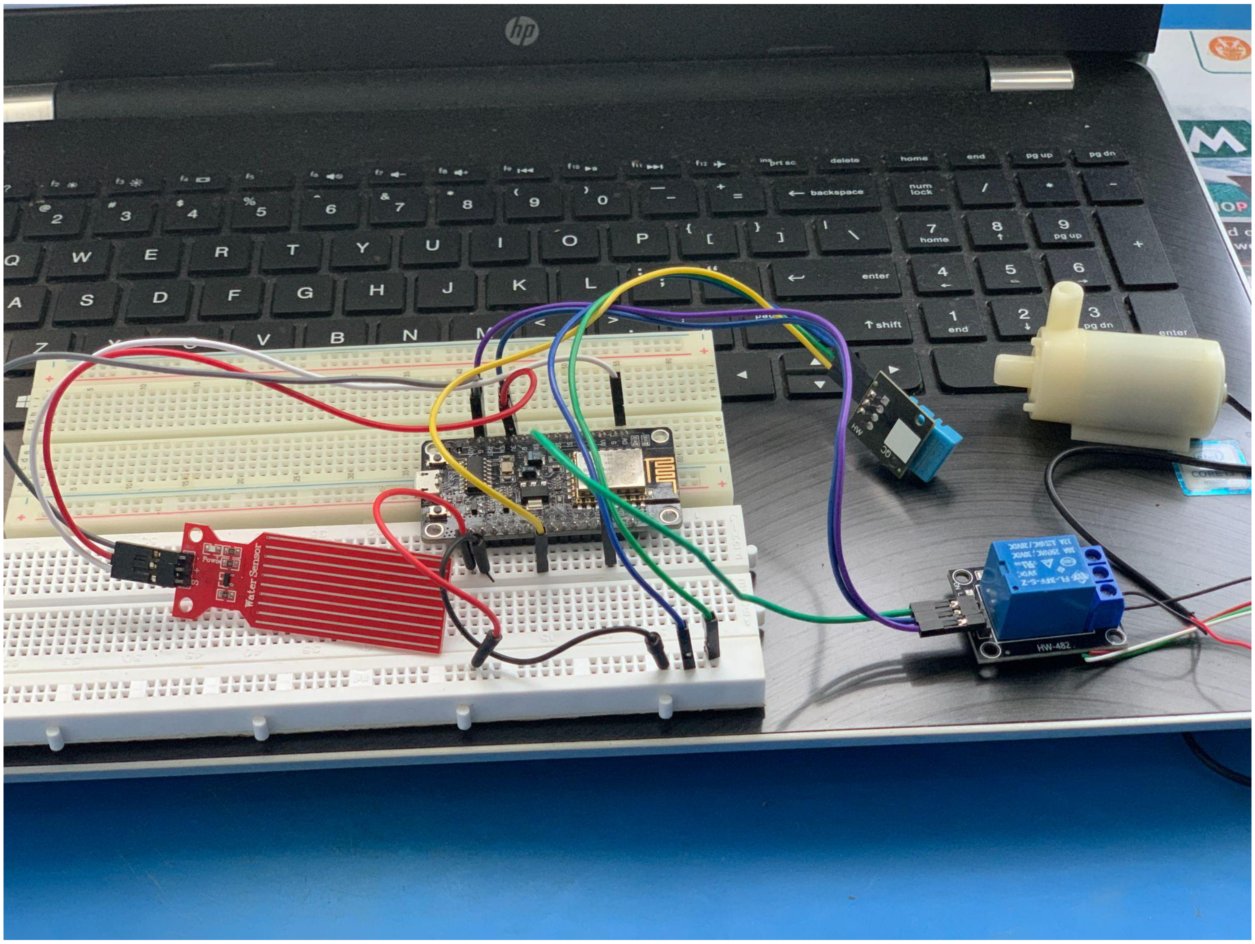

Figure (4.1) shows the automated system system wireless circuit

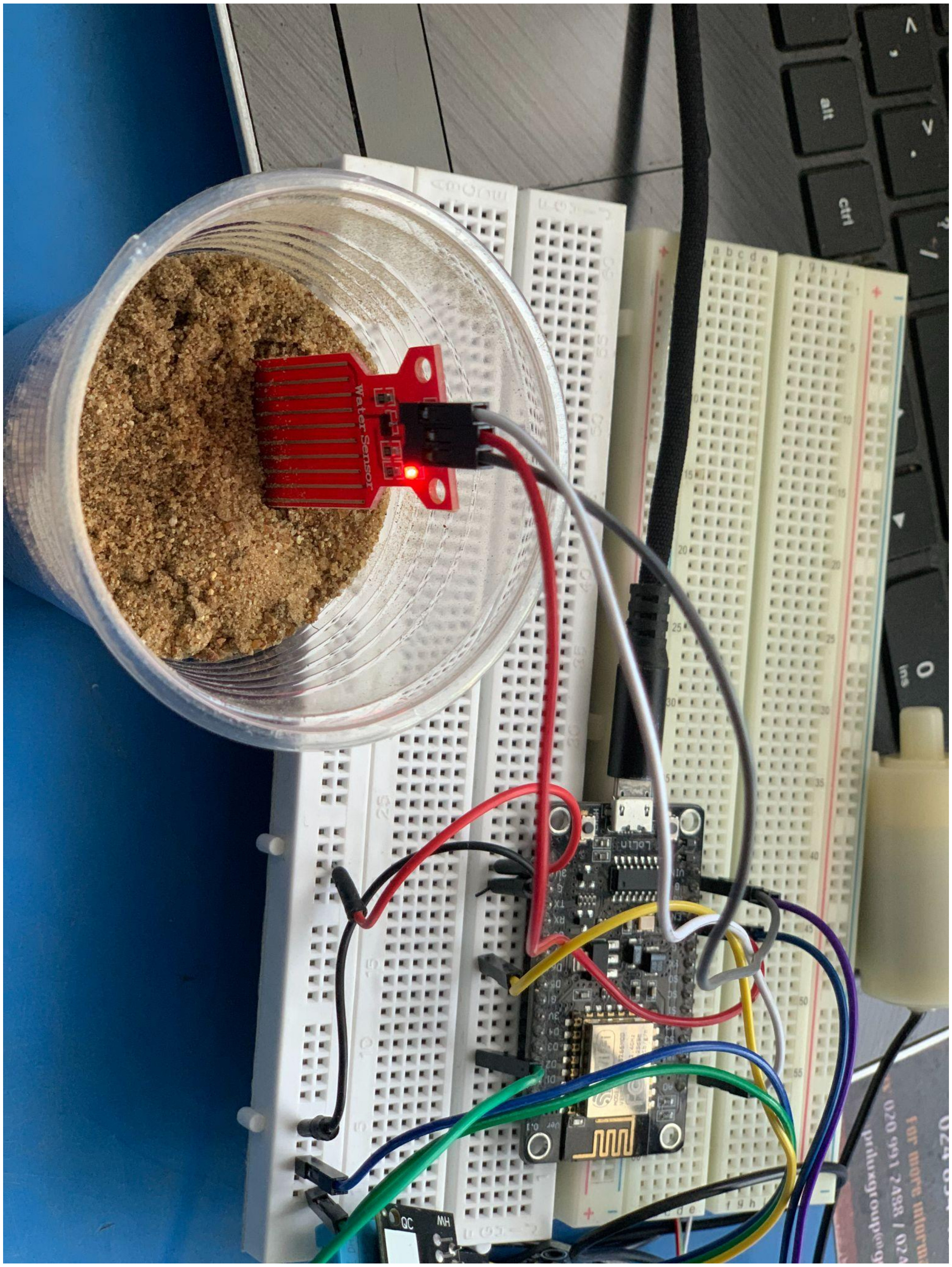

Figure 4.2 Moisture Sensor in dry sand

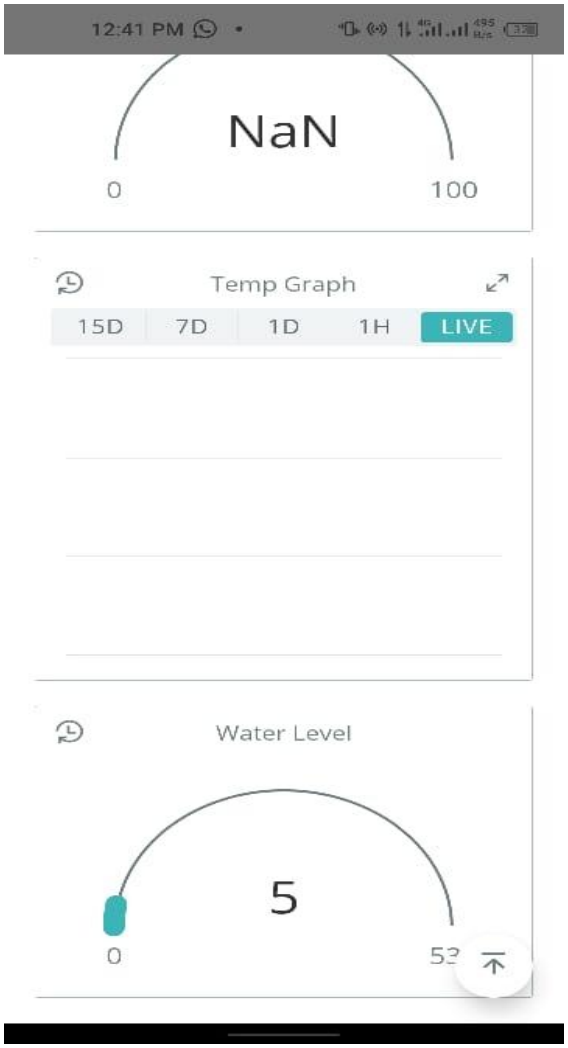

Figure 4.3 Displayed reading of moisture sensor in dry sand

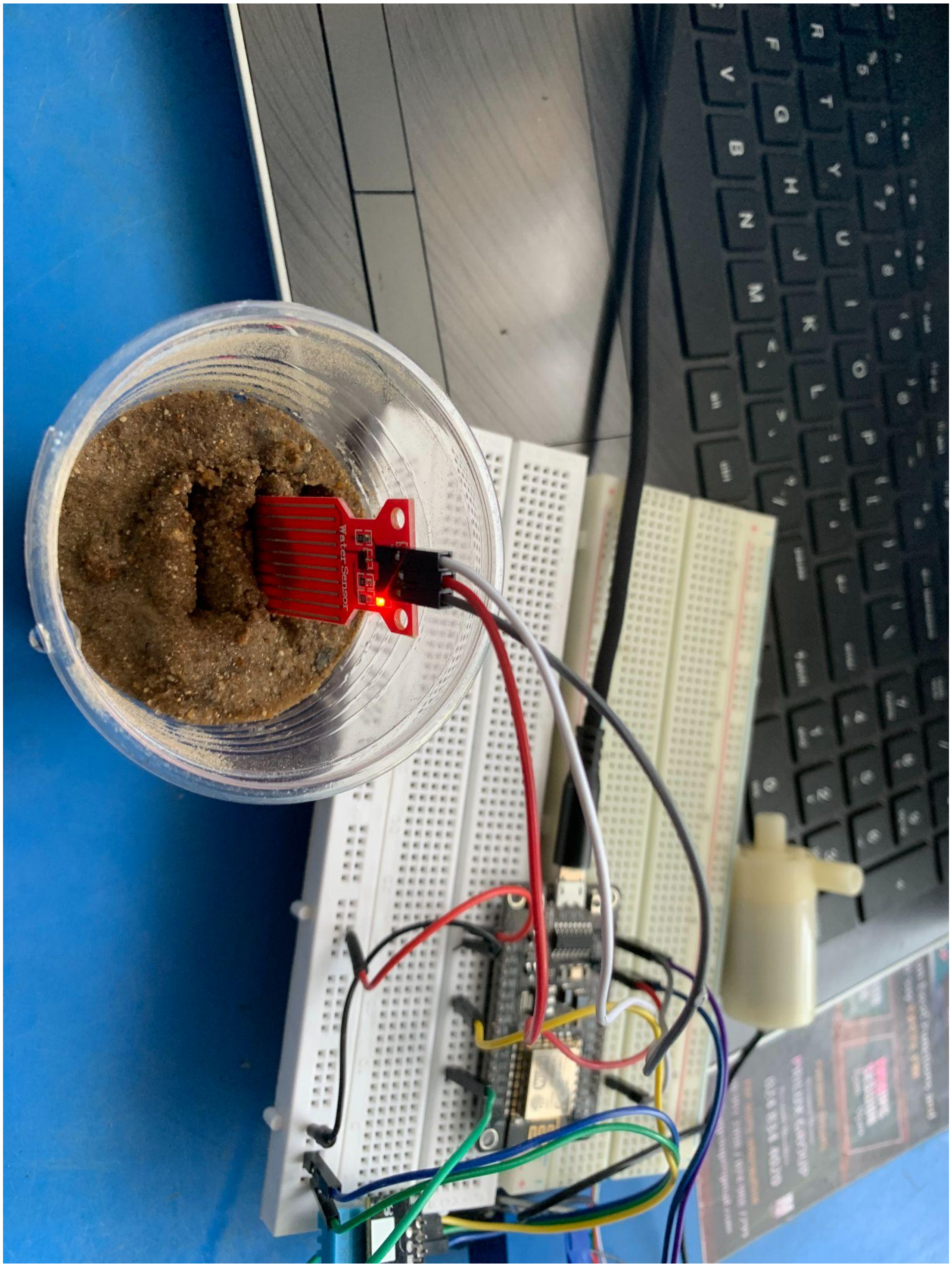

Figure 4.4 Moisture Sensor submerged in Water

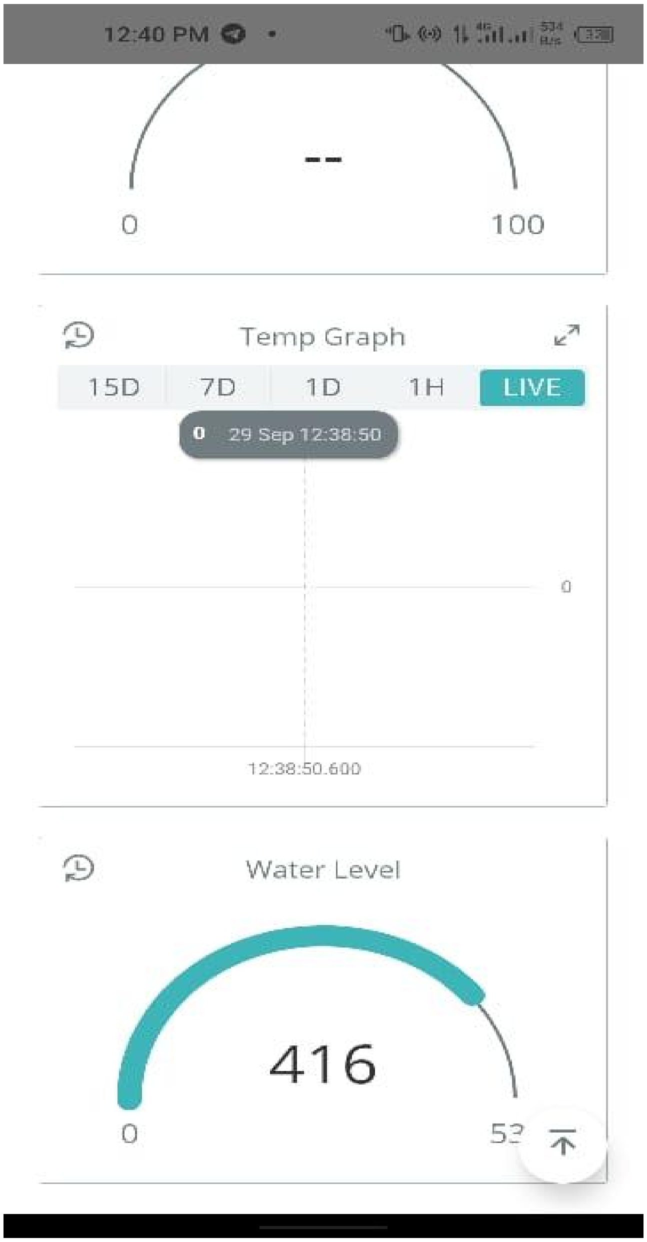

Figure 4.5 Displayed reading of the moisture sensor submerged in water.

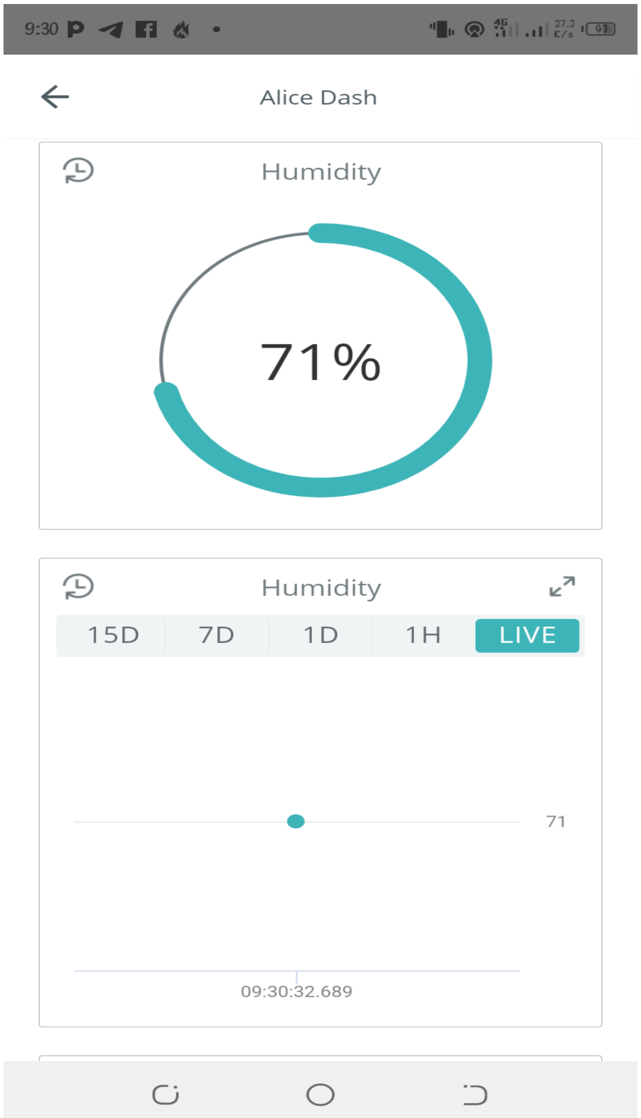

Figure 4.6 shows the Humidity value and a live graphical report

4.3 Software Development

The program was tested and verified to be operational. Allowing the needed amount of water to pass in the allotted time. The monitoring of soil moisture was also tested and proved to be effective. Figure 4.6 shows the C++ codes of the system.

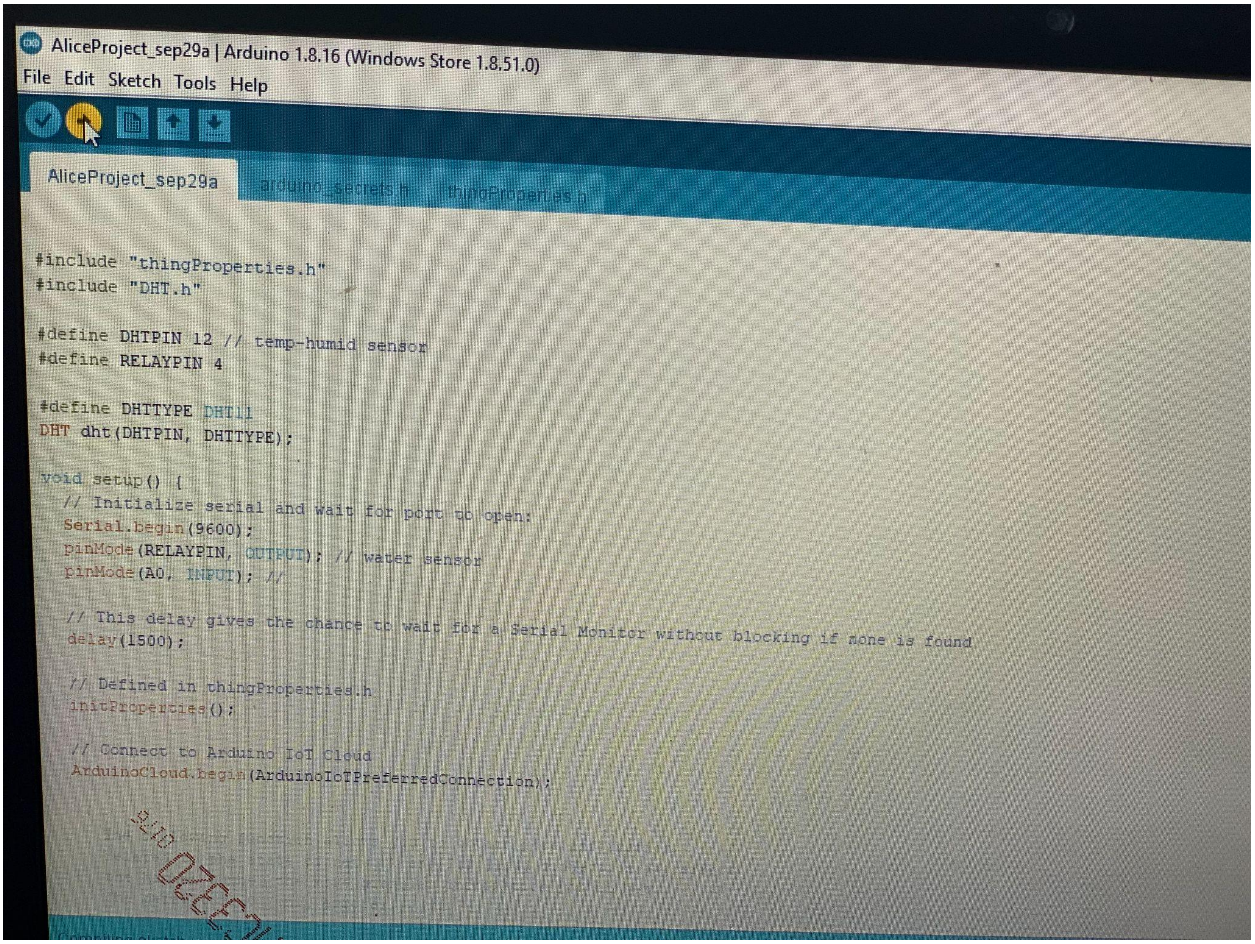

Figure 4.7 C++ code of the system

4.4 System Evaluation

Finally, after completing the various types of testing instances, the successful “Plant Communicator” was produced in accordance with the aims and objectives. Various testing cases were carried out, resulting in the system being suitable and fit for use in a real-time setting. Some of the conclusions reached through testing cases are as follows:

i. The system was able to interact with the moisture to ensure it meets the irrigation requirements.

ii. The comparison with similar systems shows that the system is market-ready.

iii. Farmers, agriculturists, and nurseries will benefit greatly from the system because it is cost effective, simple to run, and user pleasant.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

Irrigation is a critical component of economic development in underdeveloped nations such as Ghana. Irrigation professionals have used manual irrigation methods for many years. The manual approach has numerous limitations and is unreliable for large-scale irrigation. Irrigation has a direct impact on ultimate product cost and production. This technology seeks to replace the tractional manual watering method, which must be improved over time. Furthermore, the problem area indicates the need for plant communicators and irrigation systems that farmers and flower Nursery professionals can use. The project is a structural representation of the automated irrigation system for small scale gardens which can be further extended to a larger scale of farming by using the spray or sprinkler irrigation system. This project's testing phases demonstrate that it can be employed in a real-time farming scenario.

5.2 ADVANTAGE OF THE PROJECT

This project is aimed at farmers, cultivators, and nurseries, and it will greatly benefit them. The automated irrigation system has several advantages over standard irrigation systems. To begin discussing the project's benefits, there is a soil moisture sensor that allows water to be used just when and where it is needed, so aiding in water conservation. Traditional watering methods can waste up to 50% of the water utilized due to inefficiencies in irrigation, evaporation, and warming. Following that, the data is real-time data, allowing the farmer to see the water level and wetness of the spores in real time. The automated irrigation system technology collects real-time data from sensors to update watering routines and change watering schedules to optimize efficiencies. Irrigation process automation can reduce resource consumption, human error, and total expenditures, allowing farmers to lower their operating costs. This will result in energy savings and is one of the best solutions to water depletion and shortage. Because machine-to-machine interaction improves efficiency, accurate results may be achieved quickly. As a result, precious time is saved. Instead of doing the same thing every day, it allows employees to perform more creative work. This project assists farmers in increasing output by delivering the necessary amount of water. Finally, this technique aids in the reduction of soil erosion and nutrient leakage. This project is viable and cost-effective for maximizing agricultural water supplies. This project enables cultivation in water-stressed areas, hence boosting sustainability. It demonstrates that water waste can be decreased. I conclude that this method is quite simple to implement. The user should check the moisture content of his soil on a regular basis to see if the water level is adequate. “Plant Communicator” displays the water level information in the Arduino IDE monitor system for the user so that they can be operated at any time.

5.3 LIMITATIONS

i. The relay Module had no extended power supply to power the water pump for water distribution

5.4 RECOMMENDATION

The recommendations should be implemented as follows:

i. The project is a structural representation of the automated irrigation system for small scale gardens which can be further extended to a larger scale of farming by using the spray or sprinkler irrigation system to meet the qualified needs of plants.
ii. This technique might be applied by adding wheels to make it mobile as a substitute for the hanging system.
iii. To maximize the precision of the irrigation system by adding pH and other sensors.
iv. The Medani Hydraulic Research Center has a project that satellite signals notify farmers of water constraints on the ground. In order to control these fields, the addition of the automatic irrigation system GSM can be used.
v. More graphics can be added to the Android application, for instance when the pump is being executed. On the android application, the level of water tanks and soil moisture can be displayed graphically.
vi. The pumps and solenoid valves should be controlled in actual areas, and various water requirements on the same field can be controlled.

vii. Further improvements can be made to the system by making it adaptable to allow the user to measure and address moisture levels.

5.5 SUGGESTION FOR FURTHER WORK

The high recorded temperature and humidity values in the Country and precisely at Tono in the upper East region could be utilized by introducing a solar system mode of power supply where direct sunlight is converted to solar energy for power supply. By employing another high-end controller, the system's performance can be boosted further in terms of the microcontroller's operating speed, memory capacity, and instruction cycle period. The number of channels can be expanded to interface a greater number of sensors by employing sophisticated controller versions. The system can be customized by utilizing a data recorder and a graphical LCD panel, or by using the ThingsSpeak API to display the measured sensor data over time. This device's performance can be improved by using renewable energy sources to power it. Fertilizer, insecticides, and pesticides can be administered at specific times. A water meter can be installed to assess the amount of water used for irrigation, resulting in a cost estimate, and a solenoid valve can be used to control the volume of water flow.

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APPENDIX

```
#include "thingProperties.h"
#include "DHT.h"

#define DHTPIN 12 // temp-humid sensor
#define RELAYPIN 4

#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);

void setup() {
  // Initialize serial and wait for port to open:
  Serial.begin(9600);
  pinMode(RELAYPIN, OUTPUT); // water sensor
  pinMode(A0, INPUT); //

  // This delay gives the chance to wait for a Serial Monitor without blocking if none is found
  delay(1500);

  // Defined in thingProperties.h
  initProperties();
```

```
  // Connect to Arduino IoT Cloud
  ArduinoCloud.begin(ArduinoIoTPreferredConnection);

  /*
     The following function allows you to obtain more information
     related to the state of network and IoT Cloud connection and errors
     the higher number the more granular information you'll get.
     The default is 0 (only errors).
     Maximum is 4
 */
  setDebugMessageLevel(2);
  ArduinoCloud.printDebugInfo();
}

void loop() {
  ArduinoCloud.update();
  loadWaterLevel();
  loadHumidTemp();



}
```

```
void loadWaterLevel() {
  waterlevel = analogRead(A0);
}



void onRelayChange() {
  if (relay == 0){
    digitalWrite(RELAYPIN,LOW );
  }else{
    digitalWrite(RELAYPIN, HIGH);
  }
}


void loadHumidTemp(){
  float h = dht.readHumidity();
  float t = dht.readTemperature();
  humidity = h;
  temperature = t;
}
```

WIFI SETTING

```
#define SECRET_SSID "Lakyiere"

#define SECRET_PASS "alice1999***"

#define SECRET_DEVICE_KEY "FAKLJWO6AQCLLDCMSAYV"
```

ARDUINO IOT CLOUD

```
// Code generated by Arduino IoT Cloud, DO NOT EDIT.


#include <ArduinoIoTCloud.h>

#include <Arduino_ConnectionHandler.h>



const char THING_ID[]           = "e656be2a-17cb-44cd-91f8-330d324ac595";

const char DEVICE_LOGIN_NAME[]  = "a29fec49-21ca-4064-84d7-ea62a69fa4cd";


const char SSID[]               = SECRET_SSID;    // Network SSID (name)

const char PASS[]               = SECRET_PASS;    // Network password (use for WPA, or use as key for WEP)

const char DEVICE_KEY[]  = SECRET_DEVICE_KEY;    // Secret device password


void onRelayChange();


float waterlevel;
```

```
CloudSwitch relay;

CloudRelativeHumidity humidity;

CloudTemperatureSensor temperature;


void initProperties(){


  ArduinoCloud.setBoardId(DEVICE_LOGIN_NAME);

  ArduinoCloud.setSecretDeviceKey(DEVICE_KEY);

  ArduinoCloud.setThingId(THING_ID);

  ArduinoCloud.addProperty(waterlevel, READ, ON_CHANGE, NULL, 1);

  ArduinoCloud.addProperty(relay, READWRITE, ON_CHANGE, onRelayChange);

  ArduinoCloud.addProperty(humidity, READ, ON_CHANGE, NULL);

  ArduinoCloud.addProperty(temperature, READ, ON_CHANGE, NULL);


}
```