ADVANCED WATERING SYSTEM

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

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BACHELOR OF TECHNOLOGY

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ELECTRONICS AND COMMUNICATION ENGINEERING

By

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UNDER THE GUIDANCE OF

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DECLARATION

We hereby certify that the work reported in the B. Tech. Project Report entitled "Advanced Watering System" presented at Jaypee University of Information Technology, Waknaghat, India, is a genuine record of our work carried out under the supervision of Dr. Harsh Sohal. We have not submitted this work elsewhere for any other degree or diploma.

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This is to certify that the above statement made by the candidates is correct to the best of my knowledge.

Dr. Harsh Sohal

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Date: 1st June, 2024

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ABSTRACT

Natural resources are being depleted at an accelerated rate due to population expansion and demand . At least 75% of the freshwater used worldwide is utilized for irrigation, which is essential to the productivity and expansion of agriculture. The use of water for irrigation is inefficient since it is carried out by people (farmers), despite irrigation being the largest global user of water. Farmers must keep track of data such as soil type, climatic conditions, available water resources, soil pH, soil nutrients, soil moisture as well as the quality of water which been supplied to the farm, like pH, TDS & turbidity of water, to improve irrigation management and increase agricultural productivity. To address the complex issues facing agriculture, irrigation, a data-driven technology, has to be integrated with new technologies and cutting-edge approaches. The report provides a summary of contemporary IoT-enabled technologies that can improve irrigation management. This report presents the evolution of irrigation and IoT, factors to be considered for effective irrigation, the need for effective irrigation optimization, and how dynamic irrigation optimization would help reduce water use. Additionally, the report also consists of the various IoT architectures, deployment strategies, sensors, and controllers used in agriculture.

ACRONYMS AND ABBREVIATIONS

1	IoT	Internet of Things
2	IDE	Integrated Development Environment
3	IC	Integrated Chip
4	ESP	Expressive Systems
5	UART	Universal Asynchronous Receiver Transmitter
6	ADC	Analog to Digital Converter
7	I2C	Inter-Integrated Circuit
8	PWM	Pulse Width Modulation
9	HTTP	Hypertext Transfer Protocol
10	GPIO	General-Purpose Input/Output
11	TDS	Total Dissolved Solids
12	pH	Potential of Hydrogen

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CHAPTER-1: INTRODUCTION

Agriculture-related issues have historically impeded the nation's progress. Agriculture is essential to the development of the nation. Agriculture and farming contribute significantly to the Gross Domestic Product (GDP) of both emerging and many developed countries. As a result, it is urgent that existing farming methods be improved upon. Along with supporting the flourishing sustainable development of people, flora, and fauna, it will also aid in addressing global crises like climate change and pandemics like drought. Better technology will increase yield, hence reducing the likelihood of famine and malnutrition. While much research and development is being put into smart agriculture systems, but we need a lot of R&D to accomplish sustainable goals at both the industrial and grass-roots levels of modern agriculture.

The Internet of Things (IoT) has totally transformed how we work and live, and it is currently having a big impact on the agriculture industry as well. Crop irrigation systems are one of the most significant IoT applications in agriculture. Crop irrigation systems with IoT capabilities provide an effective and affordable approach to control water usage & quality of water in irrigation.Crop irrigation has always been controlled manually or semi-automatically, which can be labour-intensive and ineffective. With the help of IoT, farmers can remotely monitor and manage irrigation systems, maximising water efficiency and minimising waste. To assess soil moisture, temperature, and other environmental variables, internet of things (IoT) sensors can be buried in the ground. The ideal amount of water required for each crop may then be calculated from this data using machine learning algorithms, and the irrigation system can be modified accordingly. In the case of water quality evaluation, sensors like TDS, turbidity & pH sensors are being used, which helps to supply ideal quality of water to the agricultural fields.

An IoT-enabled irrigation system is made up of numerous parts. To begin, sensors assess soil moisture and other environmental conditions. These sensors can be put in the soil or on the surface, and they can measure moisture levels using various technologies such as capacitance, tensiometry, or time domain reflectometry. Other sensors may detect variables such as temperature, humidity, wind speed, and sun radiation. Moreover, sensors like pH, TDS & turbidity sensors will be dipped in water, from where water is supplied to the fields. This avoids usage of contaminated water in the fields & prevents humans from hazardous diseases like cancer.

The communication network that connects the sensors to a central control unit is the second part of an IoT-enabled irrigation system. To transfer data, this network can use several technologies such as Wi-Fi, cellular, or LoRa-WAN. The central control unit receives sensor data and analyses it using algorithms that consider crop kind, growth stage, and meteorological conditions. Based on this information, the control unit can optimise crop yields by adjusting the amount and timing of water delivery.

The actuators that control water distribution are the third part of an IoT-enabled irrigation system. Actuators can be valves, pumps, or other devices that regulate the flow of water to crops. Based on the data from the sensors, the control unit transmits signals to the actuators, and the actuators respond by opening or closing valves or modifying pump speed to deliver the ideal amount of water to the crops. IoT-enabled irrigation systems have a number of advantages over traditional techniques. First, by delivering the correct amount of water to the crops, they can reduce water usage and waste. This can help farmers save money on water bills while also conserving rare water supplies. Second, by supplying water when and where it is required, IoT-enabled systems can boost agricultural yields and quality. This can result in increased income for producers and higher-quality crops for consumers. Third, by automating the irrigation process and freeing up personnel to focus on other activities, IoT-enabled equipment can minimise labour expenses.

Additionally, the comprehensive analysis of both soil quality and water quality in a particular region provides crucial insights into the environmental conditions. This understanding is instrumental in determining the types of crops that are best suited for the region, ensuring optimal productivity. By delving into the intricate details of soil and water composition, we can make informed agricultural decisions that contribute to sustainable practices and maximize crop yield in the given area.

There are some drawbacks to IoT-enabled irrigation systems. The first cost of installation of sensors, communication networks, and control units is quite expensive, so this expense can prohibit small farmers or those on a tight budget to have such kind of system. Then there's the matter of data security and privacy. Farmers must guarantee that sensor data is protected from unauthorised access or hacking. Third, constant maintenance and calibration of sensors and other components is required to maintain proper operation. Despite these difficulties, IoT-enabled irrigation systems provide significant advantages that could make them an advantageous option for farmers seeking to increase crop yields and decrease waste. These technologies can aid in solving the problems of feeding a growing population while maintaining the environment for future generations by enabling precision farming and the effective use of resources.

The Internet of Things (IoT) is a network of shared physical items that, with an internet connection, may communicate with one another. IoT is crucial to the six agriculture sectors, which by 2050 will be able to feed 9.6 billion people worldwide. Smart agriculture increases crop productivity by reducing waste and making effective use of fertiliser. IoT concept would significantly enhance farmer life and boost crop production efficiency. Farmers who are given visual signals are better informed and more productive in their decision-making. The evaluation of improved data points is aided by various devices that are interconnected, and analysis will benefit farmers. The IoT gadget will make it simple for them to understand every aspect of their soil, water, and fertiliser requirement for the field, giving them the knowledge they need to increase harvests. Farmers may check on the state of their fields from anywhere.

Water shortages and the demand for more sustainable farming practices have pushed irrigation system optimization to the forefront of agricultural research and development. Water loss through evaporation is a serious difficulty for traditional irrigation technologies, resulting in inefficient water utilization and poor agricultural output. Sensor-based irrigation systems, which use advanced sensor technology to precisely monitor soil conditions and crop water requirements, have emerged as a viable answer to this problem. This introduction offers an overview of the necessity of reducing evaporative water loss and illustrates the potential of sensor-based irrigation systems to revolutionize agricultural practices. Evaporation, which is primarily influenced by meteorological variables like temperature, humidity, and wind speed, can significantly affect the effectiveness of an irrigation system. It reduces the quantity of water available for crop development and productivity by causing considerable water loss before reaching the plant roots.

Drip irrigation: Water is provided through drops directly to the plant roots using a technique called drip irrigation. This is done by placing tiny drip emitters at predetermined intervals throughout a network of tubes or pipes that are laid out along the rows of plants. Because it provides water straight to the roots of the plants, where it is most required, this irrigation system is more effective than conventional ones like sprinklers or flood irrigation. As a result, less water is lost to evaporation and runoff. The ability to precisely manage the amount of water provided to each plant is another advantage of drip irrigation for plants. This assists in avoiding overwatering and under watering, both of which can be harmful to plant health.

Since water is only provided to the plants and not to the surrounding soil where weeds may be developing, drip irrigation can aid in water conservation, plant health, and weed reduction.

Drip irrigation system delivers water to the crop using a network of mainlines, sub-mains and lateral lines with emission points spaced along their lengths. Each dripper/emitter, orifice supplies a measured, precisely controlled uniform application of water, with right amount of nutrients which are checked by TDS sensor & other water quality sensors, and other required growth substances directly into the root zone of the plant.

Mist Irrigation System: Mist irrigation is a type of irrigation system that delivers water to plants in the form of a fine mist or fog. This is accomplished through a system of tubes or pipes that are joined to misting nozzles, which release tiny water droplets into the atmosphere. In greenhouses and other enclosed growing environments where high humidity is necessary, mist irrigation is frequently used. In hot weather, it can also be used to cool plants in outdoor growth conditions. Since the mist may be regulated to a specified flow rate, mist irrigation has the benefit of enabling exact control over the amount of water provided to each plant. This may lessen water waste and assist to avoid overwatering. Mist irrigation also has the advantage of raising the humidity levels in the growing area, which is advantageous for plants that need high humidity levels to thrive.

Mist irrigation, however, may not be appropriate for all plant types because some plants may be sensitive to excessive moisture and may be vulnerable to fungi. In order to prevent overwatering, it is crucial to carefully analyse the needs of the plants being cultivated and to keep an eye on the moisture levels in the growing environment. In general, mist irrigation can be a useful technique for watering plants in some situations, but it's crucial to take into account the particular requirements of the plants being produced and to keep an eye on moisture levels to avoid overwatering and lower the danger of fungus diseases.

CHAPTER-2: LITERATURE REVIEW

Galande&Agrawal[1]: This paper explains about the drip irrigation system, Drip irrigation is a type of irrigation system that delivers water directly to the plant roots in a slow and steady manner, drop by drop, through a network of tubes or pipes. This paper also tells by this drip irrigation system water directly drip to the root zone of the plant without waste or run off. It uses up to 50% less water than conventional systems. Before installing the system, we have to check the sediment of water so that we can select the proper filter set up. Subsurface drip irrigation (SDI) gives many advantages as method of water application and also it is useful for controlled release of nutrients into the root-zone. This paper also gives us idea about the irrigation schedule that prior to the planting of plant, irrigation of 12 mm was applied so that it could be planted in the moist soil. After planting, water was supplied to according to the field moisture capacity, based on the water holding characteristics (TDM) of the soil. Irrigation scheduling was based on a combined approach using the soil moisture balance calculated from atmospheric demand and auguring to confirm the balance.

Gracia*et. al.***[2]:** The information and research in this study outlines various methods for managing water during the irrigation process. They took into consideration the works that refer to any type of water pumping actuator as an irrigation system for their analysis. 107 of the 178 papers that were evaluated present an irrigation actuator. The vast majority of studies simply mention the irrigation system's actuators (such as the pump, valve, sprinklers, etc.). Soil moisture is the irrigation parameter that matters the most. An overview of the current state of the art for IoT irrigation systems for agriculture has been provided in the study. Also, they have identified the most often used nodes for IoT and WSN systems for crop irrigation, as well as the most widely used wireless technologies, to characterise the water quality for irrigation, soil, and weather conditions. They have proposed a 4-layer architecture for controlling crop irrigation.

Rajkumar*et. al.***[3]:** This study provides an overview of IoT technology and applications relevant to agriculture. It also suggests a revolutionary irrigation management system. Our main focus in this study is agriculture, where a variety of new technologies result in increased crop growth and water supplies. This paper focus on smart irrigation monitoring system using Arduino and substitute for classical farming methods. They propose an automatic irrigation system for the agricultural lands. Currently automation is one of the important roles in human life. It not only provides comfort but also reduces energy, efficiency and time saving. An automated irrigation system was developed to optimize water use for agricultural crops. Automation allows us to control appliances automatically. The objectives of this paper were to control the water motor automatically and we can also watch live streaming of farms on android mobiles by using wi-fi.

Shekhar*et.al.***[4]:** The *k* Nearest Neighbour(*k*-NN) classification machine learning algorithm has been implemented for evaluating the sensor data in order to anticipate when to irrigate the soil with water. As a result, they have built an Intelligent IoT based Automatic Irrigation system. This is completely automated, with machines interacting with one another and using their intelligence to irrigate. This was created utilising inexpensive embedded devices like the Raspberry Pi 3 and Arduino Uno. A standalone monitoring station that uses a "MSP 430" microcontroller and a collection of weather sensors, including temperature and humidity sensors, has been constructed. Artificial intelligence's "machine learning" technology is crucial in enabling devices to learn without explicit programming. Wireless sensor based system and machine learning have been employed in agricultural monitoring pertaining to Crop Selection and Yield, Crop disease prediction. This data processing information is saved in a cloud server, which farmers can access via their mobile device. This is a complete intelligent IoT-based Automated Irrigation system prototype that was developed where intelligence was developed in training the data set for predicting the soil condition towards watering the field or not, making things easier for farmers by not having to worry about watering the field. Farmers can also view whether or not their agricultural fields have been watered from a web server.

Feng *et.al.***[5]:** The design of a novel kind of emitter for underground drip irrigation systems is covered in the text. The emitter's job is to adjust the water flow rate to the demands of the crops that are being irrigated. Surface irrigation and subsurface irrigation are the two different categories of irrigation systems, according to the text. Water is delivered to plant roots directly using subsurface drip irrigation, which requires installing drip emitters below the soil's surface.

Rao & Sridhar [6]: The agricultural system's potential to impede the nation's progress is addressed in this paper. The only answer suggested in the report is smart agriculture, which modernises the traditional ways of agriculture now in use. Hence, the suggested approach intends to use automation and IoT technology to make agriculture smart. The IoT enables this control of the systems from distant locations via the internet. It has the ability to regulate sensors used in a variety of settings, including water control systems, railway grids, and blinding highways. so that it can prevent both human and system faults from occurring. IoT is the new pitch that has impacted other fields and increased their effectiveness. These days, it advances with the addition of additional sensors, sensor networks, and RF-based communications. It is capable of showing sharp intellect, accurate sensing, and accurate identification. The addition of cloud computing and IoT changed the foundational technologies for computer networks and mobile platforms. Present-day networks including 3G, LTE, GSM, WLAN, WPAN, WiMax, RFID, Zigbee, NFC, and Bluetooth are used to create smart devices and run systems from remote locations.

Phasinam*et. al*.[7]:In this research, a cloud-based architecture and the Internet of Things are used to examine a smart irrigation system. This technology is made to gauge the soil's moisture and humidity levels before processing the information in the cloud with a number of machine learning methods. Farmers receive accurate information regarding water content regulations. Data transmission into WSN irrigation systems is made more efficient by the use of multiple access time division (TDMA). Their application was made to get weather information from weather stations around the locations where it was used. In order to increase productivity, the application calculated the necessary irrigation amounts and automatically scheduled the irrigation systems using both the built-in data and the downloaded meteorological data.Offered a project that used a wireless control system to operate drip irrigation without a human's help. Their model's capacity to gather data on rain was its main advantage.A wireless network-based drought monitoring system that would evaluate meteorological and soil characteristics in order to forecast and identify potential dry spells. Their model may gather and analyse data to determine the best ways to conserve water.

Mekala and Viswanathan[8]: In this study, the primary uses of IoT technology in agriculture are discussed. The architecture of precision agriculture, which incorporates IoT methods for urban agriculture and precision agronomy in smart cities, is discussed. Smart cities frequently rely on software-defined networks (SDN) and cyber-physical systems. This research examined several typical uses for cloud computing-based IoT sensor monitoring network technologies in agriculture. Understanding the various technologies and developing sustainable smart agriculture are the goals of this survey. A wireless network is used to handle a straightforward IoT agriculture concept. Wireless sensor networks automatically analyse sensed data from agricultural field using intelligent software, and this will take a decision that is passed on to the farmer for a healthy crop delivering a greater yield overall.

Nawandar and Satpute[9]: The IoT, which consists of a number of components aimed at improving human comfort, has emerged. The agricultural industry is one such area where it can be useful. While using smart irrigation techniques in the fields, a number of sensors are included, including temperature, humidity, soil moisture, soil pH, wind speed, etc.The irrigation management system described in this study has the ability to retrieve and compress sensor data, communicate compressed data, process data, make decisions, and activate actions.The entire system, which consists of a network of sensors inserted in the plants and three fundamental building pieces, compresses the observed data before sending it to an FTP server that reconstructs it back into its original form. With the 4 inputs, a 2-layer neural network is employed to make decisions in this situation. The user is alerted, and water motors for drip and sprinkler irrigation are turned on and off. The suggested system may monitor a farm's water and other needs in addition to monitoring the test object round-the-clock. Because it can compress data and make decisions, it is beneficial for home gardens, greenhouses, etc. It is also cost effective and operates on batteries, making it beneficial for remote locations and areas with a lack of water for good water management.

Ahmed [10]: The control unit is implemented using the microcontroller ATMEGA328P on the Arduino Uno platform. The system makes use of soil moisture sensors to determine the precise moisture content of the soil. This value enables the system to avoid over- or under-irrigation by using the proper amounts of water. IoT is utilised to inform farmers on thecondition of their sprinklers. The system can autonomously water the field while it is not being watched and determines the irrigation time based on the type of crop, temperature, and humidity readings from sensors. The planned system and the far end communicate via SMS via the GSM network. Readings from the two sensors were also sent to a THINGSPEAK channel in order to generate graphs. ThingSpeak is an open data platform and Internet of Things API that allows to collect, store, analyse, visualise, and act on data from sensors or actuators like Arduino.

Murtiningrum*et. al*[11]: This paper describes that agriculture is the largest user of water resource in the world and it consumes around 70% of total fresh water. As the growth of population, we need 60% more food by 2050 also the demand of water will also increase. To fulfil all the demands, we have to use effective way of irrigation method. There is various way of irrigation method such as surface irrigation, sprinkler irrigation, drip irrigation and mist irrigation. Among all these method drip and mist irrigation are considered to be most efficient. The objective of this paper is to assess the performance of drip and mist irrigation methods for supplying water to vegetables and to suggest irrigation methods that can produce more vegetables per unit of water consumption. Water productivity, which is the amount of vegetable produced per unit of water consumed, is an essential factor to consider when selecting an irrigation method. Drip and mist irrigation methods have been shown to be more efficient in terms of water productivity than surface and sprinkler irrigation.

Kumar&Ravi[12]: The data in the field can be calculated in numerous ways. The most important is data transmission via the GPRS system to remote areas. ZigBee-based transmission is mostly used to gather data in the field from various sensor nodes. This is accomplished using the Wi-Fi module. A microcontroller is interfaced to the ESP8266. The values are periodically updated on the web using this. The system receives the temperature and soil moisture sensing information. The most crucial component for a sensor is energy; without it, a sensor is essentially useless and unable to assess the value of the network. Better battery performance is a result of the designs for dynamic power management. Electrical energy can be produced by power harvesting that uses thermal, wind, solar, and human power. The irrigation system is effective because WSN is integrated into a system that manages the amount of water applied to each field based on the environmental conditions and the feedback provided by the various sensors.

Kansara*et. al*. [13]: The major objective of the research is to give farmers access to an automatic irrigation system that will save them time, money, and energy. Traditional farmland irrigation methods necessitate manual labour. Human intervention can be reduced with irrigation equipment that is automated. These sensors detect changes in the temperature and humidity of the immediate environment and send an interrupt signal to the microcontroller whenever they occur. Using an autonomous microcontroller-based rain gun irrigation system that only activates irrigation when there is a significant need for water, which conserves a lot of water. With the development of the Android software stack which includes an operating system, middleware, and important applications which is utilised for mobile devices, this system changes how field resource management is done.

Ogunti[14]: We can achieve better results by keeping track of the temperature, humidity, and soil moisture without physically being at the farm. Via a network of wireless sensors and WI-FI, the data from the field are obtained. The data is displayed through the data presentation in a way that is human readable. Via a mobile app and online design and development system, these data are evaluated and presented to users. In order to gather temperature, humidity, and soil moisture readings from a farm field and transmit them to a distant user over the internet, DHT11 temperature and humidity sensors and soil moisture sensors were integrated with the MCU (Microcontroller) of the ESP8266 NODE MCU. The ARM CPU of the Node MCU is coupled to temperature, humidity, and soil moisture sensors through a breadboard. These sensors collect environmental data and transmit it via the internet to the web server for additional processing. The system is capable of using sensors to monitor, read, and store data. It can also produce some actions based on the data.

Goapa*et.al.***[15]:**In the precision agricultural environment, IoT-based smart irrigation management systems can aid in achieving optimal water resource efficiency. The smart system described in this study uses open-source technology to estimate a field's irrigation needs by monitoring ground characteristics like soil moisture, soil temperature, and ambient variables, as well as online weather forecast data. The sensing nodes involved in environmental and ground sensing take into account soil moisture, temperature, UV light radiation, air temperature, and relative humidity of the agricultural field. The proposed system's intelligence is built on a clever algorithm that takes into account both sensory data and weather forecast elements including precipitation, air temperature, humidity. The entire system has been created and deployed on a pilot scale, and it wirelessly collects sensor node data over the cloud using web services, while a web-based information visualisation and decision support system offers real-time information insights based on the analysis of sensor and weather forecast data. The system has a feature for closed-loop water supply regulation to enable fully autonomous irrigation.

Anandkumar*et.al.***[16]:** The research explored ultra-low power wireless applications utilising a single 2.4GHz transceiver device with an integrated baseband protocol engine (Enhanced Shock Burst). The embedded baseband protocol engine is based on packet communication and supports a variety of operating modes, including complex autonomous protocol operation and human control. A constant data flow is ensured by internal FIFOs between the radio front end and MCU. Enhanced Shock-Burst reduces system expenses by handling all high-speed link layer tasks. User-configurable components on the radio front include air data rate, output power, and frequency channel. The chip offers a 2Mbps maximum configurable air data rate.Very low power designs are implemented using the NRF24L01's two power-saving modes and high air data rate. A wide power supply range and a high power supply rejection ratio are guaranteed by the internal voltage regulators (PSRR).The irrigation process is automated by this device, which benefits the farmers. We start with the transmission and receiving processes for any wireless system. A soil moisture sensor in the transmission module is used to read the soil data. The Arduino microcontroller is used to interface with the NRF transmitter.

Abioye*et. al.***[17]:** This study describes how irrigation utilises a lot of freshwater and how precision irrigation might increase its effectiveness. This can be done by integrating cutting-edge technology like the IoT to manage, identify, and regulate solutions for prediction and optimisation of irrigation management and monitoring. With the help of wireless network connectivity, IoT may link sensors and gadgets like flow metres, cameras, and robots to the internet in order to measure things like soil moisture, temperature, humidity, and other weather conditions. These sensors' data can be utilised to develop forecasts for data-driven modelling, which will lead to more precise and quick real-time decision-making for agriculture that conserves water. In predictive modelling, specific trends or outcomes for decision-making are predicted using dynamic models and algorithms. The mustard leaf vegetable plant cultivation experiment was carried out in a greenhouse. The roof is made of a transparent plastic nylon and tick net material, and a treated net surrounds and covers the greenhouse to provide natural ventilation and prevent pest attack. To reduce soil erosion, runoff, and save water, an IoT-based drip irrigation system with emitters placed close to the roots zone of the plants was installed to supply water to the coco peat inside the poly bags, which is the growing medium. Coco peat is an excellent plant growing medium with a high water retention capacity.They used an IoT-based monitoring framework comprised of a Davis Vantage Pro 2 weather station and a Raspberry Pi as controller, which was interfaced with various EXPresso Lite2 with a sensor (flowmeter, VH400 soil moisture sensors) to achieve this. The YF-S201 flow metre sensor measures the volume of water used for irrigation at each irrigation time step and is connected to a Raspberry Pi via an ESPressoLite V2.0, where all sensed data is collected for decision making and action based on the Raspberry Pi's scheduling algorithm. They collected all experimental data on comma separated value (CSV) file on the data base of web server.

Paulet.al. [18]: The paper underscores the significance of such systems in preserving the environment, ensuring water source security, and fostering economic growth in rural areas. The focus is on the utilization of pH and Turbidity sensors to assess water quality, with a detailed exploration of various water sources, including wells, lakes, rivers, and ponds. The integration of an effective model that classifies water samples as fit or unfit for human consumption is discussed, with particular attention to the model's validation using Support Vector Machine, Random Forest, and XGBoost methods. The notable achievement of 95.12% accuracy with XGBoost is highlighted. This literature review positions the study as a valuable contribution to the field, emphasizing the practical application of Machine Learning and IoT in real-time water quality monitoring for informed decision-making in rural areas.

CHAPTER-3: PROBLEM STATEMENT

We learned about the current issues in agriculture by reading multiple papers& articles. Traditional farming methods and knowledge become outmoded over time as the pressures of modernisation and globalisation mount. Smart farming employs cutting-edge technology, requires less labour than traditional agriculture, and produces larger yields.

Almost 70% of all fresh water is used for agriculture, which is the world's largest user of water resources. By 2050, we'll need 60% more food than we do today, and water use will rise along with population expansion. We must employ an efficient watering strategy in order to meet all requirements. Flood irrigation involves supplying water to the field through a pipe, a ditch, or another method such that it just flows over the crop's ground. It is customary to assume that only half of the water given by flood irrigation really ends up irrigating the fields, with the remaining half being lost through runoff, evaporation, infiltration of uncultivated fields, and transpiration through the leaves of crops. Flood irrigation is an un-efficient method of irrigation because only 20% of the water is used by the crops. The remaining water is being lost by evaporation, runoff, and seepage. Sadly, farmers still rely on age-old practises that were developed hundreds of years ago.The stated objective for crop irrigation systems is to develop new and efficient irrigation techniques that can optimise water use and improve crop yields while having the least possible environmental impact. Some of the specific issues that must be addressed are as follows:

- *Scarcity of water resources:* As water resources grow more limited, farmers must develop strategies to optimise water usage and minimise wastage.
- *Soil moisture monitoring:* Accurate soil moisture monitoring is crucial for optimal crop irrigation, but traditional soil moisture measurement methods can be time-consuming and labour-intensive.
- *Precision irrigation:* In order to maximise agricultural production, farmers must be able to supply the appropriate amount of water to each plant at the appropriate time. Precision irrigation techniques can aid in this endeavour, but they necessitate complex monitoring and control systems.
- *Cost:* Many farmers, especially small-scale farms, may lack the financial means to invest in advanced irrigation systems. As a result, low-cost solutions are required to

ensure that all farmers have access to effective irrigation systems.

- *Environmental impact:* Traditional irrigation methods can harm the environment by causing soil erosion and water contamination. Irrigation systems should be built to have as little environmental impact as possible.

Ultimately, crop irrigation systems seek to develop creative and efficient strategies for optimising water consumption, increasing crop yields, and minimising environmental effect. By tackling these issues, we can assist ensure that agriculture remains a viable and profitable industry for future generations.

CHAPTER-4: METHODOLOGY

The use of IoT in agriculture may have the one of biggest effects, especially in underdeveloped countries with limited access to infrastructure like cable transmission lines and electricity. The need for additional food must be satisfied in order to combat issues like extreme weather, accelerating climate change, and environmental damage brought on by intensive farming methods. With the use of IoT technologies, growers and farmers will be able to improve production by using less fertiliser and reducing the number of trips that farm vehicles need to make. A high-tech, capital-intensive method of producing food for the masses that is clean and sustainable is known as smart farming. Precision agriculture, commonly referred to as smart farming, is a kind of farming that employs data and technology to increase productivity and efficiency. It entails gathering and analysing data regarding soil characteristics, weather patterns, crop development, and other aspects that influence agricultural productivity using sensors, drones, GPS technology, and data analytics. Making data-driven crop management decisions is one of the main advantages of smart farming for farmers. To reduce water use and increase crop yields, farmers can, for instance, employ soil sensors to monitor soil moisture levels and modify irrigation schedules accordingly. Similar to this, farmers can utilise drones with cameras and sensors to monitor crop development and identify stressed regions so that they can take appropriate action. Water can also be recycled & reused in the farm once water quality is checked using sensors, which will avoid contamination of the field & save wastage of water.

IoT-enabled crop irrigation systems collect and analyse data relating to soil moisture, temperature, moisture in the atmosphere, water quality and other environmental parameters to calculate the appropriate irrigation demands of crops. The following steps are involved in the operation of an IoT-enabled crop irrigation system:

- *Data Collection:* In the field, IoT sensors collect data on soil moisture levels, weather conditions, water quality and other environmental parameters.
- *Data Transmission:* Sensor data is communicated to a central cloud-based platform via wireless connectivity protocols such as Mathwork's Thingspeak software.
- *Data Processing:* Using criteria such as soil moisture levels, weather conditions, and plant growth phases, the cloud-based platform evaluates data to calculate the ideal irrigation demands of crops.

- *Action and control:* Based on the data analysis, the cloud-based platform sends instructions to IoT-enabled irrigation systems to manage the flow of water and mist to crops. This ensures that crops receive the appropriate amount of water, minimising water waste and increasing crop output.

It entails integrating contemporary methods and techniques into farming. A system is created in IoT-based smart farming to monitor the crop field using sensors. As a result, farmers now have the capacity to check on the state of their fields from anywhere. When compared to the traditional method, IoT-based smart farming is significantly more efficient. Due to the unpredictability and uncertainty of monsoon rainfalls, irrigation is a crucial component in agriculture. Water scarcity has made agriculture a significant concern. To increase the effectiveness of irrigation systems, there is a huge demand for technical expertise.

Since the two are intertwined, irrigation and agriculture are closely related. The right amount of soil moisture is necessary for crop growth, but too much moisture can damage the roots of crops, remove a lot of fertiliser, which can pollute the water, and stifle gas exchange between the soil and the atmosphere, which lowers root respiration and growth. An ideal degree of moisture must be guaranteed for good root growth and the general development of the crop because water is essential for seed germination and plant nutrient uptake. Manual irrigation does not target plant roots with any real degree of accuracy. Automated irrigation systems, which encourage water saving, can be designed to disperse more accurate amounts of water in a designated region. Because water is only delivered to the crops if the moisture and temperature on the field fall below the brink (threshold) set by the crop's water requirements, irrigation is automated. Periodically, notifications are delivered to the Web (thingSpeak) to keep him informed about events on his farm. As a result, farmers may check on the state of their fieldsfrom anywhere at any time. Additionally, we can monitor the quality of water on the real-time basis depending on the needs of the crop. Further, suspending the nutrients & fertilizers after assessing the water at the initial stage. As we know, almost 70% of all fresh water is used for agriculture, which is the world's largest user of water resources. It is very crucial to us to save this water, therefore, we must use it as efficiently as possible while minimising our use. Further we are also prioritising human health, prohibiting excess fertilizers & contamination in the soil, just by regulating the water quality. Irrigation is the process of providing water to plants, and there are numerous methods available, including manual irrigation, flood irrigation, drip irrigation, sprinkler irrigation, centre pivot irrigation, localised irrigation, sub-irrigation, mist irrigation, and cutting-edge technology as well. We will be mostly watering the plant with drip and mist irrigation. A plant's root and shoot systems both require water, but in different amounts and for distinct functions.

The root system of a plant takes water and nutrients from the earth. The amount of water required by the roots is determined by several factors, including plant type, soil type, temperature, humidity, and light conditions. Water is necessary for plant growth and development since it is involved in various vital activities such as photosynthesis, transpiration, and nutrient uptake.

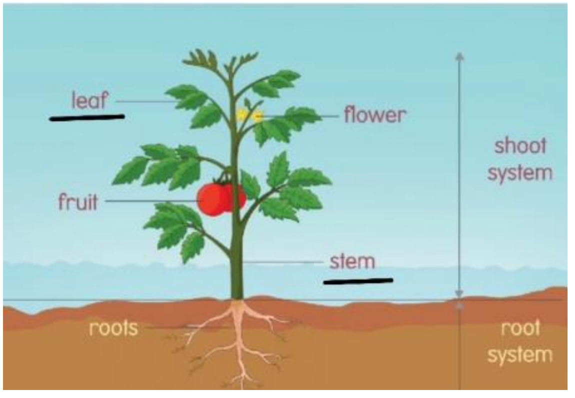


Fig.1: Root and Shoot System of Plant

The upper part of plant is shoot system of plant as shown in figure 1. A plant's shoot system requires water for a variety of reasons, including photosynthesis, transpiration, and chilling. Water and carbon dioxide interact during photosynthesis to make oxygen and glucose. This process occurs in the plant's leaves. Plants shed water vapour through their leaves and stems, which serves to chill the plant and deliver water and nutrients to different regions of the plant. The amount of water required by the shoot system changes according on environmental circumstances and transpiration rate. Temperature, humidity, and wind all have an impact on the rate of transpiration and the amount of water lost by the plant. A plant's root and shoot systems both require water to function correctly and to sustain growth and development. The amount of water required by each system is determined by a variety of factors and varies substantially between plant species.

For the root we will make smart drip irrigation system and for the shoot, we will make the smart IoT enable mist irrigation System. The root systems of plants will be effectively supplied with water and nutrients using a smart drip irrigation system, which will also ensure optimal development and output while minimising water waste. The proper quantity of water and nutrients will be delivered to the plant roots at the right time by employing sensors, actuators, and controls to monitor and regulate the soil moisture content, temperature, and other environmental parameters. Similar to this, a smart IoT-enabled mist irrigation system will be created to deliver water and nutrients to plants' shoot systems as fine mist or droplets. This can help to cool and humidify the plant, lower water loss through transpiration, and enhance nutrient absorption and photosynthesis. This will be done by monitoring and adjusting the temperature, humidity, and other environmental conditions using sensors, actuators, and controls, and delivering the mist or droplets to the plant shoot at the appropriate time and in the proper amount.

We will build a comprehensive and effective irrigation system that will satisfy plants' water needs, enhance their growth and output, and conserve water resources by integrating smart drip irrigation systems for the root with smart IoT-enabled mist irrigation systems for the shoot. In this study, a system is created to manage irrigation and monitor crop fields utilising various sensors namely soil moisture, temperature, humidity, and light. Wireless transmission is used to transfer sensor data to a web server database. The proposed system will calculate the required amount of water based on the data sent by the sensors.

CHAPTER-5: PROPOSED DESIGN

It is crucial to have an effective irrigation system. It became more important for the countries in which the agriculture sector is an important contributor to their GDP. When we design a smart crop irrigation model, all kinds of environmental factors like climate, soil, crop, and water requirements, water quality and availability will be taken into consideration for the water requirements of crops and for reducing water waste. Means all the factors will affect the system.

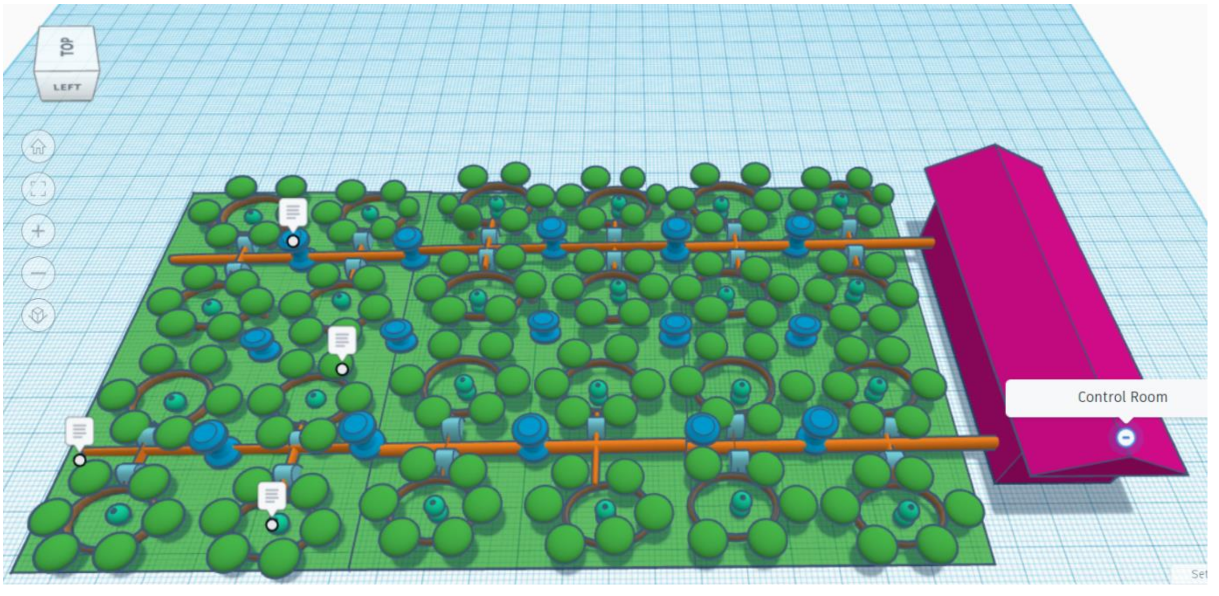


Fig. 2: Top Left View of Proposed Design

Design Link : *https://www.tinkercad.com/things/dMjdUHcVqeX-iot-crop-irrigation/edit*

The purpose of creating a smart agricultural irrigation system is to enhance crop growth, crop health and yield while limiting water loss and giving the crops the appropriate amount of water at the appropriate time. This can be accomplished using a variety of irrigation technologies, including drip irrigation, sprinkler irrigation, and subsurface watering. Plants, as previously stated, require water for both their root and shoot systems. We planned to use drip irrigation for the root part and will eventually move to subsurface irrigation. For the shooting section, we planned to use a sprinkler system as represented in figure 2.

In *our design*, firstly, we will take a rectangular or square field (for the ideal condition), and we will try to irrigate that field by the new hybrid method of drip and mist (fogging)-like systems. For a single unit, we will arrange our plants in a circular manner, with the soil moisture sensor in the center of the plants. As the plant will be arranged in a circular manner, a pipe for the dripping will be there in a circular manner. A main pipe will also be present in the field, and a subcircular pipe will also connect to the field through an electric valve. When our soil moisture sensor discovers the water deficiency in the soil, an electric valve will open, allowing drip irrigation to take place. This is only for the *root of the plant,* as shown in Figure 3.

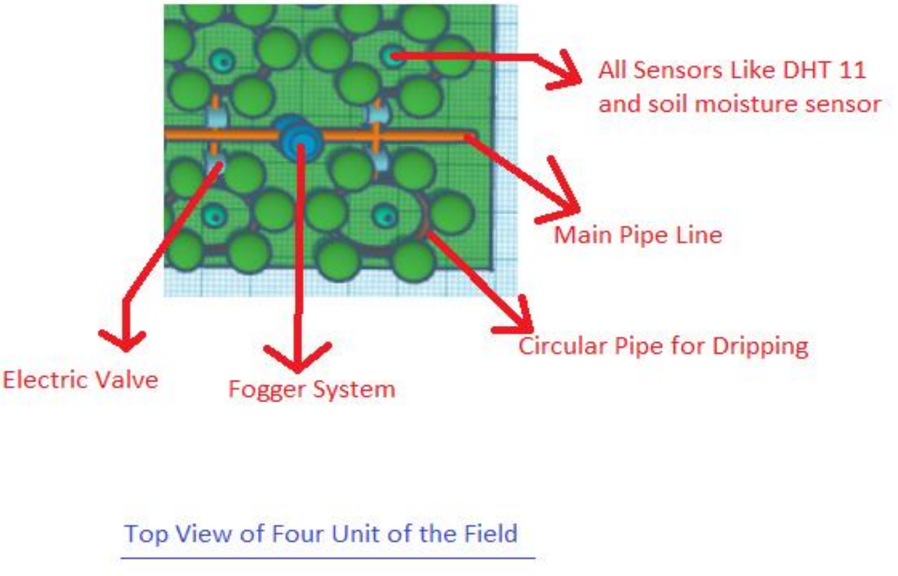


Fig. 3: Description of Proposed Design

{Fogger System => Mist Maker System}

Besides the soil moisture sensor, we will place the temperature and moisture sensor (DHT 11 or DHT 22) on the *shoot of the plant* (upper part of the plant). We will place this along the soil moisture sensor in the middle of the circular plant and the pipe. This DHT 11 or 22 will detect the moisture and temperature of the environment. As the moisture or temperature drops below the threshold value, the mist maker will automatically open. We will place the mist irrigation system in the middle of four units. This means we will place the mist system in the middle of the four circular plant systems as depicted in figure 3.

Our project is mainly divided into two parts: one is for the root of the plant (inside the ground level), and another is for the shoot of the plant (upper of the ground level). For the root of the plant, as we discussed earlier, we will place a soil moisture sensor and connect this with the microcontroller, like Arduino Uno R-4 or Esp 32. We will connect the electric valve to the microcontroller. When the sensor feels there is deficiency of water or moisture in the ground, the valve will open automatically with the help of a microcontroller. We will also send this data to the cloud. In the cloud, we will abstract our data, then visualize and apply different learning algorithms for better understanding.

As we discussed above and in previous reports, that plant required water in the root and shoot as well. On the shoot of the plant, we will place a fogging system. We will create a mist maker that will create the mist or fog. As we abbreviated above, we will place a DHT-11 sensor that senses the environment and the temperature of the atmosphere. We will add this sensor to the microcontroller. When the temperature and atmospheric moisture go below a certain value, the signal goes to the mist maker through a microcontroller to create the fog or mist.

CHAPTER-6: IMPLEMENTATION

6.1: PART - 1

AUTOMATION OF ELECTRIC VALVE, SOIL MOISTURE SENSOR,MICRO-CONTROLLER AND CLOUD FOR THE ROOT OF PLANT

In this part, we will connect sensor to micro-controller after that with the help of electric valve and relay, we will automate the things. The design aims to use a soil moisture sensor and send data to a cloud service for analysis. The sensor, through a microcontroller, will control the electric valve for watering the plants. The circular pipes for the drip to the plant are connected to the main pipe line through an electric valve.

- ***BLOCK DIAGRAM OF THE WORKING OF PART 1:***

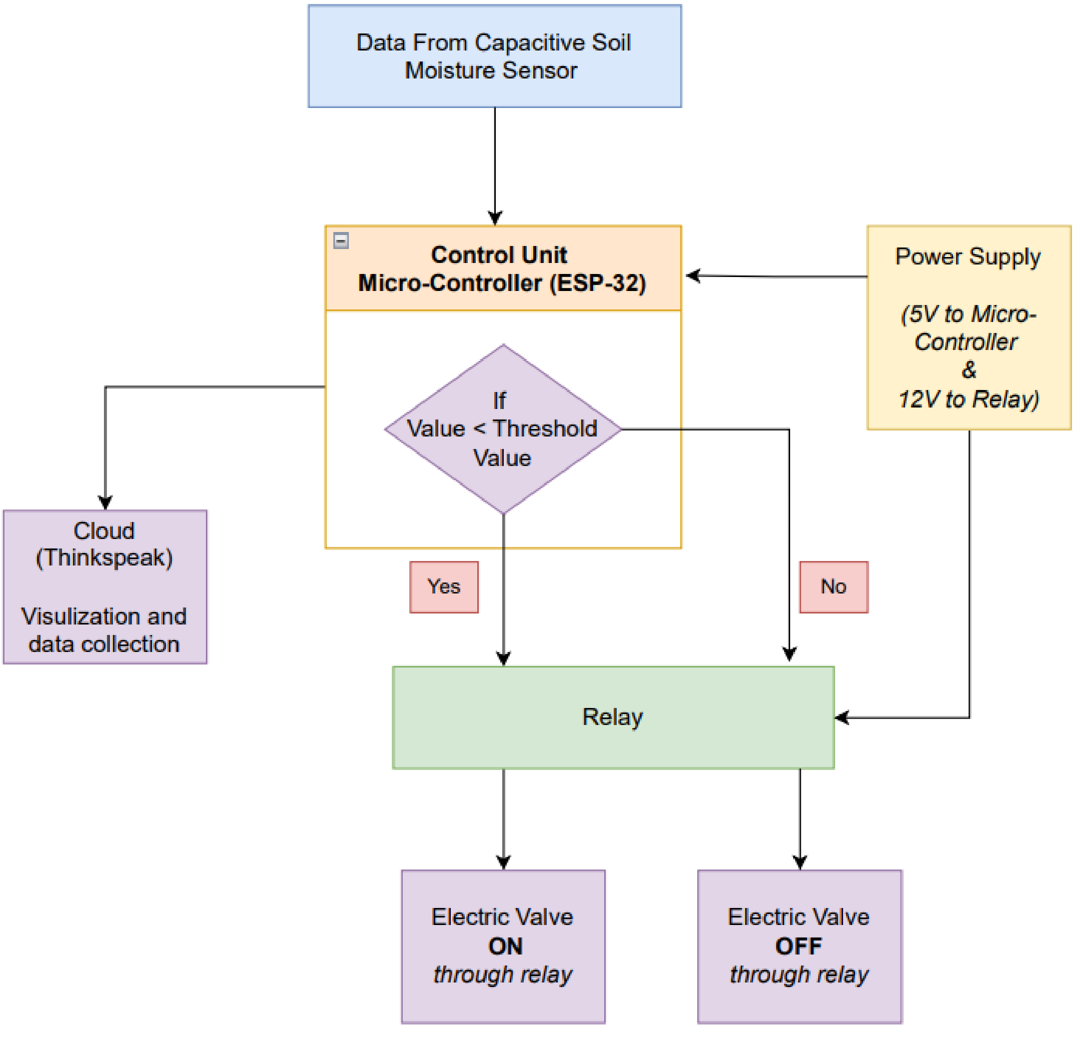


Fig. 4: Block Diagram of Part 1

As we describe in figure 4, firstly we connected capacitive soil moisture sensor to micro-controller (currently we are using Esp 32). In micro-controller, we set a threshold value of moisture. We set threshold value according to set the crop and seeing the soil. Through micro-controller, we connected a relay and because this micro-controller is Wi-Fi enabled, we connected it to cloud. Currently, we are using thingSpeak as cloud (a platform of Mathworks). We are using thingSpeak as cloud because of visualization and better data collection. Till now, we have connected relay to micro-controller. After connecting relay, we connected relay to electric valve. According to soil moisture sensor (condition/controlling value), our electric valve will open or close.

- ***MICROCONTROLLER WITH SOIL MOISTURE SENSOR:***

We created a simple setup for the experiment using a capacitive soil moisture sensor and an esp32 microcontroller. We filled a glass with half a cup of water and soil, and then our sensor was inside the glass as shown in figure 5. We will transfer this data to the cloud using an ESP-32 microcontroller.

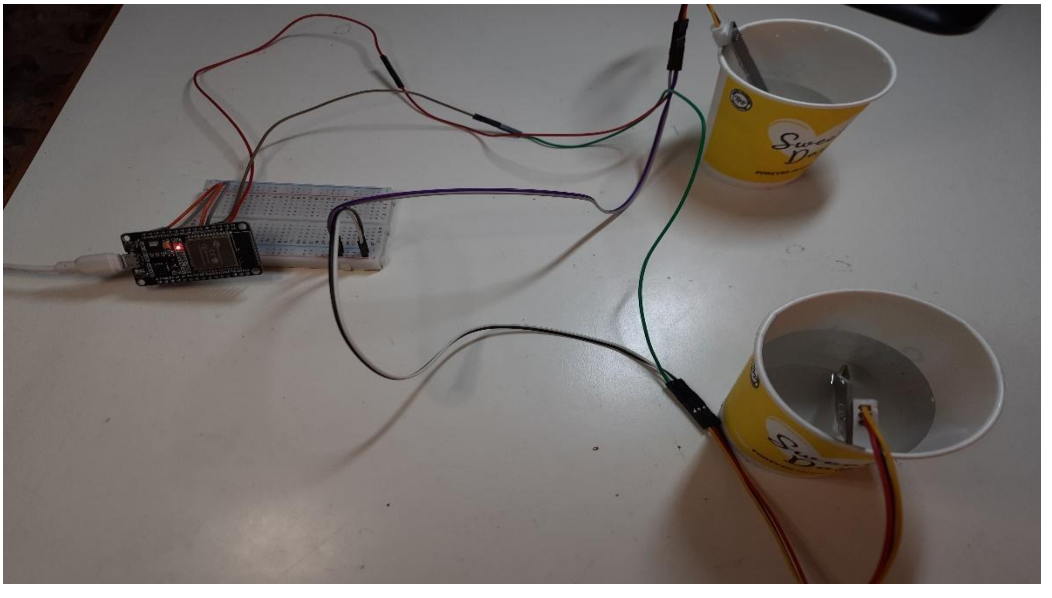


Fig. 5: Model of Soil Moisture Sensor and Microcontroller

First, we connect our sensor to the esp32, and then we connect the esp32 with our laptop, and then we write the code in the Arduino IDE as shown in figure 6. After that, we will send this data to ThingSpeak (a cloud platform from Mathworks). In the esp32, we will visualize our data as shown in figure 7.

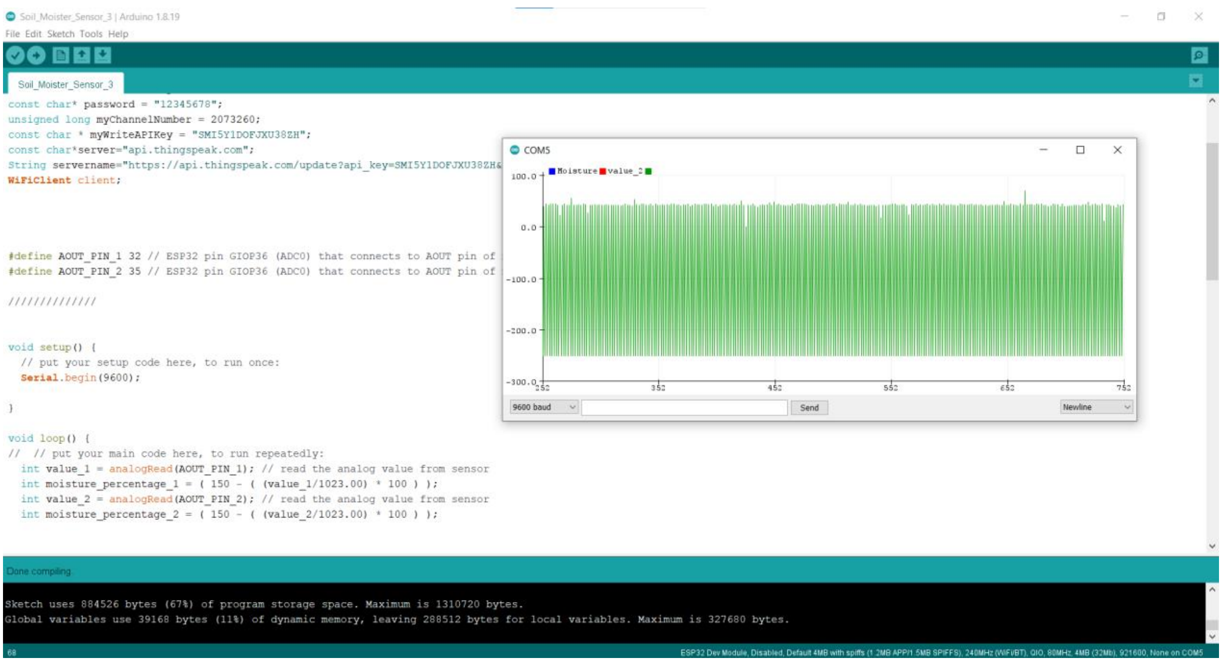


Fig. 6: Interface of Arduino IDE with code

(Code of Arduino IDE present in appendix section)

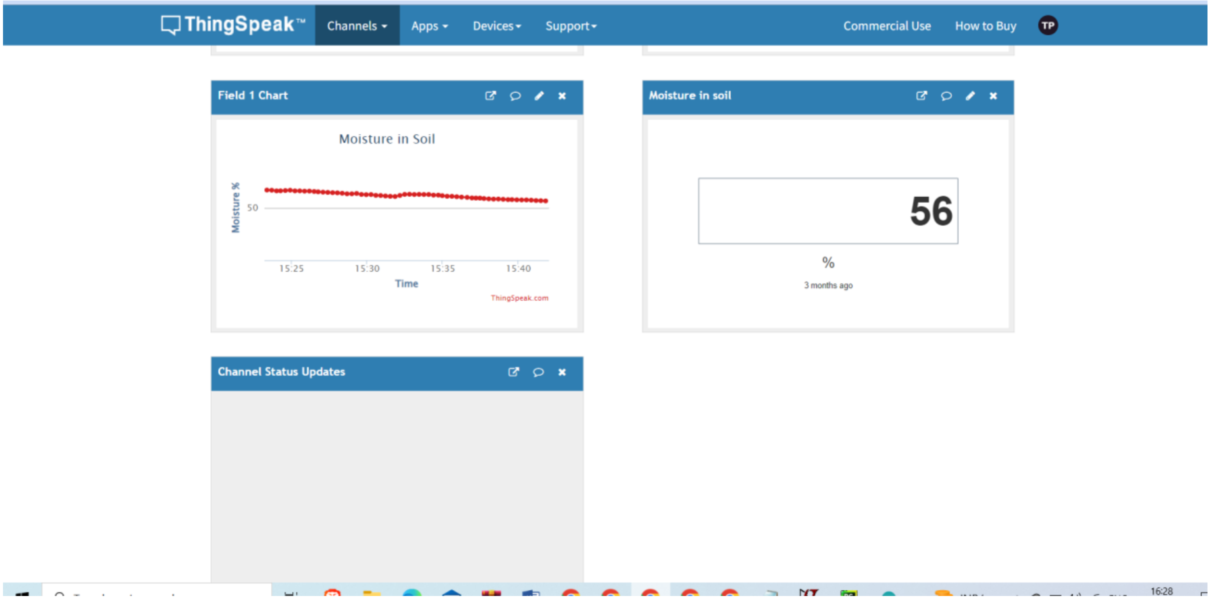


Fig.7: Interface of Cloud Think-Speak with Visualization of soil moisture set up of figure 5

- ***12V DC SOLENOID ELECTRIC VALVE:***

A 12V DC 1/2" Electric Solenoid Water Air Valve Switch (Normally Closed), as shown in figure 8, is a specific type of solenoid valve designed to control the flow of water or air in applications where the valve is normally closed when not energized. Here's an explanation of its working principle and construction:

Fig. 8: 12V DC 1/2″ Electric Solenoid Water Air Valve Switch (Normally Closed)

Construction:

The construction of a 12V DC 1/2" Electric Solenoid Water Air Valve Switch (Normally Closed) typically includes the following components

1.*Solenoid Coil:* The coil is wound around a bobbin or spool and connected to electrical terminals for the 12V DC power supply.

2.*Plunger (Armature):* The plunger is made of a ferromagnetic material and moves within the solenoid coil.

3.*Valve Body:*The valve body houses the orifice, valve seat, and fluid passages. It is constructed from materials compatible with the type of fluid being controlled (e.g., brass or stainless steel for water applications).

4.*Return Spring (if applicable):* Some valves include a spring to provide a default closed position for the plunger when the solenoid is de-energized.

5.*Electrical Connectors:* There are typically electrical connectors or terminals for connecting the valve to the 12V DC power source.

Working Principle:

The working principle of this solenoid valve is based on the electromagnetic attraction of a plunger when an electrical current is applied to the solenoid coil. Here's how it works

1.*Solenoid Coil:*The valve contains a solenoid coil, which is typically wound with copper wire and connected to a 12V DC power source. When current flows through this coil, it generates a magnetic field.

2. *Plunger (or Armature):* Inside the solenoid coil, there's a plunger or armature. This plunger is made of a ferromagnetic material (such as iron or steel) and is free to move within the coil.

3. *Valve Seat and Orifice:* The valve has an orifice (an opening) and a valve seat that controls the flow of fluid (water or air) through the valve. In the normally closed configuration, the valve seat is closed, preventing fluid flow.

4. *Return Spring (if applicable):* Some solenoid valves, including this type, may have a return spring that pushes the plunger towards the closed position when the solenoid coil is not energized.

Operation Sequence:

The operation of a 12V DC 1/2" Electric Solenoid Water Air Valve Switch (Normally Closed) typically follows these steps:

1. *De-energized (Valve Closed):* When the 12V DC power supply to the solenoid coil is turned off, the coil generates no magnetic field. In this state, the plunger is held in its default position, often by the force of a return spring. In the normally closed configuration, the plunger is pressed against the valve seat, sealing the orifice and preventing the flow of fluid.

2. *Energized (Valve Opens):* When 12V DC power is applied to the solenoid coil, it generates a magnetic field. This magnetic field attracts the ferromagnetic plunger, pulling it away from the valve seat against the force of the return spring. As the plunger moves, it opens the orifice, allowing fluid (water or air) to flow through the valve.

3. *De-energized Again (Valve Closes):* When the electrical power is removed from the coil (i.e., it's de-energized), the magnetic field dissipates. The return spring, if present, pushes the plunger back into its default position, sealing the valve seat and closing the orifice. The valve returns to the normally closed position.

These solenoid valves are commonly used in various applications, including controlling water flow in irrigation systems, regulating air flow in pneumatic systems, and automating fluid control in industrial processes. Their normally closed configuration ensures that they remain closed in case of power failure, making them suitable for safety-critical applications.

AUTOMATION OF ELECRIC VALVE WITH MICRO – CONTROLLER THROUGH RELAY:

In this part, we mainly connect micro-controller, relay and electric valve. Currently we are not using soil moisture sensor but we are giving or putting manually through Arduino IDE. In this section, we combined Arduino Uno with relay and Arduino IDE. Also we combined relay to 12V DC power supply, Arduino Uno and LED & electric valve. If manually value (in future value form soil moisture sensor) is less than threshold value than Arduino Uno will send ON signal to relay and 12V DC form power supply will go to electric valve through Led. In ON condition Led will on and voltage across electric valve will be power supply voltage as shown in figure 9.

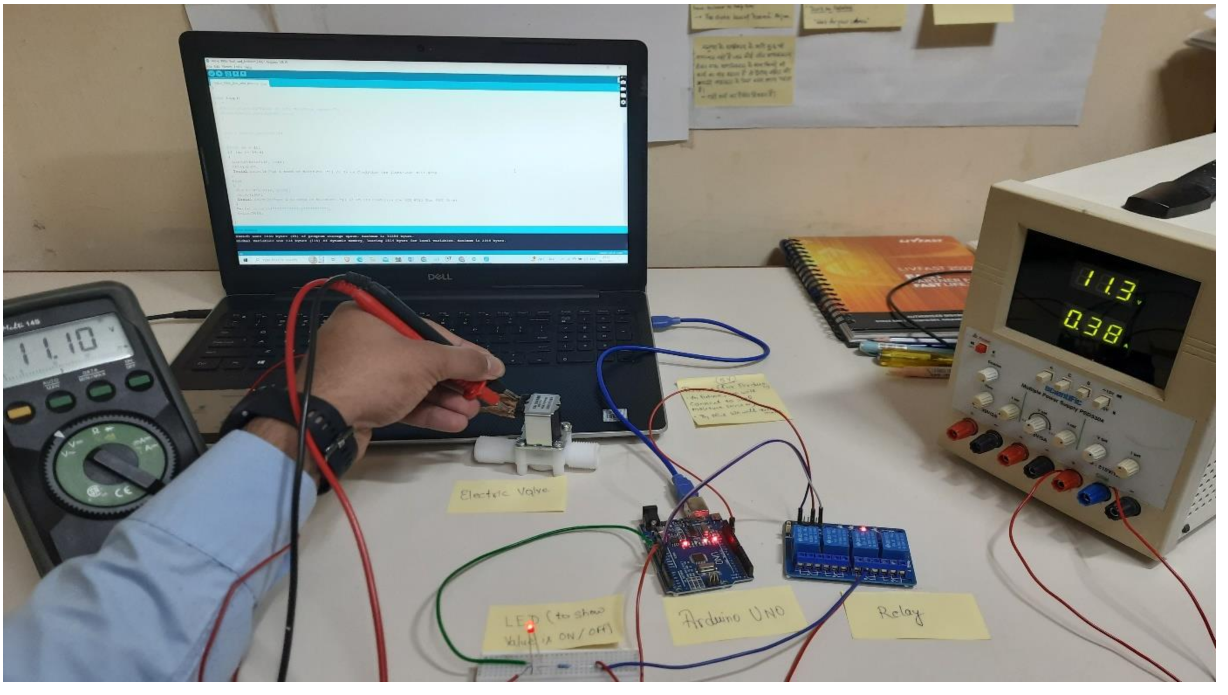


Fig. 9: Automation of Electric Valve through Relay and Arduino Uno (Currently ON Condition of Electric Valve and LED is ON)

In other hand, If we want to close the electric valve than we have to change the value through Arduino IDE. If the value from the soil moisture sensor is greater than the threshold value, Uno will send OFF signal to relay and 12V DC form power supply will NOT go to electric valve through LED. In OFF condition LED will turn OFF and voltage across electric valve will be approx. Zero Volts as shown in figure 10.

Fig. 10: Automation of Electric Valve through Relay and Arduino Uno (Currently OFF Condition of Electric Valve and LED is OFF)

Working Sub-model video link:
https://drive.google.com/file/d/11bd9CkVyL34TdvoXfJiysQUmwOYHyzc-/view?usp=sharing

6.3: PART 2:

AUTOMATION OF MIST IRRIGATION USING DHT 22, MIST MAKER SYSTEM, MICRO-CONTROLLER & RELAY MODULE

In this section, we will focus on irrigation of shoot of the plant. We will irrigate shoot part form the mist of water. We will connect Ultrasonic Humidifiers, Digital Humidity and Temperature sensor (DHT 22), micro-controller and relay. After Connection, we will automate the irrigation of shoot part. DHT 22 sensor measures humidity and temperature through micro-controller. We will connect sensor to micro-controller after that with the help of Ultrasonic HumidifiersCktand relay, we will automate the things. The design aims to use a DHT 22 and send data to a cloud service for analysis. The sensor, through a microcontroller, will control the Ultrasonic Humidifiers for watering the plants by mist.

- ***BLOCK DIAGRAM OF THE WORKING OF THIS (PART 2):***

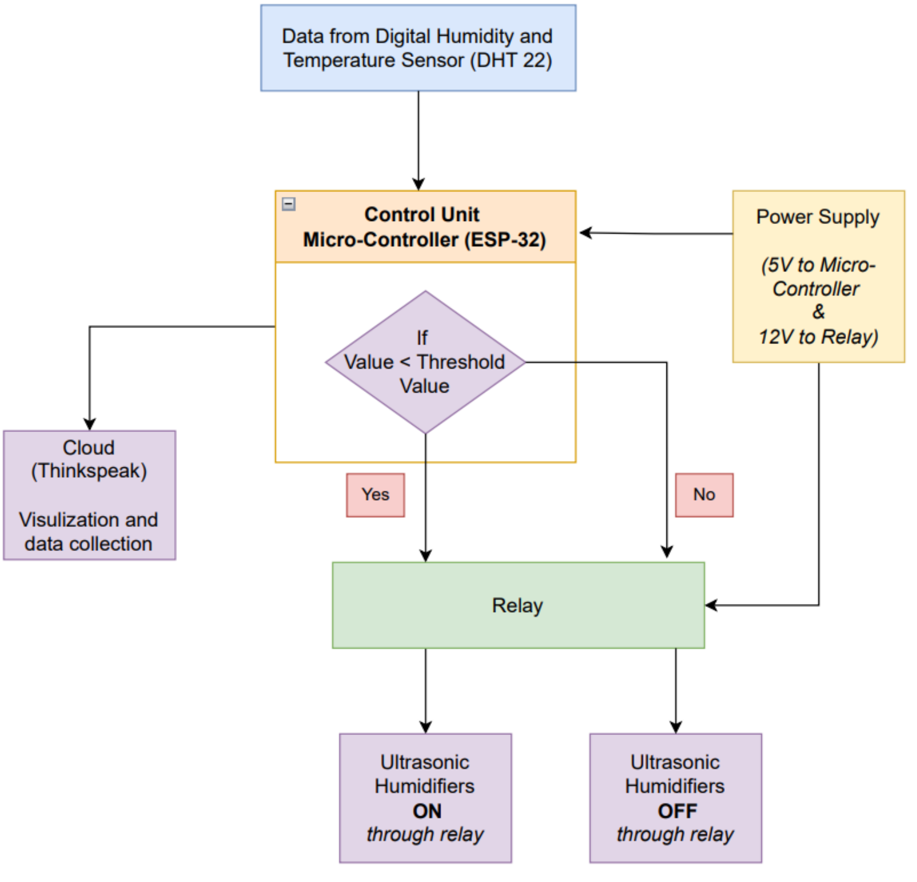


Fig. 11: Block Diagram of Part 2

As we describe in figure 11, firstly we connected DHT 22 sensor to micro-controller (currently we are using Esp 32). In micro-controller, we set a threshold value of moisture/Humidity. We set threshold value according to the crop and seeing the soil. Through micro-controller, we connected a relay and because this micro-controller is Wi-Fi enabled, we connected it to cloud. Currently, we are using thingSpeak as cloud (a platform of Mathworks). We are using thingSpeak as cloud because of visualization and better data collection. Till, we have connected relay to micro-controller. After connecting relay, we connected relay to Ultrasonic Humidifiers Circuit. According to Humidity and Temperature of shoot(upper part from the soil) (condition/controlling value), Ultrasonic Humidifiers Circuit will open or close means it will mist the shoot of the plant or not.

- ***MICROCONTROLLER WITH DHT11 BOTH SIMULATION & HARWARE MODEL:***

For creating mist like system, we use humidity sensor and temperature (DHT 11), micro controller and ultrasonic transmitter Cktusing 555timer ic. For sensing the moisture and temperature of shoot, we are using DHT11 sensor. DHT 11 send the data of moisture and temperature to micro-controller (Esp32). Esp32 send this data to cloud as well to flogger system circuit so that fog can be generated as shown in figure 12.

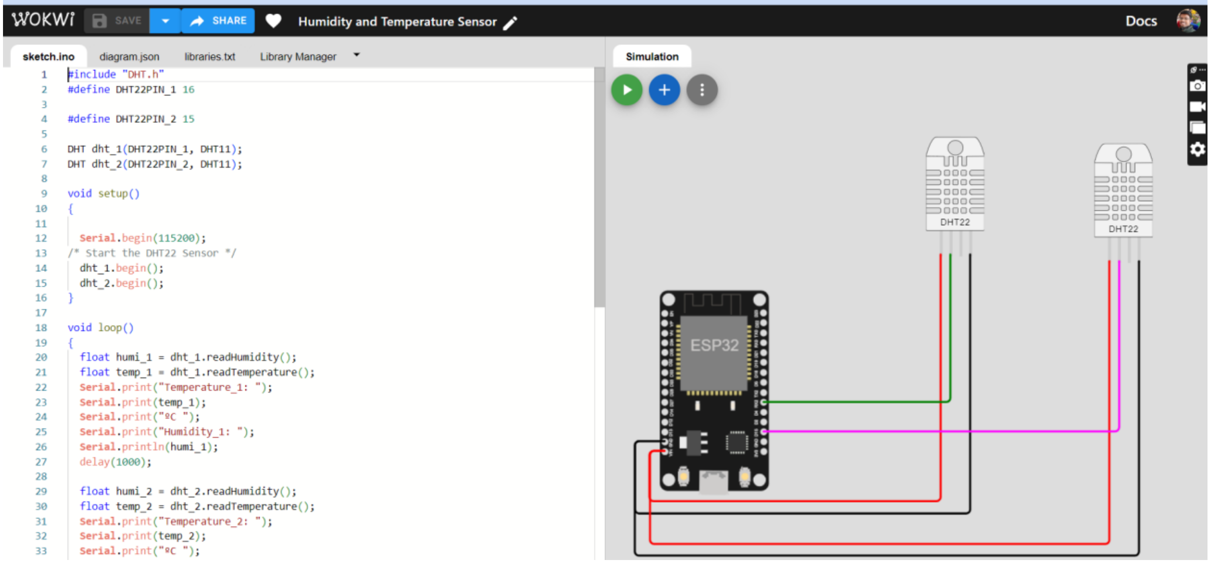


Fig.12: DHT11 with Esp32 simulation

Design link: https://wokwi.com/projects/365808618213764097

We used DHT-11 (a humidity and temperature sensor) and connected it to a microcontroller. After this, we will connect it to the ultrasonic transmitter Circuit using 555 timer IC to create the mist-like system. We are using a DHT11 sensor to measure the moisture and temperature of the shot. The microcontroller (Esp32) receives moisture and temperature data from DHT 11. Esp32 sends this information to the flogger system circuit and to the cloud, as seen in figure 16, to create the fog.

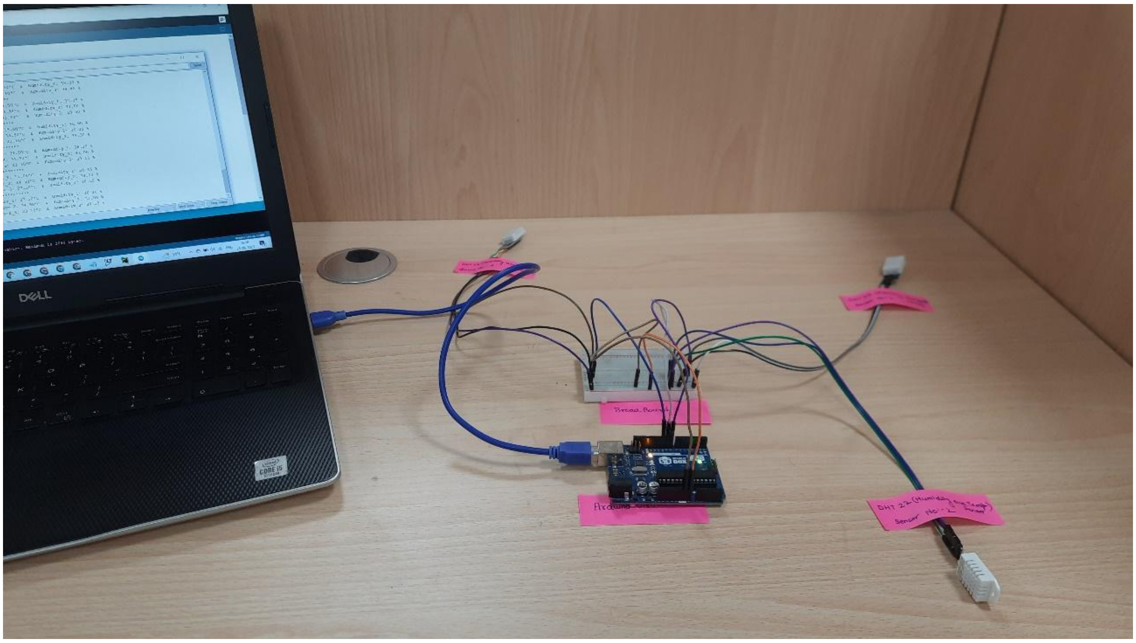


Fig.13: Working Model of DHT11 with Esp32

Working Model link: https://drive.google.com/file/d/1Y7RhqLpSUxYEsR2-zsqlgTJs8wztOFYp/view

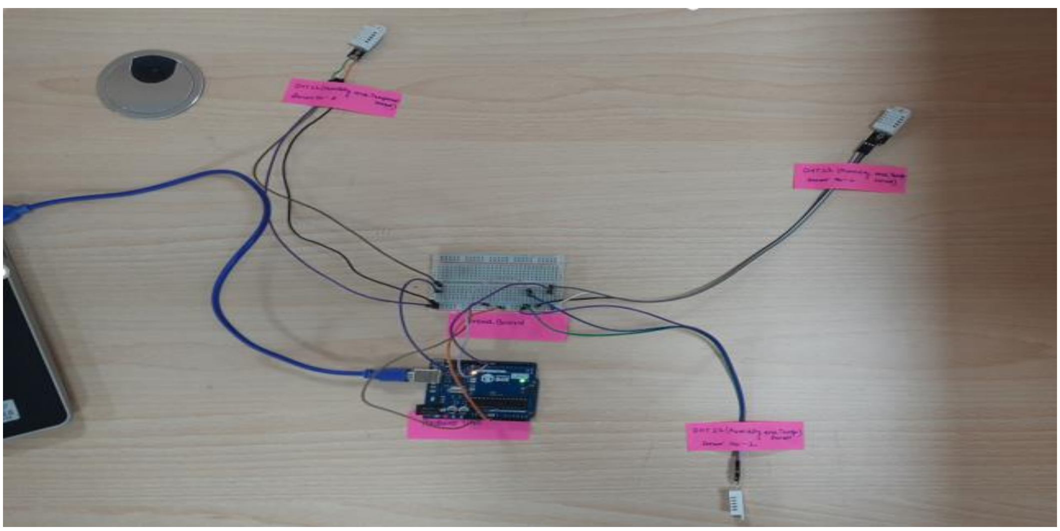


Fig. 14: Top View of System (DHT11 with Esp32)

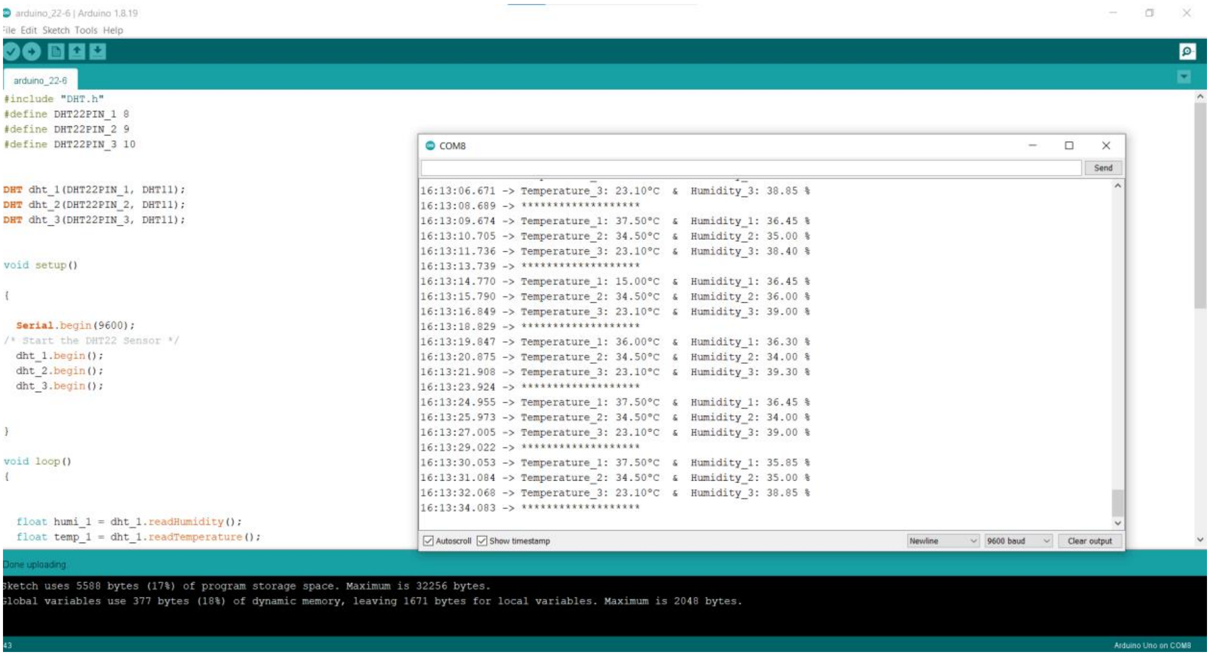


Fig. 15: Interface of Arduino IDE with code for DHT 22

(Code of Arduino IDE Present in appendix section)

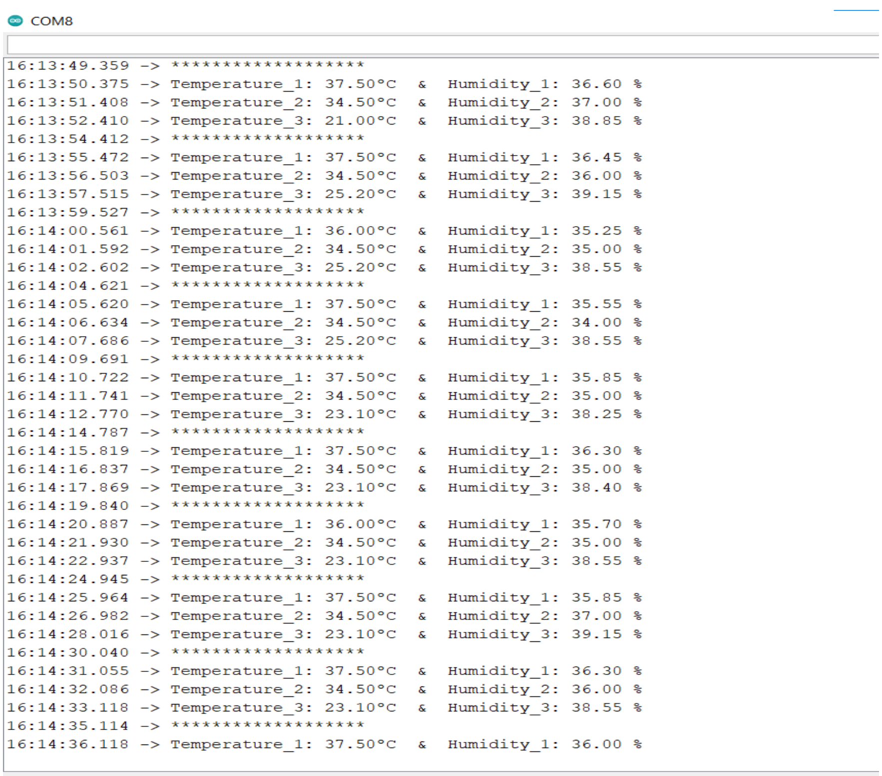


Fig. 16: Data Coming from Sensor (DHT 11) and Microcontroller

- ***ULTRASONIC TRANSMITTER CIRCUIT USING IC 555 (BOTH SIMUATION & HARWARE MODEL) AND IT'S WORKING:***

The 555 timer IC is a versatile integrated circuit used in electronic circuits for various applications, including generating precise timing signals. In ultrasonic transmission circuits, it can be used to generate the required frequency for driving an ultrasonic transducer. To construct an ultrasonic transmission circuit using a 555 timer IC, connect pins 8 (VCC) to the positive terminal of the power supply and pin 1 (GND) to the negative terminal. Disable reset functionality and keep control voltage constant. Connect a resistor (R1) between pins 7 (Discharge) and pin 8 (VCC), a capacitor (C1) between pins 6 (Threshold) and pin 1 (GND), a resistor (R2) between pins 7 (Discharge) and pin 6 (Threshold), and a capacitor (C2) between pins 2 (Trigger) and pin 1 (GND).

Adjust the values of R1, R2, C1, and C2 to obtain the desired frequency for ultrasonic transmission. Apply power to the circuit, and the 555 timer will generate the required frequency at pin 3 (Output), connected to the ultrasonic transducer. The transducer converts the input pulse into ultrasonic sound waves. Piezoelectric crystals, typically made of nitride, change size when a voltage is applied, resulting in high-frequency sound waves. Some components use alternative methods to generate ultrasonic waves, such as transistors driven by crystals.

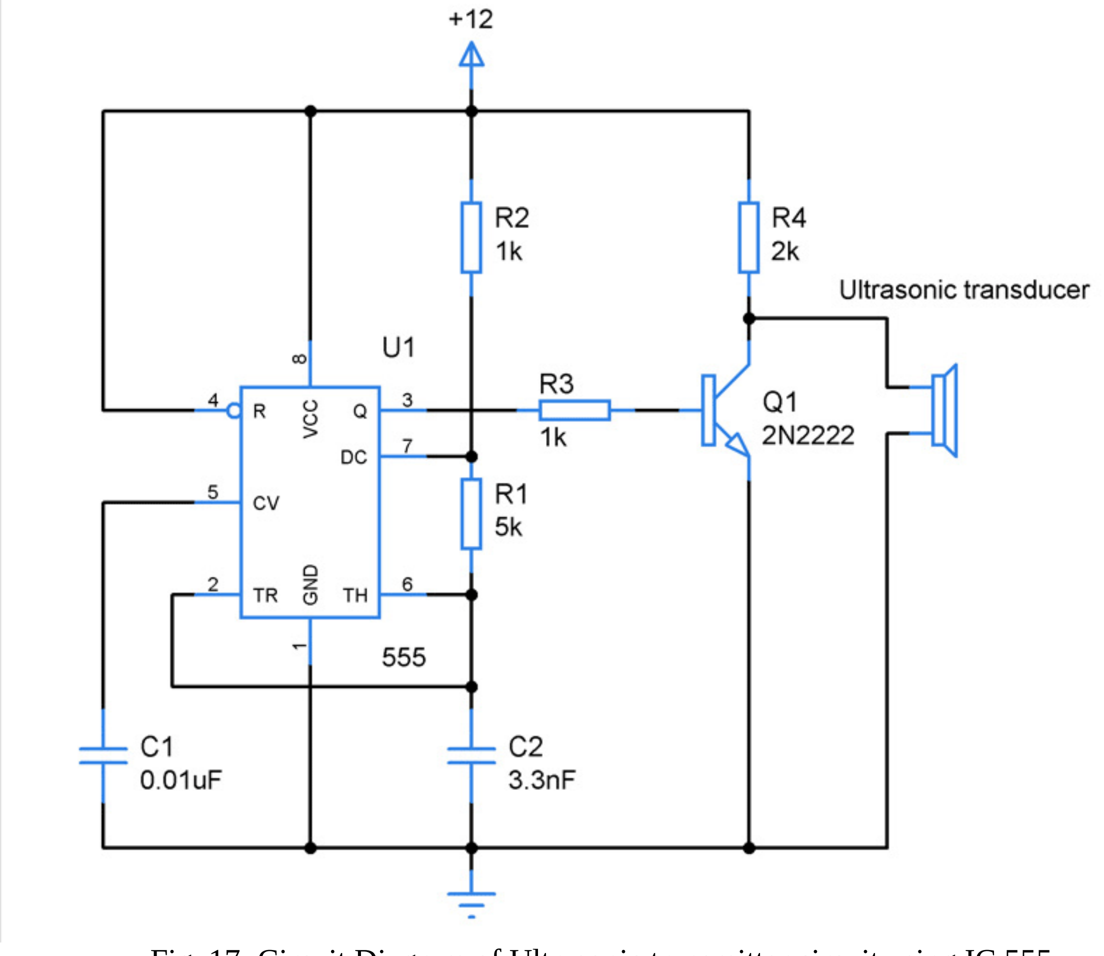


Fig. 17: Circuit Diagram of Ultrasonic transmitter circuit using IC 555

__Simulation of an ultrasonic transmitter circuit using IC 555 for the fogging system:__

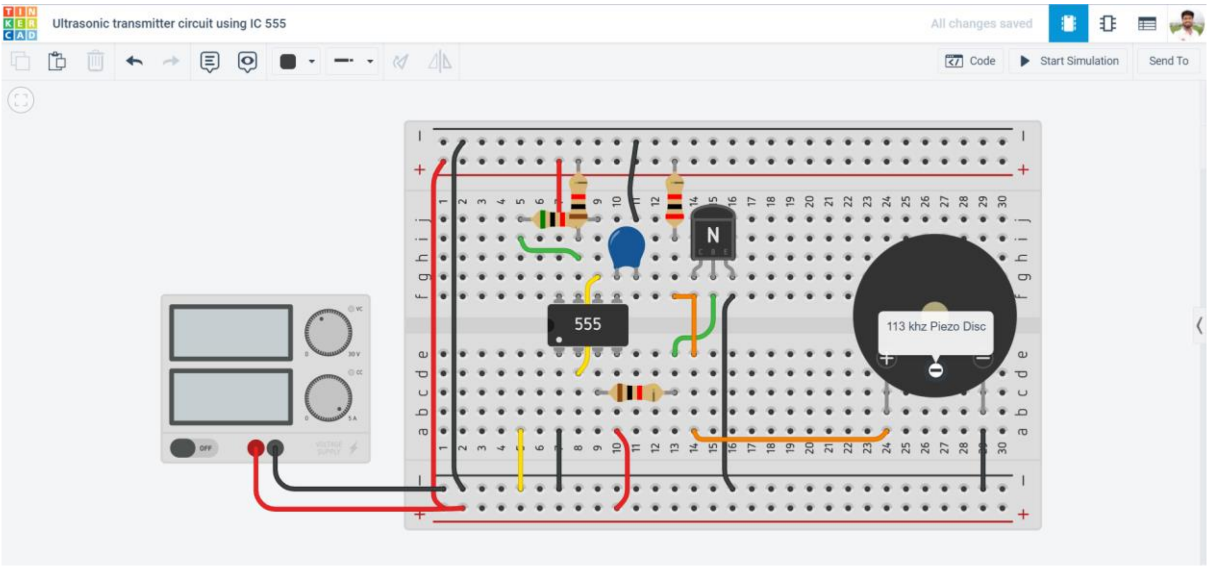


Fig. 18: Simulation of Ultrasonic transmitter circuit using 555 IC

Circuit Diagram link: https://www.tinkercad.com/things/eMwVDgawjb6

Working Model of Ultrasonic Transmitter Circuit Using IC 555 for the System:

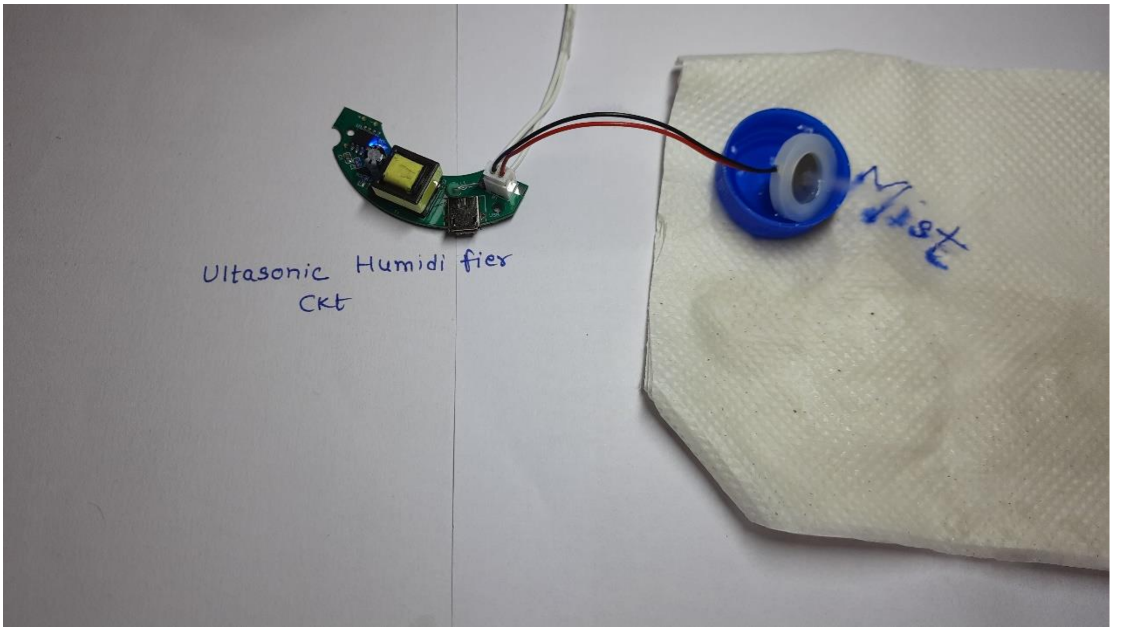


Fig. 19: Working Model of Ultrasonic transmitter circuit using 555 IC

Working Model link:
https://drive.google.com/file/d/17uICYctvZBPnXjWDMjlaNjXZfbzjO-3E/view?usp=sharing

- **AUTOMATION OF MIST MAKER SYSTEM WITH DHT-22, MICRO – CONTROLLER THROUGH RELAY:**

we have emphasised our dedicated focus on optimising the growth and development of the system's shoot through innovative methods, with particular attention to the integration of fogging systems and environmental control measures. In pursuit of this objective, we have taken significant steps to enhance the overall cultivation environment. This month, a pivotal achievement was the successful establishment of a compact and efficient setup. This setup relies on a sophisticated array of sensors, including the DHT 22, a microcontroller of the calibre of the Arduino Uno R3, and a strategically designed ultrasonic transmitter circuit utilising the 555 timer IC. The seamless coordination and synchronisation of these components are facilitated through a relay system, ensuring the precise and timely execution of various tasks critical to maintaining the shoot's health and productivity.

The integration of these elements in our setup represents a pivotal milestone in our project's progress. The DHT 22 sensor provides real-time data on temperature and humidity, allowing us to fine-tune the environmental parameters to suit the specific needs of the shoot. Meanwhile, the Arduino Uno R3 microcontroller serves as the brain of the operation, processing data and executing commands with remarkable precision. The ultrasonic transmitter circuit, driven by the versatile 555 timer IC, plays a crucial role in monitoring distances and facilitating automated adjustments as required.

With this setup in place, we are well-equipped to implement fogging systems that will significantly improve the shoot's growth conditions. The fogging system will enable us to regulate humidity levels effectively, providing the shoot with an environment conducive to robust development. As we proceed with our research and development, we anticipate that this innovative setup will be instrumental in achieving our goals of sustainable and optimised shoot growth through controlled environmental interventions.

Brief Description of Relay:

A relay is an electromechanical switch that is used to make or break an electrical connection in a circuit. It consists of two main components: a coil and one or more sets of contacts. Here's a brief description of these components and how a relay works:

- *Coil:* The coil is an electromagnetic winding typically made of copper wire. When an electrical current is applied to the coil, it generates a magnetic field. This magnetic field causes the coil to become magnetised.
- *Contacts*: Relays have one or more sets of contacts, which are switch-like terminals that can be either open or closed. These contacts are usually made of conductive materials like metal.

How a Relay Works:

Normally Open (NO) and Normally Closed (NC): Relays can have two primary contact states: normally open (NO) and normally closed (NC). In the NO state, the contacts are open (not touching), and in the NC state, the contacts are closed (touching) as shown in figure 20.

- *Activation:* When an electrical current flows through the coil of the relay, it creates a magnetic field. This magnetic field causes the movable part of the relay, which is connected to the contacts, to either move towards or away from the stationary contacts.
- *Switching:* Depending on the design and purpose of the relay, the magnetic field's effect on the movable part can either open or close the contacts. If the relay is NO, applying current will close the contacts, and if it is NC, applying current will open them. This change in contact state can control the flow of electrical current in another part of the circuit.

Fig. 20: 5 Volt - 4 Channel Relay

Relays are widely used in various applications, including automation, control systems, and electrical circuits, to isolate and control high-voltage or high-current circuits using low-voltage signals. They provide a way to electrically control a circuit without the need for direct physical interaction, making them valuable components in both industrial and electronic applications.

Proposed Model:

In the development of our prototype fogger model, we embarked on a systematic process to ensure the effective integration of key components. Our journey began with the incorporation of the DHT 22 sensor, which was meticulously connected to the versatile Arduino UNO R3 microcontroller. This initial step laid the foundation for the data acquisition and control aspects of our fogging system.

To enable seamless control over the fogging process, we employed a four-channel relay, strategically interfacing it with both the ultrasonic transmitter circuit and the Arduino in its normally closed (NC) configuration. In the NC configuration, the relay becomes active when an input signal is low. This choice of configuration allowed us to establish a fail-safe mechanism wherein the fogging system would remain inactive by default, ready to respond to specific triggers.

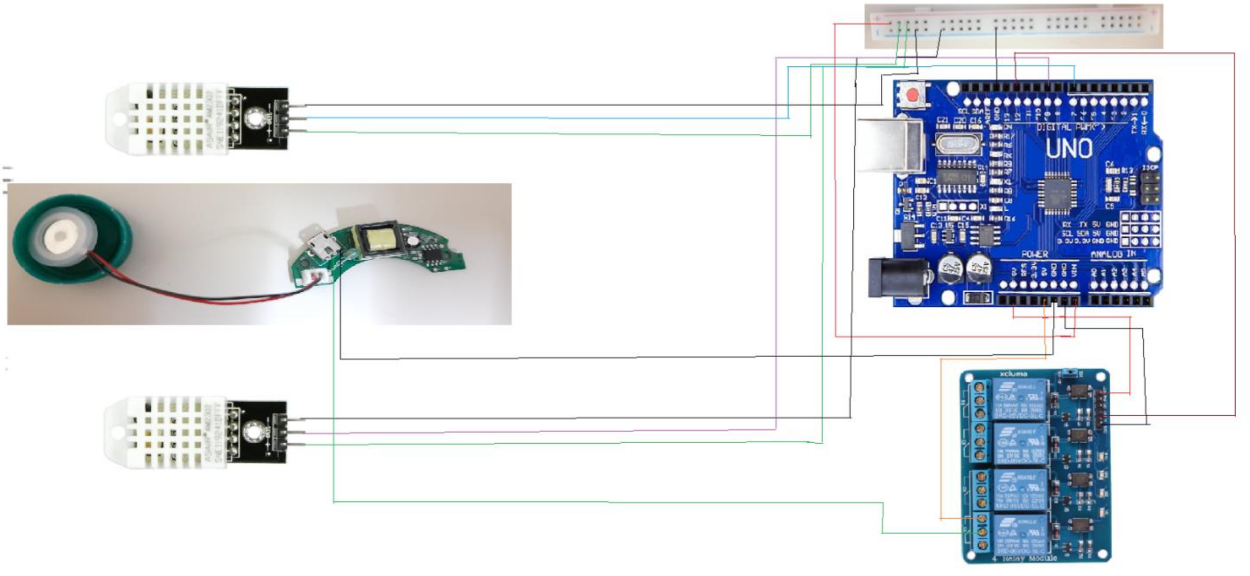


Fig. 21: Circuit Diagram of the Mist Maker System

Circuit Diagram Photo Link:

https://drive.google.com/file/d/1uvO6PZAoHnR-nfae1mAE_Uny_Yd87UXG/view?usp=sharing

The pivotal role of programming came into play after the hardware components were effectively interconnected. Within the code, we set a critical threshold value of ***19*** (*nineteen percentage points*). This threshold served as the reference point for initiating the fogging process. In essence, when the sensor's data indicated a humidity level lower than 19, it signalled the Arduino to activate the fogger, initiating the mist generation process as shown in figure 21. Conversely, if the humidity value exceeded 19, the fogger would remain in a closed state, ensuring that mist production was only triggered when necessary.

This carefully designed control mechanism not only ensures the efficient use of resources but also guarantees that the fogging system responds precisely to the shoot's requirements. As we continue to refine our prototype fogger model, this combination of hardware and software components promises to provide a reliable and intelligent solution for optimising the shoot's growth environment through controlled fogging operations.

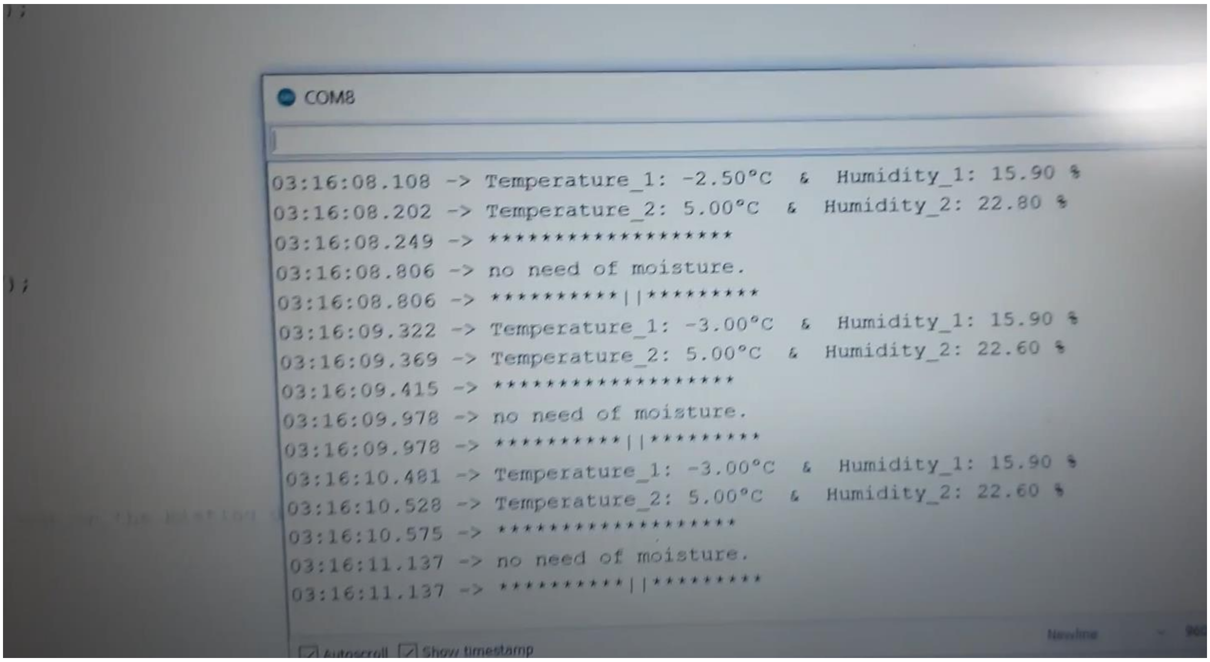


Fig. 22: Data Set Created by Mist Maker System (Sensors and Model)

Data set created by Model:

https://docs.google.com/document/d/1O2bRlRJdgXJ2x0Xf71C1H_txsIhg19mq/edit?usp=sharing&ouid=110914689408116988817&rtpof=true&sd=true

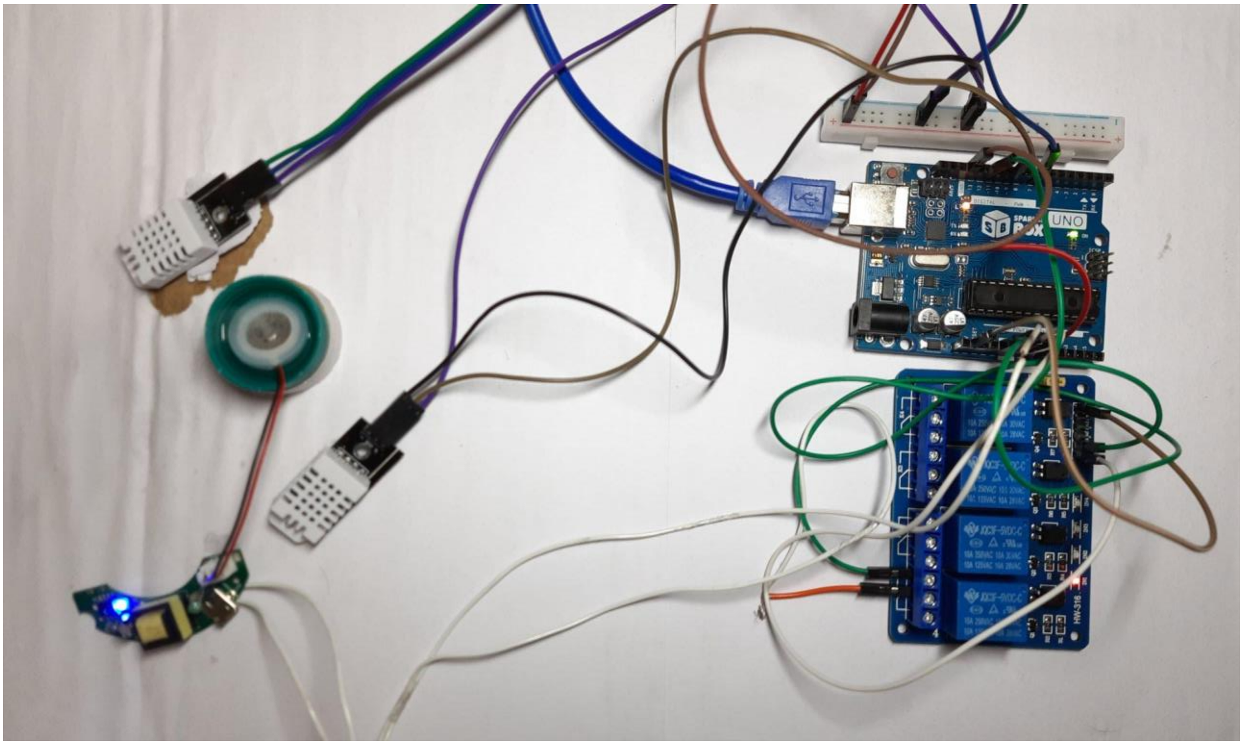


Fig. 23: Prototype Working Model of Mist Maker System

Photograph of the prototype working model:

https://drive.google.com/file/d/1UsFh1CcdPVnMiiYUNXfux6kGumJHqvCA/view?usp=sharing

https://drive.google.com/file/d/1UuOkWmnh1ZQx3iA8xLIjOpBiSVb5DD3q/view?usp=sharing

Video of the Working Model:

https://drive.google.com/file/d/1Q1Cc5NtZDMlLgLCQSM0Kse9XnDPtSaQJ/view?usp=sharing

6.3: PART 3:

WATER QUALITY MONITORING USING IOT SENSORS,

TDS, pH & TURBIDITY OF WATER & ANALYSING THE WATER

In this dedicated section, our primary emphasis lies in the critical domain of water quality monitoring, specifically targeting the water destined for farm irrigation. The overarching goal is to optimize the utilization of fertilizers and nutrients, ensuring their efficient application in the agricultural process. By implementing stringent monitoring measures, we aim to curb the excessive use of fertilizers, heavy metals, and chemicals, thereby fostering a holistic improvement in crop health. It's important to recognize that this strategic approach not only safeguards the well-being of crops but also directly contributes to human health. By mitigating the risks associated with the consumption of contaminated vegetables, which are known contributors to cancer, our water quality monitoring initiative plays a pivotal role in promoting a healthier agricultural ecosystem with far-reaching implications for human well-being.

- **SENSORS USED: pH, TDS & TURBIDITY SENSORS :**

pH sensor **TDS sensor** **Turbidity sensor**

Fig. 24: Sensors (pH, TDS, Turbidity)

pH Sensor

A pH sensor measures the acidity or alkalinity of a solution, commonly referred to as its pH value. A pH sensor is based on the interaction of hydrogen ions with a glass membrane sensing electrode that is selective to hydrogen ions.

Turbidity Sensor

A turbidity sensor measures the amount of suspended particles or solids in a liquid or gas. A turbidity sensor measures the attenuation of light as it passes through a sample containing suspended particles or solids.

TDS Sensor

The TDS sensor, integral to our monitoring system, quantifies dissolved solids concentration in water. This rapid assessment delivers precise insights into water quality, essential for optimizing agricultural practices. The sensor's data informs decision-making, ensuring both crop health and human well-being by proactively addressing potential water quality issues in real-time.

We seamlessly integrated a network of sensors with the ESP32, harnessing its powerful Wi-Fi module to establish a dynamic and responsive monitoring system. Through meticulous interfacing, we synchronized various sensors with the ESP32, creating a comprehensive network that captures real-time data. This invaluable data is then transmitted to the ThingSpeak cloud system, a sophisticated platform that not only facilitates the real-time visualization of data but also offers robust analytical capabilities. This integrated system empowers us to not only monitor environmental parameters efficiently but also to delve into insightful data analysis. By leveraging the connectivity of ESP32 and the capabilities of ThingSpeak, our approach not only ensures real-time responsiveness but also lays the foundation for a sophisticated data-driven understanding of the monitored ecosystem.

Farmers can also access this data very easily, just by clicking on the web link. With that they can adjust the addition of fertilizers & nutrients to the water which is to be supplied to the farm.

The below diagram shows the whole setup, where we have connected all the sensors to ESP32 micro-controller. This is the live model of our water quality monitoring setup.

- **IMPLEMENTATION OF THE SYSTEM**

Connected all the water quality sensors together to the micro-controller ESP32. Then sending the data to the cloud system of MathWorks.

The model is tested on various samples of water& also the sensors are calibrated accordingly.

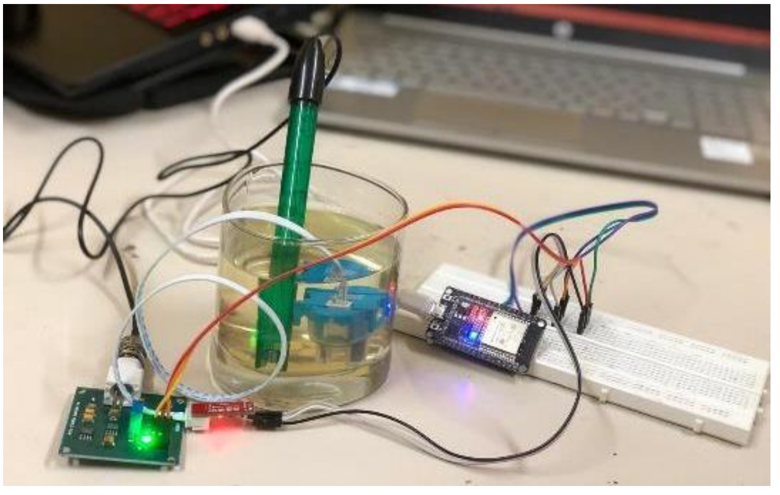


Fig. 25: Water Quality Setup

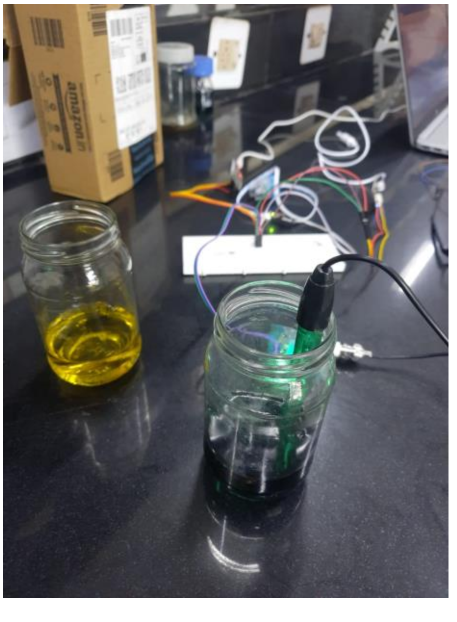


Fig. 26: Testing our system at different pH of water in BioTech Lab

The ThingSpeak platform seamlessly amalgamates real-time data from all sensors into an accessible and centralized graphical representation. Not only does it serve as a repository for storing extensive datasets, but it also facilitates analytical capabilities& analysis.

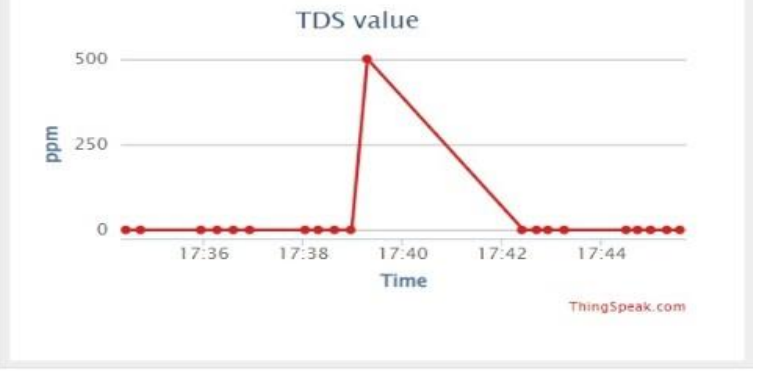


Fig. 27: ThingSpeak real-time graph of Turbidity, TDS & pH in water

CHAPTER-7: CONNECTION OF SENSORS TO CLOUD

In this portion, we will connect all the sensors to our cloud server i.e. thingSpeak. After that we will fetch this data from the cloud and send to google colab for the visualizing. As we know data visualization is very important for show our data in proper format. So in this report, we are mainly focusing on the visualization part.

Previously, we discussed the operation of sensors and foggers (mist maker systems) for the shoot system of the plant. These sensors are critical for gathering data about the plant's environment, while the mist maker systems help with humidity and moisture. Also we have seen soil moisture sensor and micro-controller. This connection is facilitated through the use of relays. A relay is an electromechanical device that serves as a switch, allowing us to make or break an electrical connection. Unlike traditional mechanical switches that require manual operation, relays can be controlled electronically, making them an essential component of our automation system.

In subsequent reports, we'll turn our focus to the first component of our system, which is concerned with the plant's root system. The focus of our next study will be on coupling electric valves with sensors. By precisely controlling the water supply to the root system based on the sensor data, this integration will be essential for ensuring that the entire plant—above and below ground—receives the best care and attention necessary for healthy growth.

Moreover, we have calculated & analysed the water quality parameters, which helps to analyse water. The detailed display of data on thingSpeak helps farmers to directly alter the water nutrients & fertilizer supply in water.

In our comprehensive part, we've placed paramount importance on the meticulous process of seamlessly transferring data from a microcontroller to a cloud server. To achieve this, we've employed the versatile microcontroller Esp-32, notable for its dual capabilities in Bluetooth and Wi-Fi communication. Our initial and fundamental step involved the integration of various sensors with the Esp32 microcontroller, creating a cohesive data collection system. Subsequently, we harnessed the power of Wi-Fi connectivity to efficiently transmit this data to the thingSpeak cloud server, ensuring real-time monitoring and analysis.

The heart of this intricate connection lies in the meticulously crafted code that drives the microcontroller. This code was meticulously developed within the Arduino Integrated Development Environment (IDE), ensuring optimal performance and reliability. Our unwavering dedication to this process underscores our commitment to harnessing technology for effective data acquisition and management, contributing to the success of our project.

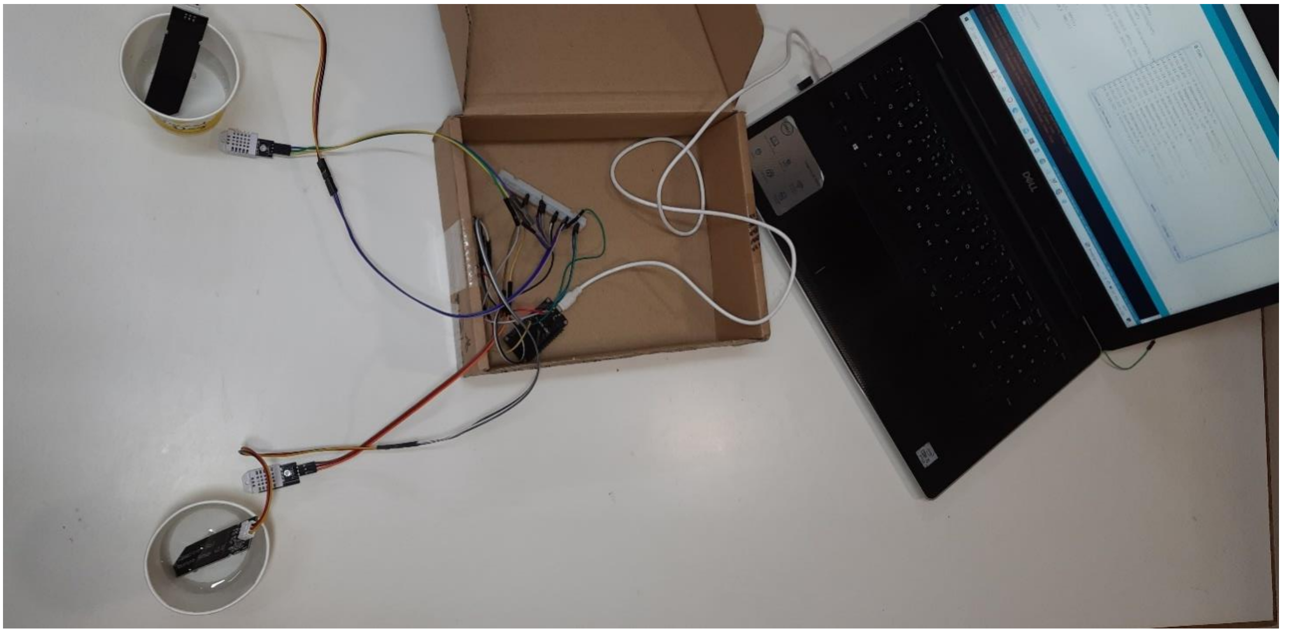


Fig.28: Circuit Diagram (Connection of micro-controller Esp32 with cloud thingSpeak and Sensors)

Video Link: https://drive.google.com/file/d/1zLAxOPkpeQurECZRrr6Ib-HeLyqA9MPw/view

In the above figure i.e. figure 28, we have connected all sensor like water quality sensors, soil moisture and digital humidity and temperature sensor to micro-controller esp32 and through wifi, we connect this micro-controller to cloud server.

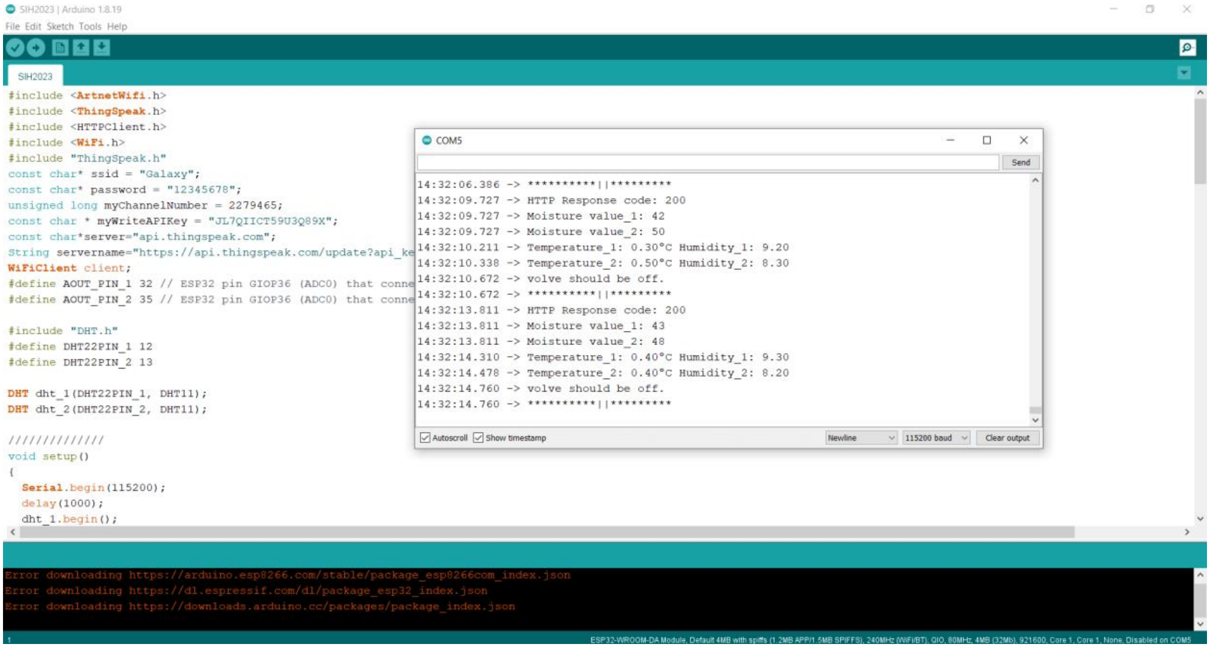


Fig.29: Arduino IDE and Code and Real time date

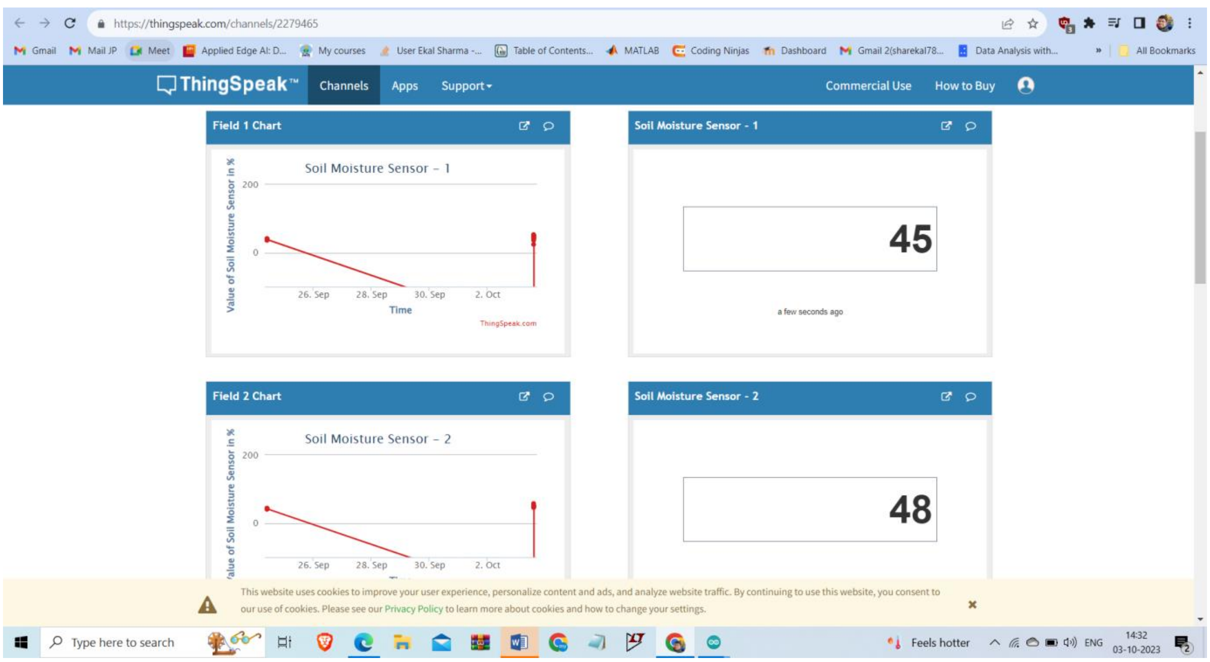
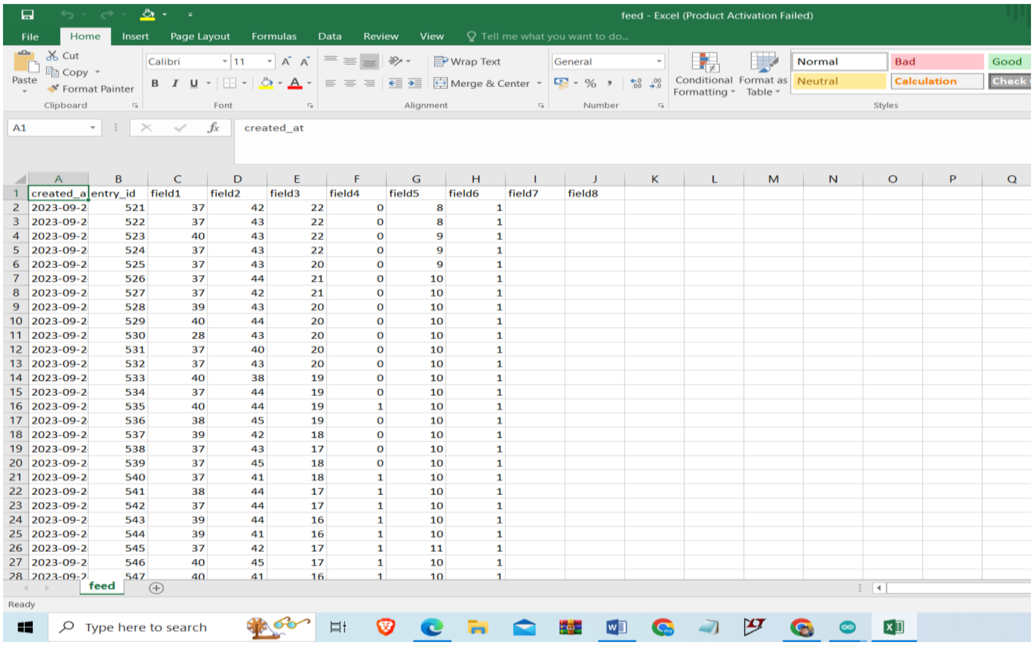


Fig.30: Data at cloud server thingSpeak

Link of thingSpeak server: https://thingspeak.com/channels/2279465

Link of ThingSpeak server (WQI) :https://thingspeak.com/channels/2029314

After connecting all these sensors to esp32, we will send the data to cloud and we have shown this data in thingSpeak as shown in figure 30. After that we can download the csv file from these thingSpeak platform as shown in figure 31.



	A	B	C	D	E	F	G	H	I	J
1	created_a	entry_id	field1	field2	field3	field4	field5	field6	field7	field8
2	2023-09-2	521	37	42	22	0	8	1		
3	2023-09-2	522	37	43	22	0	8	1		
4	2023-09-2	523	40	43	22	0	9	1		
5	2023-09-2	524	37	43	22	0	9	1		
6	2023-09-2	525	37	43	20	0	9	1		
7	2023-09-2	526	37	44	21	0	10	1		
8	2023-09-2	527	37	42	21	0	10	1		
9	2023-09-2	528	39	43	20	0	10	1		
10	2023-09-2	529	40	44	20	0	10	1		
11	2023-09-2	530	28	43	20	0	10	1		
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13	2023-09-2	532	37	43	20	0	10	1		
14	2023-09-2	533	40	38	19	0	10	1		
15	2023-09-2	534	37	44	19	0	10	1		
16	2023-09-2	535	40	44	19	1	10	1		
17	2023-09-2	536	38	45	19	0	10	1		
18	2023-09-2	537	39	42	18	0	10	1		
19	2023-09-2	538	37	43	17	0	10	1		
20	2023-09-2	539	37	45	18	0	10	1		
21	2023-09-2	540	37	41	18	1	10	1		
22	2023-09-2	541	38	44	17	1	10	1		
23	2023-09-2	542	37	44	17	1	10	1		
24	2023-09-2	543	39	44	16	1	10	1		
25	2023-09-2	544	39	41	16	1	10	1		
26	2023-09-2	545	37	42	17	1	11	1		
27	2023-09-2	546	40	45	17	1	10	1		
28	2023-09-2	547	40	41	16	1	10	1		

Fig.31: Excel sheet of Data from the cloud server thingSpeak

CHAPTER-8: AI BASED SUGGESTIVE APPROACH & ENHANCEMENT

Artificial Intelligence (AI) simulates human intelligence in machines to perform tasks like visual perception, speech recognition, and decision-making. Google Gemini is a cutting-edge AI model developed by Google, designed to be more powerful and versatile than predecessors like GPT-3 and BERT.

Gemini's architecture is likely transformer-based and multimodal, enabling it to process and integrate text, images, and potentially other types of data. It is built for scalability, allowing it to handle large data volumes and complex computations efficiently. Additionally, Gemini can be fine-tuned for specific tasks, making it adaptable for various applications, from search engines to virtual assistants.

In Colab workspace, we integrated the Google Gemini API key into our code to facilitate specific, crop, and water-oriented results based on user inputs. The process involves initializing the API, sending relevant data inputs (such as pH, TDS & Turbidity levels), and receiving tailored responses from the model.This streamlined process ensures accurate and efficient delivery of agricultural insights, enhancing decision-making for users as shown in the figures below.

Results are provided below:

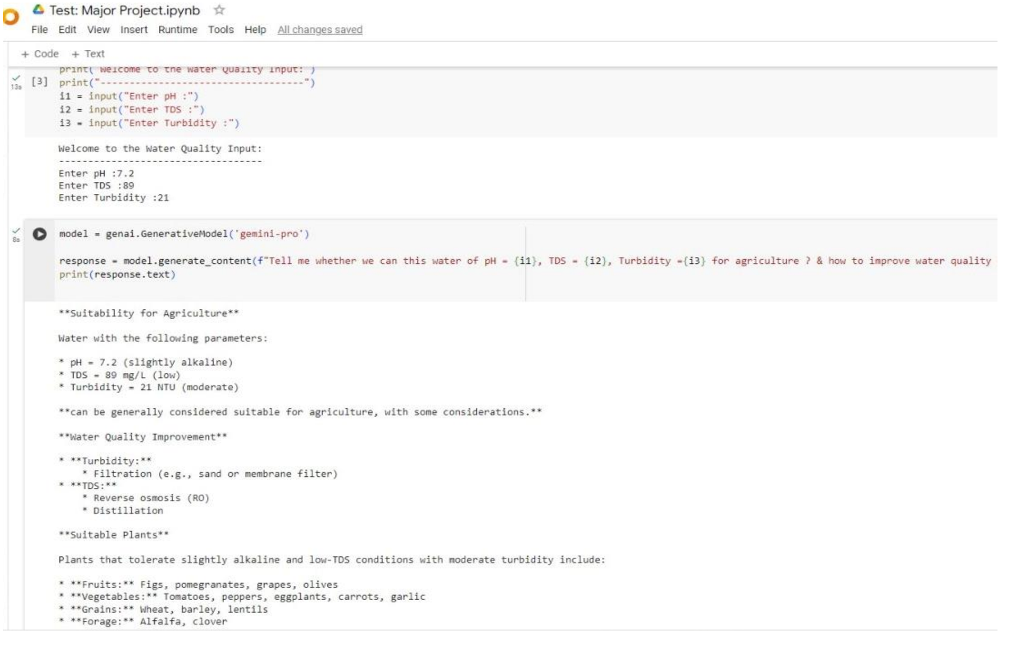
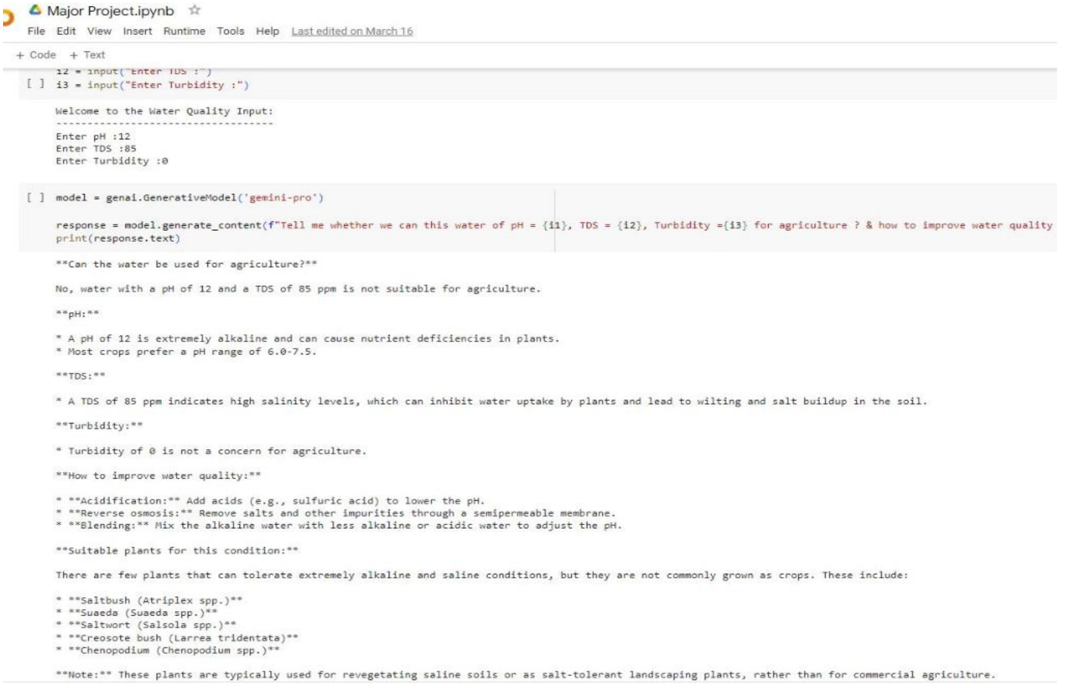


Fig.32: AI based results to enhance productivity



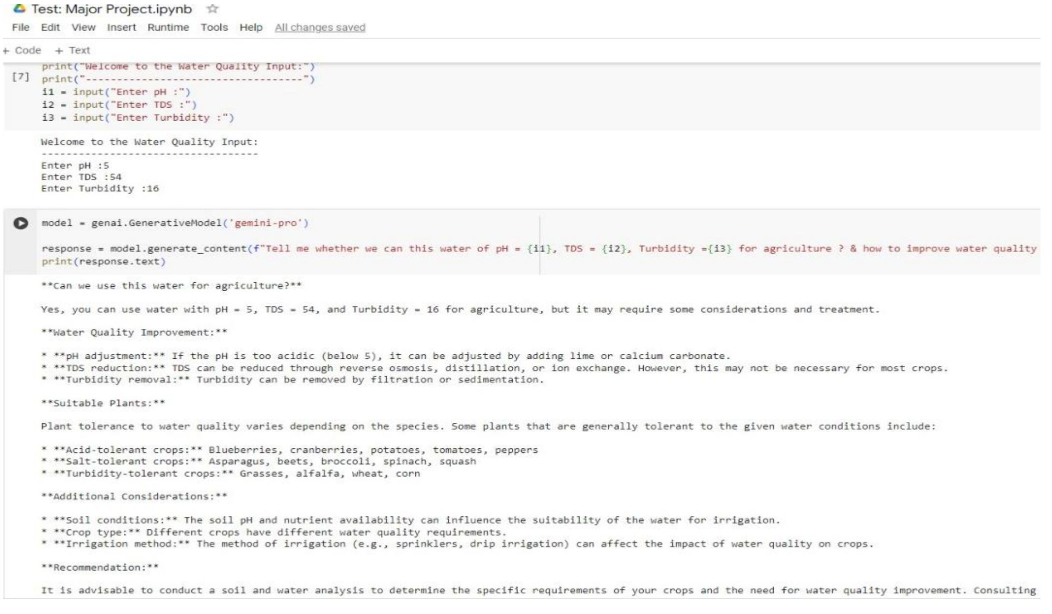


Fig.33: AI based results for specific inputs

CHAPTER-9: CONCLUSION

In this Consolidate progress report, we have discussed many things which we have done in this duration. In this report, we have explained our irrigation model means the proposed model of the field as described in figure 2 & 3. After that we have divide our model into three parts. Part first for the drip type irrigation as well as Mist type irrigation and second part water quality monitoring. For the part 1, we used soil moisture sensor, solenoid electric valve, relay and micro-controller. We connect all this. But this now (except sensor soil moisture) we automated all the parts. In future report, we will connect sensor as depicted in figure 9 & 10. For part 2, we also used digital humidity and temperature sensor (DHT 22), Ultrasonic Humidifiers (mist Maker), micro-controller and relay. Also We have automated this part as shown in figure 22. After this we connected all the sensor and sent the data to cloud thingSpeak (platform of matlab) as depicted in figure 30 & 31. In part 3, we have interfaced sensors like TDS, pH & Turbidity with micro-controller. The real-time helps us to visualize the data & have a in depth analysis of water quality, which enhances the crop health, prohibits contamination & improves human health.

CHAPTER-9: FUTURE WORK

- We will fully automate our first part with soil moisture sensor. Till now, It is partially automated without soil moisture sensor as we described in page no.33.
- We are working on proper physical hardware model as shown in figure 32 of proposed design as shown in figure 3.

Fig. No. 34: Physical Proto-type Model (Working on it)

- After making proper hardware model, we will use image processing for finding moisture in the soil and humidity in the environment so that the use of sensor can be neglected.
- Add more water quality sensors, which helps to calculate calcium, potassium, etc. level in the water, which affects the cultivation.
- Implement the data pre-processing on the data acquired & have detailed analysis of data.

REFERENCES

[1] S. G. Galande, G.H. Agrawal, Agricultured Automatic Drip Irrigation System, IOSR Journal of Agriculture and Veterinary Science, 1(2), Sep-Oct. 2012.

[2] L. García, L. Parra, Jose M. Jimenez, J. Lloret and P. Lorenz,Network andTelecommunicationResearchGroup,UniversityofHauteAlsace, 20(4),2020.

[3] M. N. Rajkumar, S. Abhinaya,V. V. Kumar, Intelligent Irrigation System – An IoT Based Approach, International Conference on Innovations in Green Energy and Healthcare Technologies (IGEHT),2017

[4] Y. Shekhar, E. Dagur, S. Mishra, Intelligent IoT Based Automated Irrigation System, Research India Publications, 18,2017

[5] J.J. Feng; L.J. Fei; Z.Deng; G. l. Zhai; Y. Liu; H.S. Zhao, Research of flow adaptive function and structure design for subsurface drip irrigation emitter,International Conference on New Technology of Agricultural IEEE, 2011

[6] R. N. Rao, B.Sridhar, IoT BASED SMART CROP-FIELD MONITORING AND automation irrigation system IEEE, 2nd International Conference on Inventive Systems and Control (ICISC), 2018

[7] K. D. Phasinam, T. Kassanuk, P. P. Shinde C. M. Thakar,D. K. Sharma, M. K. Mohiddin and A. W. Rahman, Application of IoT and Cloud Computing in Automation of Agriculture Irrigation, KhongdetPhasinam et al.,2022

[8] Mekala, M.S., Viswanathan,A survey: smart agriculture IoT with cloud computing, International conference on Microelectronic Devices, Circuits and Systems (ICMDCS),8(17),2017

[9] N. K. Nawandar and V. Satpute, IoT based intelligent irrigation support system for smart farming applications, ADCAIJ: Advances in Distributed Computing and Artificial Intelligence Journal,8(2),(2019)

[10] A.Ahmed, IoT based Smart Irrigation System, International Journal of Computer Applications, 159(8), 2017

[11] M. Murtiningrum, I. N. Rasyid, L. Christyaningrum, E. Fahrunisa and N. Ngadisih, Performance of Drip and Mist Irrigation to Supply Water for Vegetable, IOP Conference Series: Earth and Environmental Science

[12] M.K.Kumar, K.S.Ravi, Automation of Irrigation System based on Wi-Fi Technology and IoT, Indian Journal of Science and Technology ,9(17)

[13] K. Kansara, V. Zaveri, S. Shah, S. Delwadkar, K. Jani, Sensor based Automated Irrigation System with IoT: A Technical Review, Karan Kansara et al ,6 (6) , 2016

[14] E. Ogunti, IoT Based Crop Field Monitoring and Irrigation Automation System, International Journal of Innovative Science, Engineering & Technology, Vol. 6(3), March 2019

[15] A. Goapa, D. Sharmab, A.K. Shuklab, C. R. Krishnaa, An IoT based smart irrigation management system using Machine learning and open source technologies, CSIR-Central Scientific Instruments Organisation, Chandigarh 160030, India, 155

[16] V Anandkumar, Kalaiarasan ,S.Balakrishnan, IoT Based Soil Analysis and Irrigation System, International Journal of Pure and Applied Mathematics, 119(12)

[17] E. A. Abioye, M. S. Z. Abidin, M. S. A. Mahmud, S. Buyamin, M. K. I. AbdRahman, IoT-based monitoring and data-driven modelling of drip irrigation system for mustard leaf cultivation experiment, Information Processing in Agriculture, 8(2), 2021

[18] T. Paul, R. Raj, P. Garg and S. Jain, "Real Time Monitoring of Water Quality for Rural Areas: A Machine Learning and Internet of Things Approach," *2023 4th International Conference on Intelligent Engineering and Management (ICIEM)*, London, United Kingdom, 2023

[19] P. Garg, R. Raj, T. Paul, S. Jain and R. Kumar, "Indigenous Development of Water Quality Monitoring System for Urban Areas using IoT& ML," *2023 International Conference on Computer, Electronics & Electrical Engineering & their Applications (IC2E3)*, Srinagar Garhwal, India, 2023

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Internet Source <

11 robu.in
Internet Source <

12 www.ijspr.com
Internet Source <

13 Shailendra Kumar Gupta, Prakhar Bhardwaj, Ritik Kumar, Pragya, Abhishek Bag. "Rain-Prediction-system-Incorporated Automatic Water Feeding System for Agriculture Application", 2023 9th International Conference on Smart Computing and Communications (ICSCC), 2023
Publication <

14 T. Akilan, K.M. Baalamurugan. "Automated weather forecasting and field monitoring using GRU-CNN model along with IoT to support precision agriculture", Expert Systems with Applications, 2024
Publication <

15 ijircst.org
Internet Source <

16 Submitted to University of Johannsburg
Student Paper <

17 Md. Mamun Hossain, Md. Ashiqur Rahman, Sudipto Chaki, Humayra Ahmed et al. "Smart- <

Agri: A Smart Agricultural Management with IoT-ML-Blockchain Integrated Framework", International Journal of Advanced Computer Science and Applications, 2023
Publication

---

18 Submitted to Jabatan Pendidikan Politeknik Dan Kolej Komuniti <
Student Paper

---

19 Varun Katoch, Karan Verma, Shruti Jain. "Design of Plant Leaf Diseases Detection System employing IoT", 2023 International Conference on Computer, Electronics & Electrical Engineering & their Applications (IC2E3), 2023 <
Publication

---

20 apessay.elementfx.com <
Internet Source

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21 dokumen.pub <
Internet Source

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22 ijcrt.org <
Internet Source

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23 Submitted to Rwanda Institute for Conservation Agriculture <
Student Paper

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24 acadpubl.eu <
Internet Source

---

25 www.e3s-conferences.org
Internet Source
<

26 Submitted to Middlesex University
Student Paper
<

27 fdp.com.pk
Internet Source
<

28 Subhranshu Sekhar Tripathy, Niva Tripathy, Mamata Rath, Abhilash Pati, Amrutanshu Panigrahi, Manoranjan Dash. "Smart Farming based on Deep Learning Approaches", 2022 2nd Odisha International Conference on Electrical Power Engineering, Communication and Computing Technology (ODICON), 2022
Publication
<

29 ijres.iaescore.com
Internet Source
<

30 Submitted to Amrita Vishwa Vidyapeetham
Student Paper
<

31 "Proceedings of Eighth International Congress on Information and Communication Technology", Springer Science and Business Media LLC, 2024
Publication
<

32 Submitted to Eastern Illinois University
Student Paper
<

fastercapital.com

33 Internet Source <

34 skill-lync.com
Internet Source <

35 "ICT for Agriculture and Environment", Springer Science and Business Media LLC, 2019
Publication <

36 Murtiningrum Murtiningrum, Ilham Nawan Rasyid, Lia Christyaningrum, Erlina Fahrunisa, Ngadisih Ngadisih. "Performance of Drip and Mist Irrigation to Supply Water for Vegetable", IOP Conference Series: Earth and Environmental Science, 2022
Publication <

37 docshare.tips
Internet Source <

38 Submitted to Durban University of Technology
Student Paper <

39 Submitted to Beirut Arab University
Student Paper <

40 K. Sudharson, Badi Alekhya, G. Abinaya, C. Rohini, S. Arthi, D. Dhinakaran. "Efficient Soil Condition Monitoring with IoT Enabled Intelligent Farming Solution", 2023 IEEE <

International Students' Conference on Electrical, Electronics and Computer Science (SCEECS), 2023
Publication

41 Amarendra Goap, Deepak Sharma, A.K. Shukla, C. Rama Krishna. "An IoT based smart irrigation management system using Machine learning and open source technologies", Computers and Electronics in Agriculture, 2018 <
Publication

42 Emmanuel Abiodun Abioye, Mohammad Shukri Zainal Abidin, Mohd Saiful Azimi Mahmud, Salinda Buyamin et al. "IoT-based monitoring and data-driven modelling of drip irrigation system for mustard leaf cultivation experiment", Information Processing in Agriculture, 2020 <
Publication

43 Hakan Buyukcangaz, Abdurrahim Korukcu. "Integrated approach for water resources and irrigation management in Turkey", Water International, 2007 <
Publication

44 Yousif Al Mashhadany, Hamid R. Alsanad, Mohanad A. Al-Askari, Sameer Algburi, Bakr Ahmed Taha. "Irrigation intelligence—enabling a cloud-based Internet of Things <

approach for enhanced water management in agriculture", Environmental Monitoring and Assessment, 2024
Publication

45 static.ohu.edu.tr
Internet Source
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