SMART IRRIGATION SYSTEM

A major project report submitted in partial fulfillment of the requirement for the award of degree of

Bachelor of Technology

in

Computer Science & Engineering / Information Technology

Submitted by

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DECLARATION

I hereby declare that the work presented in this report entitled **'Smart Irrigation System'** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Computer Science & Engineering** submitted in the Department of Computer Science & Engineering and Information Technology**,** Jaypee University of Information Technology, Waknaghat is an authentic record of my own work carried out over a period from August 2023 to May 2024 under the supervision of **Dr. Ravindar Bhatt**(Associate Professor, Department of Computer Science & Engineering and Information Technology).

The matter embodied in the report has not been submitted for the award of any other degree or diploma.

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This is to certify that the above statement made by the candidate is true to the best of our knowledge.

Supervised by:

(Dr. Ravindar Bhatt)

Associate Professor

CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"Smart Irrigation System"** in partial fulfillment of the requirements for the award of the degree of B.Tech in Computer Science And Engineering and submitted to the Department of Computer Science And Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **"Abhishek(201225) and Arpan(201249)"** under the supervision of "**Dr. Ravindar Bhatt"**, Department of Computer Science and Engineering, Jaypee University of Information Technology, Waknaghat.

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Firstly, I express our heartiest thanks and gratefulness to Almighty God for his divine blessing makes it possible for us to complete the project work successfully.

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I would also generously welcome each one of those individuals who have helped straightforwardly or in a roundabout way in making this project a win. In this unique situation, I might want to thank the various staff individuals, both educating and non-instructing, which have developed their convenient help and facilitated our undertaking.

Finally, I must acknowledge with due respect the constant support and patients of my parents.

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ABSTRACT

The purpose of the Smart irrigation system using Arduino is to overcome problems associated with traditional irrigation practices by utilizing new technologies to improve irrigation water management in agriculture. The proposed system provides an intelligent automated irrigation solution by utilizing Arduino, one of the most prominent open-source electrical platforms. The system is designed to be energy-efficient by utilizing low-power components and maximizing the efficiency of irrigation pumps and valves.

Temperature sensors give further environmental data, while soil moisture sensors assess the soil's moisture level. This data is processed by the Arduino microcontroller, which also controls the watering system.

Temperature sensors, Arduino microcontrollers, and soil moisture sensors are key components of the Smart Irrigation System. Temperature sensors give further environmental data, while soil moisture sensors assess the soil's moisture level. This data is processed by the Arduino microcontroller, which also controls the watering system. By automating irrigation based on real-time data, the system is intended to reduce water consumption by ensuring that crops receive the appropriate amount of water at the appropriate time. The Arduino module architecture's versatility allows for easy scaling and modification. To adapt to the needs of different crops, the system can also be expanded to cover a greater area of land or have its characteristics changed. By using smart irrigation systems, sustainable and technologically advanced agricultural practices that conserve water and increase crop yields while minimizing the ecological effects of irrigation techniques are made possible.

CHAPTER 01:
INTRODUCTION

1.1 INTRODUCTION

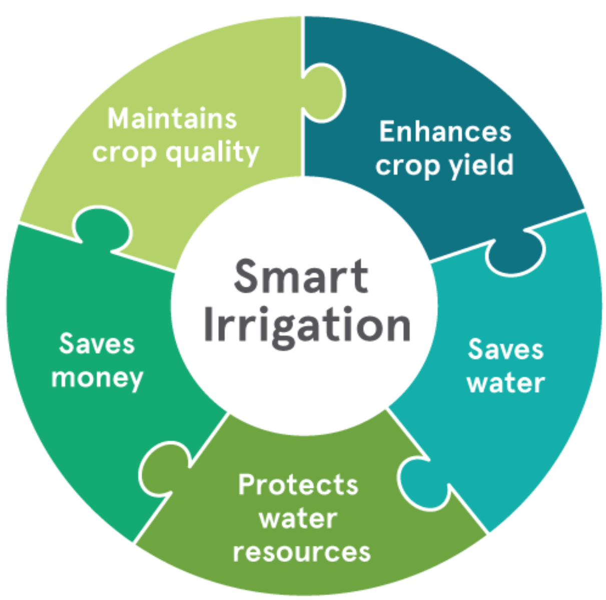
In this fast-paced era, people expect everything to be motorized. Everything in our lifestyle needs a controller. However, in a few unique cases, man has motorized several aspects of his world. It is a clear-cut, exact creation approach for a nation like India, where the water system is the primary economic motor. Some of its many benefits include time reserve funds, the disposal of human agribusiness, isotropic environmental conditions, errors made in controlling the accessible soil dampness levels, and the failure to fully utilize agrarian assets. increase the extent of their net benefit margin. The two main factors are the scarcity of land and the lack of rainfall.

Automatic facial expression analysis has numerous problems as well as potential applications in emotion recognition, human-computer interaction, behavior analysis, fatigue detection, health treatment, entertainment, and education.

Due to a lack of technology, farmers had to perform a lot of manual labor in the past. One of the inventions that allowed for the first agricultural revolution was the tractor. Everything is totally perceived through its different embedded handling and it works as the present structure of the Internet. For farmers, this was a major development because it could result in much greater efficiency. The third agricultural revolution, which we are already experiencing, will inevitably come after the digital revolution. The way we raise crops is drastically altering as a result of current and upcoming technologies. Arduino detected the things remotely constrained by getting across a current establishment of the framework, making progressively open a gateway for an alternate of this current reality into the PC based structures, and results in improved precision, budgetary focal points, and profitability to human considerations. Exactly when the development is performed with the sensors and actuators, it envelops motorization in various fields, for instance, astute force plants, sharp transportation, adroit homes, splendid systems, and sharp urban networks.

Flood irrigation was the most often used method of irrigation until recently. Because sprinkler and drip systems are now much more efficient (90–95% and 70–75%), they are becoming more and more popular. There are now two methods available to determine errors made in controlling the accessible soigne the water requirements of plants. The first has been in use for a very long time and is based on the evaporation of crops. For farmers, this was a major development because it could result in much greater efficiency. The two main factors are the scarcity of land and the lack of rainfall and scarcity of land.

Automatic facial expression analysis has numerous problems as well as potential applications in emotion recognition, human-computer interaction, behavior analysis, fatigue detection, health treatment, entertainment, and education. Automatic facial expression analysis has numerous problems as well as potential applications in emotion recognition, human-computer interaction, behavior analysis, fatigue detection, health treatment, entertainment, and education. Some of its many benefits include time reserve funds, the disposal of human agribusiness, isotropic environmental conditions, errors made in controlling the accessible soil dampness levels, and the failure to fully utilize agrarian assets. increase the extent of their net benefit margin. The two main factors are the scarcity of land and the lack of rainfall.



The suggested framework's contributions are as follows:

1. A framework consisting of an Arduino automation system and moisture sensors is utilized to precisely estimate.

2. Monitor watering demands based on soil conditions that vary on a regular basis.

3. Low-power parts that were designed with energy efficiency in mind are incorporated into the system.

4. Power will be less with efficient energy.

1.2 PROBLEM STATEMENT

1.2.1 BACKGROUND:

Inappropriate water use in traditional agricultural irrigation techniques frequently results in crops that are either overwatered or underwatered. The absence of real-time monitoring and control systems exacerbates this inefficiency, raising farmers' operating expenses and negatively affecting the environment.

Agriculture is becoming more and more important to the global sustainability of resources and food because of this. However, there are several disadvantages to traditional farming methods, such labor-intensive irrigation and excessive water use. The scarcity of water, the necessity for environmentally friendly farming methods, and the changing climate all highlight the need for creative irrigation strategies. Conventional irrigation systems often follow set schedules and aren't flexible enough to adjust to changing weather conditions. This lowers crop quality and productivity by causing overwatering in some regions and underwatering in others, wasting water resources. The creation of Smart Irrigation Systems (SIS), which make use of contemporary technology like data analytics and sensors, is gaining popularity.

The aim is to create, implement, and evaluate a smart irrigation system that strategically manages agricultural water resources. Soil moisture levels, weather forecasts, and sensor data have to be integrated into the system in order to optimize water consumption and make dynamic adjustments to irrigation schedules. To satisfy the different needs of farmers across different regions, the solution needs to be accessible, flexible, and easy to use, aim is to create, implement, and evaluate a smart irrigation system that strategically manages agricultural water resources.

1.2.2 CHALLENGES:

1.Inefficient Water Management: Traditional irrigation methods are inaccurate, which results in insufficient water being applied to farmland water being applied to farmland. This inefficiency not only wastes precious water resources but also lowers crop yields.

2.Limited Access to Technology : Farmers frequently lack access to modern irrigation systems, especially in places with limited resources with limited resources. The adoption of more effective irrigation techniques is hampered by the lack of readily available and user-friendly irrigation devices.

3.Environmental Impact : Ineffective irrigation techniques harm the surrounding ecosystems by causing soil degradation, increasing energy use, and soil degradation, increasing energy use, increasing the chance of water runoff.

4.Manual Intervention and Labor Intensity : Farmers have an even heavier workload because they have to physically supervise and maintain and have to physically supervise and maintain traditional irrigation systems. This restricts the scalability of agricultural practices and raises operating costs.This is of agricultural practices and raises operating costs.

5.Precision Irrigation : Accurate irrigation scheduling is made possible by real-time tracking of soil moisture levels and weather variables using Arduino-based sensors. Real-time surveillance of soil moisture levels and meteorological conditions using Arduino-based sensors enables accurate irrigation scheduling. This inefficiency not only wastes precious water resources but also lowers crop yields. Real-time surveillance of soil moisture levels and meteorological conditions using Arduino-based sensors enables accurate irrigation scheduling. Accurate irrigation scheduling is made possible by real-time monitoring of soil moisture levels and weather variables using Arduino-based sensors. This inefficiency reduces crop yields in addition to wasting valuable water resources.

6.Data Accuracy and Reliability: It is critical that temperature, moisture content in the soil, and other environmental sensors be accurate. Inaccurate information may cause poor irrigation decisions. To guarantee that they continue to give reliable results, sensors.

7.Cost: The cost of purchasing and installing sensors, controllers, and connecting solutions might be high. Ongoing expenses include things like upkeep, data storage, and even subscription fees for cloud computing or data analytics platforms.

8.Energy Management: Especially in off-grid places, it might be challenging to ensure a constant and reliable power source for sensors and communication devices. Since many sensors are battery-operated, they need to be examined and replaced on a regular basis.

.**9. Data Security and Privacy :** Protecting the system from hacking and data breaches is imperative, especially if it is an online system. Clearly stated policies governing the ownership, use, and sharing of sensor data.

10.Accurate Watering : Accurate irrigation scheduling is made possible by real-time tracking of soil moisture levels and weather variables using Arduino-based sensors. Real-time surveillance of soil moisture levels and meteorological conditions using Arduino-based sensors enables accurate irrigation scheduling. This inefficiency not only wastes precious water resources but also lowers crop yields.

1.3 OBJECTIVE

In India, we have more or less **seventy%** of the populace relies completely upon the development and related exercises and **thirty-three%** of the country's capital originates from it. Problems concerning farming have reliably impeded the advancement of the nation to a great extent or the other. The featuring highlights of this venture incorporate the better practice of pesticides utilized in ranches and forestalling soil disintegration subsequently bringing about more noteworthy yields. Also, it fuses a customized water framework with appropriate control and keen fundamental administration reliant on precise continuous field data. Thirdly, keep up the idea about soil by inspecting various parameters of soil like dampness, temperature and supplement content.

Lastly, shielding crops from being damaged by homeless animals coming from assault area framework using PIR Sensor deployed on required separation over the complete fringe of the homestead. These all undertakings should be managed through a shielding crop from being damaged by homeless animals coming from assault area framework wireless contraption or PC related with the Internet and the exercises would be performed by Arduino

The proposed study's major objective is to:

- Reduce water waste by using the real-time soil moisture information to accurately time irrigations.
- Enable data-driven, automated decision making to guarantee optimal water flows for crop health and output.
- Use energy-saving parts and a smart watering plan to maximize energy usage.
- Overcome the limitations of the irrigation system in conventional farming.
- Provide and maintain the crops in an optimum environment for maximum growth.
- Utilize the real-time soil moisture data to precisely schedule irrigations to cut down on water.

1.4 MOTIVATION AND SIGNIFICANCE

Motivation

Intelligent irrigation system development is being driven by new technology and urgent agricultural issues. Water scarcity brought on by climate change emphasizes how vital it is to optimize water use in agriculture, and intelligent irrigation systems are necessary to cut waste and guarantee a sufficient supply of water. Climate change is unpredictable, which emphasizes the necessity of adjusting irrigation techniques to crop needs as they change over time. One of the most crucial elements is environmental sustainability because conventional irrigation techniques can make issues like soil erosion and water pollution worse. Precision agriculture, sometimes referred to as intelligent irrigation, provides a solution to these issues and encourages ecological balance and higher productivity by modifying the delivery of water and fertilizers in accordance with the actual needs of crops.

Smart irrigation systems use state-of-the-art technologies including soil moisture sensors, meteorological data, and real-time monitoring to optimize water efficiency. Emphasize the ways in which this technology helps conserve water resources, which is crucial in regions that are facing drought or a lack of water.

In addition to its positive effects on the environment, smart irrigation systems can optimize resources, save costs, and increase agricultural returns. Therefore, farmers can maintain their economic viability by using more profitable and sustainable farming practices. Global food security is necessary due to a number of factors, Global food security is necessary due to a number of factors, including the expanding global population, increased need for food production, and the requirement for intelligent irrigation. Intelligent irrigation Global food security is necessary due to a number of factors, systems are critical to solving the challenges of feeding a growing population in a sustainable and efficient way because they maximize output while minimizing environmental impact. Therefore, in addition to tackling the current environmental concerns, the objective is to improve the agriculture sector's long-term sustainability, innovation, and prosperity.

Significance

By conserving water resources and minimizing environmental damage, the effective installation of a smart irrigation system would not only help individual farmers but also advance sustainable agriculture practices. This project aims to lower the ecological imprint of farming practices, address the need for creative solutions in agriculture, and ensure food security.

Implementing a smart irrigation system efficiently can benefit individual farmers and promote sustainable agriculture practices by preserving water resources and reducing environmental harm. The goals of this project are to provide food security, lessen the environmental impact of farming practices, and satisfy the need for creative ideas in the field of agriculture.

In addition to helping individual farmers, effectively implementing a smart irrigation system can also support sustainable agriculture practices by protecting water supplies and minimizing environmental damage. This project aims to reduce the environmental impact of farming practices, ensure food security, and meet the demand for innovative ideas in the agricultural sector.

When smart irrigation systems are used, farmers can profit financially. Describe how these devices might reduce water bill costs and possibly boost overall farm profitability by preventing over-watering and optimizing resource consumption.

Effectively implementing a smart irrigation system can help individual farmers and advance sustainable agricultural practices by protecting the environment and conserving water resources. The objectives of this project are to reduce the negative effects of farming techniques on the environment, provide food security, and meet the demand for innovative ideas in the agricultural sector.

1.6 METHODOLOGY

The methodology got a handle on in the defined structure is that, it contains assorted Arduino sheets according to the requirements and assembled at a PC, the Raspberry. The pi is moreover organized with a joined server that goes about as an intersection purpose of data exchange among pi and the client (the farmers). Different notices with respect to low wetness, manure essential and attack will be given to the farmer who is using the system through an application stage. The Application has 2 fundamental procedures for working, first is that procedure in which the client The Application has 2 fundamental procedures for working, first is that procedure in which the client will pick what we basically call robotization mode whereas the client just picks the data which he has collected just now and then the application finds a choice, it is going to perform off/on the motor to supply water. The Arduino Uno is connected with different sorts of sensors that send their output for managing Arduino. The sensors passed on for this framework are soil sensor, pH sensor, electrochemical sensor, moisture-temperature sensor and PIR Sensor.

The Arduino Smart Irrigation System was built using a methodical approach to ensure that cutting-edge technology is successfully incorporated into traditional farming processes. The project commenced with an extensive project planning process that produced precise goals and a timeframe. A comprehensive literature review was conducted to gain an understanding of existing smart irrigation systems and Arduino-based projects, as well as to gain insight into potential hurdles and best practices.

A thorough analysis of the literature was done to learn about current smart irrigation systems and Arduino-based projects, as well as to get advice on best practices and potential roadblocks. The Arduino Uno is connected with different sorts of sensors that send their output for managing

Arduino. The sensors passed on for this framework are soil sensor, pH sensor, electrochemical sensor, moisture-temperature sensor and PIR Sensor.

CHAPTER 02:
LITERATURE SURVEY

2.1 INTRODUCTION

The employment of cutting-edge technologies to address pressing concerns such as environmental sustainability, water scarcity, and the demand for increasing agricultural output has recently resulted in a dramatic shift in the agricultural industry. Smart irrigation systems have emerged as advantageous solutions that optimize water usage in agricultural processes through automation, data analysis, and real-time monitoring.

Traditional irrigation methods frequently result in inefficiencies, excessive watering, and insufficient utilization of resources. They are characterized by preset schedules and manual intervention. In order to tackle these issues, researchers and professionals in the field have focused on developing and executing intelligent irrigation systems that utilize cutting-edge technologies to improve the precision, efficiency, and long-term viability of irrigation practices.

This literature study aims to provide an extensive overview of the body of knowledge currently available on smart irrigation systems. By means of an extensive analysis of several scholarly works, continuing investigations, and technological advancements, this survey aims to provide a current state of knowledge concerning the basic concepts, components, and methods that comprise smart irrigation. We'll also look at how these systems evolved from simple prototypes to intricate, data-driven solutions that interact with cloud computing and the Internet of Things.

2.2 OVERVIEW OF RELEVANT LITERATURE

From farmers who employ cutting-edge farming equipment to impoverished rural communities, Indian agriculture is unique. China's infrastructure has complete control over the world's agriculture industry. However, its technology and system for monitoring the environment are still in their formative years and are only somewhat intelligent. A number of issues that farmers encounter will be addressed by integrating contemporary technologies into farming. The loss of productivity is caused by the absence of crucial information.

Arduino's price, versatility, and ease of use make it a popular choice for smart irrigation systems. Its adaptability in enabling data processing, managing actuators, and integrating with a broad range of sensors makes it a popular choice for both amateur and commercial applications. Arduino boards have microcontrollers that can process sensor data and implement irrigation algorithms. Using information from soil moisture and weather sensors, the Arduino can make intelligent decisions about when to begin irrigation cycles in order to maximize water consumption.

An Arduino can interface with sensors that track soil moisture to find out how wet the soil is. This information can be used to calculate the amount and timing of water needed for irrigation. Arduino can be linked to weather sensors, such as temperature and humidity sensors, to incorporate real-time weather data into irrigation decision-making processes .Arduino can be used to provide real-time feedback on the state of the system when integrated with user interfaces like LEDs or LCD screens. This is especially helpful for monitoring.

Ref. No.	IEEE/Year	Description	Contribution	Key approaches
[1]	Youness Taco Et al. (2022)	Intelligent watering system based on IoT and machine learning	This study postulates a smart, flexible irrigation method that takes little energy and costs minimal money and can be used in a range of situations...	In a setting that encourages good plant growth for months, they used a set of sensors (soil humidity, temperature),from which they gathered info based on an acquired map using the MongoDB.
[2]	D. Poornima et al. (2020)	Achievement of correctness soil and water conservation agriculture (PSWCA) through ML, cloud enabled IOT Integration and wireless sensor network	In this study, unique method to ML based precision soil and water conservation agriculture using cloud enabled (IoT) integration, wireless sensor	Wireless sensor network, that is made up of a different type of sensor including moisture, temperature, light, soil nutrition, and others.

[3]	Bhanu K.N. et al. (2020)	Internet of Things based intelligent System for improved Irrigation in Agriculture	This study takes account of a few of these variables while analyzing data to propose ways for customers to use IoT to make better farming decisions.	The main factor 4 better crop growth are soil type, soil moisture, essential minerals, temp, light, and oxygen, among others.
[4]	S. Meisel et. Al. (2020)	Standard farming drone information analytics using KNN algorithm	Such a system does real-time data processing, create correlations, produces insights from Standard Drone - Agricultural data, and makes those insights	This strategy improves each software's performance while optimizing the standard Drone - Farm data (Drone Network) investments through various application.

			accessible to	
[5]	Sachin Kumar et. Al. (2017)	Accurate sugarcane caring using SVM classifier	In this study, a system model for managing sugarcane crops is proposed. The model recommended parameters—temperature, humidity are actively monitored to ensure the crop grows healthily.	In this case, virus identification through images taken at periodic intervals is done utilizing KNN clustering and an SVM classifier.

[6]	Anusha Kumar et al. (2017)	IOT Based Intelligent Irrigation Using Regression Algorithm	The suggested system uses the Internet of Things to automatically monitor and control the irrigation method in an effort to perform	Regression analysis is used in this study to predict how much water will be required for daily irrigation using data
[7]	IEEE Access (2021)	IoT Sensors Cloud Computing Services Farm Management Software Cyber security Tools	These integrated systems hold the potential to transform traditional farming practices into more sustainable, efficient, and data-driven operations.	Renewable Energy Integration into Cloud & IoT-Based Smart Agriculture

[8]	IEEE Access (2020)	RNN and SVM used , ensemble learning Used for improving overall performance a nd robustness	Crop yield, soil properties and weather prediction, disease and weed prediction	Machine Learning Applications for Precision Agriculture
[9]	IEEE Access (2020)	1. Heuristic algorithm (ELIOT-EFC) 2. IBM CPLEX 3. MILP 4. LoRa	1. Energy efficiency Improvement 2. Validation of Heuristic Algorithm 3.Network Traffic Reduction	Energy-Efficient Edge -Fog cloud Architecture for IoT-Based Smart Agriculture Environm
[10]	IEEE Access (2018)	1.Raspberry PI (WIFI) 2. NODEMCU (WIFI) 3.HC-05 module (Bluetooth) 4.MQTT Cloud Server	1. Improved Crop Management 2. Data- Driven Insights. 3. Remote Monitoring	IOT Based Smart Agriculture System

2.3 KEY GAPS IN THE LITERATURE

2.3.1 Advancements in Sensor Technologies:

The literature review indicates that developments in sensor technologies for intelligent irrigation systems have received a lot of attention. Integration of weather sensors, soil moisture sensors, and other environmental sensors with Arduino platforms is highlighted in a number of research. These sensors are essential for delivering data on soil conditions and meteorological parameters in real time, which allows for accurate scheduling of irrigation. Precise irrigation scheduling is made possible by the real-time data on soil conditions and climatic parameters that these sensors provide. The progression from conventional, imprecise techniques to increasingly intricate sensor-driven systems highlight the significance of sensor technology in augmenting water efficiency.

Precise irrigation scheduling is made possible by the real-time data on soil conditions and climatic parameters that these sensors provide. Integration of weather sensors, soil moisture sensors, and other environmental sensors with Arduino platforms is highlighted in a number of research.

These days, sensors are frequently a part of larger IoT ecosystems, facilitating smooth device interaction and data transfer. Because of this integration, real-time monitoring and control are made easier, increasing system efficiency overall. Artificial intelligence (AI)-capable sensors can learn from their data and adjust to changing conditions. This eliminates the need for continual manual calibration, allowing for more effective and contextually aware decision-making. Artificial intelligence (AI)-capable sensors can learn from their data.

2.3.2 Energy-Efficient Solutions:

Numerous scholarly works examine the significance of energy efficiency in intelligent irrigation systems, particularly in isolated or off-grid farming areas. The literature review emphasizes how well-suited it is for solar panels, energy-efficient actuators, and low-power components.

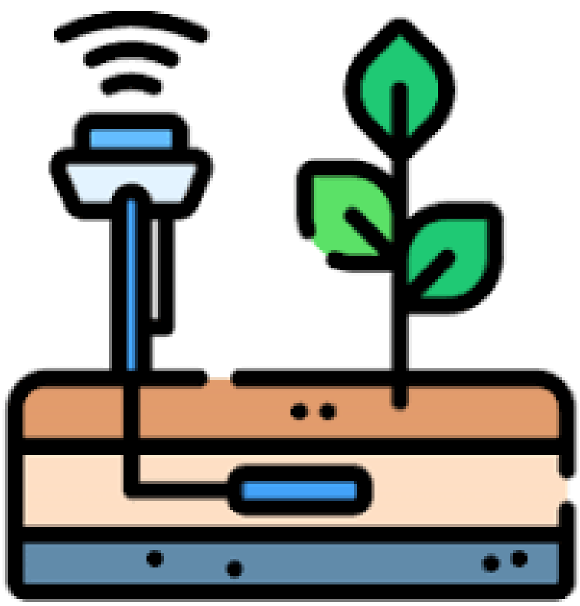
When solar-powered sensors power data collecting in smart irrigation systems, there is less reliance on traditional power sources. These sensors can evaluate soil moisture, weather, and other relevant factors without the need for external power, ensuring continuous monitoring. The literature review emphasizes how well-suited it is for solar panels, energy-efficient actuators, and low-power components alternatives and smart agriculture's decreased environmental effect are becoming good.

There is less dependency on conventional power so data collection in smart irrigation systems is driven by solar-powered sensors. Continuous monitoring is ensured by these sensors' ability to assess soil moisture, weather, and other pertinent variables without the need for external power. The literature study highlights its suitability for solar panels, energy-efficient actuators, low-power component replacements, and the growing positive environmental impact of smart agriculture.

The goal of these energy-efficient designs is to provide irrigation solutions that are both ecology and sustainable. The conversation about energy efficiency suggests that alternatives and smart agriculture's decreased environmental effect are becoming more and more important. The discourse surrounding energy efficiency indicates off-grid options and the reduced environmental impact of smart agriculture. The conversation about energy efficiency suggests that alternatives and smart agriculture's decreased environmental effect are becoming more and more important. These sensors can evaluate soil moisture, weather, and other relevant factors without the need for external power, ensuring continuous monitoring.

2.3.3 Arduino-Based Smart System for Improver Agriculture Irrigation :

Modern sensor technologies, wireless communication, and decision-making algorithms are combined in this system to produce an irrigation system that is intelligent and flexible. Because of its adaptability, Arduino serves as the main controller for this. Precise irrigation scheduling requires real-time data that is provided by weather and soil moisture sensors that are easily communicated with Arduino. Irrigation cycle adjustments are made using sound decision-making techniques in response to changing environmental circumstances. Machine learning and threshold-based control are two examples of these tactics. By integrating wireless communication modules, farmers may remotely monitor and manage their irrigation systems from any place, which encourages more flexibility and responsiveness.



Arduino-based smart irrigation systems promise a sustainable and cutting-edge method of irrigation management in the rapidly changing sector of agriculture, making it a beacon for future research and development in precision agriculture. Because of its adaptability, Arduino serves as the main controller for this. Precise irrigation scheduling requires real-time data that is provided by weather and soil moisture sensors that are easily communicated with Arduino.

The continuously evolving field of agriculture may benefit from the innovative and sustainable irrigation management techniques that Arduino-based smart irrigation systems may provide. They might also act as a template for additional precision agricultural research and development. Arduino is the primary controller for this due of its versatility. Accurate irrigation scheduling necessitates real-time data, which can be obtained from soil moisture and weather sensors that are readily interfaced with Arduino.

Therefore, knowledgeable farmers are necessary for the agriculture sustainability monitoring system. These efforts can benefit indoor gardening. Despite the fact that there are several solutions for assisting farmers, each one assumes that the users are knowledgeable about the industry. In this work, we implement a home gardening aid method that doesn't require any prior information of agriculture.

CHAPTER 03:
SYSTEM DEVELOPMENT

Since we had collected the dataset of the sensor values and stored it in a csv file format.Sometimes due to the data sent is either unavailable or the data being send it too much high.In our project we had found that in some of the cases the value of humidity was more 100% and the percentage of green was too much less due to less amount of light. To overcome these kinds of problems we had come forward with the data Preprocessing Techniques.

The entire system can run on batteries or solar panels for sustainability and energy efficiency. Through the system's user interface, which provides real-time insights into soil conditions and permits manual tweaks, farmers can also interact with the system manually. Arduino's adaptability makes it possible to design intelligent irrigation systems that provide farmers with the resources they need to maximize water consumption and raise agricultural yield.

An automated and effective crop-watering solution requires the integration of sensors, actuators, and a microprocessor when building a smart irrigation system using Arduino. Because Arduino is open-source and has a large network of supporters, it's an affordable platform for designing and testing these kinds of devices. To detect the moisture content in real time, soil moisture sensors are first positioned in key points around the area. The brains of the system are these sensors connected to an Arduino microcontroller. When analyzing sensor data, the Arduino considers variables such as crop water requirements and soil type.

3.1 REQUIREMENT AND ANALYSIS

SOFTWARE REQUIREMENT:

• ARDUINO IDE:

A software platform called the Arduino IDE (Integrated Development Environment) is used to programme and upload code to Arduino boards. It makes writing code for Arduino microcontrollers easier and offers a user-friendly interface that is suitable for both novice and seasoned developers. The Arduino IDE's salient characteristics and attributes are as follows:

Open Source: The Arduino IDE is available for free; users are free to examine, alter, and share the source code. This promotes a helpful and cooperative community.

Cross-Platform Compatibility: A broad spectrum of users can access the IDE due to its compatibility with multiple operating systems, such as Windows, macOS, and Linux.

Library Support: Pre-written code for frequently used components and functions can be found in a large number of Arduino libraries. By making the coding process simpler, these libraries free up users' time to concentrate on the particular functionality they wish to implement.

Serial Monitor: To facilitate real-time communication between developers and their Arduino board, the IDE has a tool called Serial Monitor that enables developers to track and debug programme behavior.

Board Manager: This feature makes it simple for users to install and maintain board support for various platforms that are compatible with Arduino.

Community and Documentation: The user and development community for Arduino is sizable and vibrant. Users of all skill levels can find support from forums, tutorials, and copious documentation.

• VS CODE:

Visual Studio Code (VS Code) is among the most popular code editors for a variety of reasons. Here are some key advantages of using VS Code in projects.

Performance: VS Code is lightweight and fast, even on low-end hardware.Modularity: Users can only install the extensions they require, keeping the editor streamlined and responsive.

Language Support: VS Code supports a wide range of programming languages out of the box and even more through extensions, including JavaScript, Python, Go, Rust, and others.

• Google Colab: Google Collab provides access to powerful computing resources, such as GPUs and TPUs. This allows you to train and run complex machine-learning models quickly and efficiently.

HARDWARE REQUIREMENT:

• Soil Moisture Sensor(Hygrometer) :

The soil moisture sensor is a device used to calculate the percentage of water in the soil. The gravimetric method of measuring soil wetness requires the weighting, drying. These sensors can estimate the volumetric water content indirectly by using other soil laws, such as the dielectric constant.

Capacitance is the primary method used by this sensor to determine the water content, or dielectric permittivity, of the soil. Burying this sensor in the earth activates it; once buried, it records a percentage of the liquid content of the soil.

This relationship may alter due to ecological factors such as temperature, soil type, the link between the computed value and soil moisture needs to be adjusted. Scientific 33, including biology, horticulture, soil science, farming, and environmental sciences, will find it ideal for conducting experiments

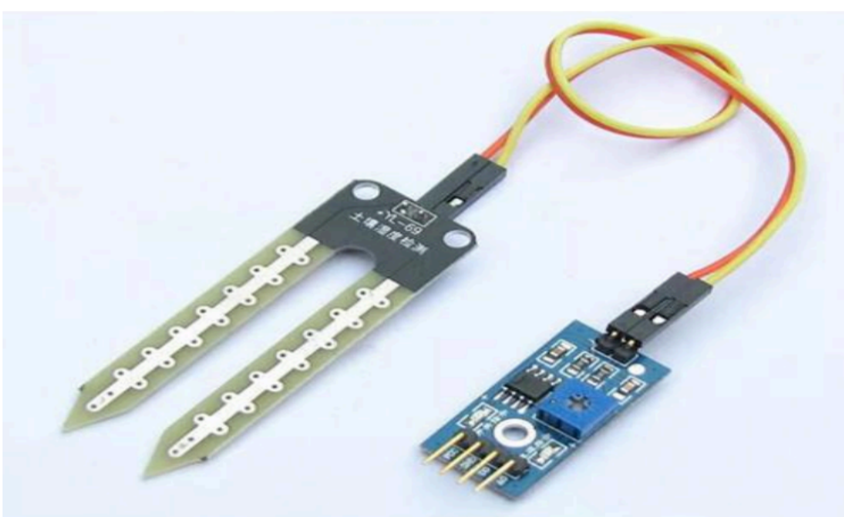


Fig 3.1.1: Soil Moisture Sensor

• DHT 11 Sensor :

A well-liked and reasonably priced digital temperature and humidity sensor is the DHT11 sensor. It is extensively utilized in many different applications, such as industrial systems, home automation, and weather stations. The DHT11, made by Aosong, is renowned for its dependability and simplicity.

Among the DHT11 sensor's salient features are:

Temperature and Humidity Sensing: The DHT11 is a flexible sensor for climate monitoring because it can measure both temperature and humidity. The digital output feature of the sensor makes it easier to interface with microcontrollers and other digital systems.

Low Cost: One of the DHT11's primary benefits is its affordability, which makes it suitable for projects and hobbyists with tight budgets.

Large Operating Voltage Range: The sensor can be used with a variety of electronic systems because it operates within a wide voltage range, usually between 3.5 and 5.5 volts.

Easy Interface: The DHT11's single-wire interface makes communication easier and makes integrating it into projects easier. To guarantee accurate readings, it's crucial to remember that timing and protocol need to be properly controlled.

Accuracy: The DHT11 is less expensive than more sophisticated sensors, but it might not be as accurate. It works well in situations where a broad indication of humidity and temperature is adequate.

To guarantee accurate readings and 2 correct operations, it is essential to adhere to the manufacturer's datasheet when using the DHT11 sensor. Furthermore, users should think about other sensors, such as the DHT22 or BME280, for more demanding scenarios, as the sensor might not be appropriate for applications of that precision.

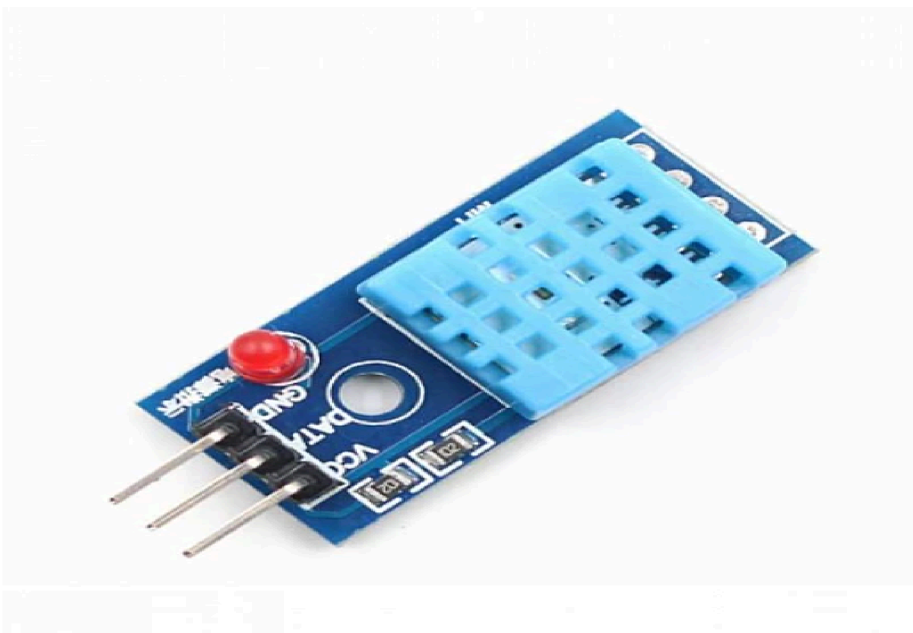


Fig 3.1.2: DHT 11 Sensor

2 INTEL GALILEO GEN 2 BOARD :

The Intel Galileo Gen 2 development board is intended for embedded computing and the Internet of Things (IoT). The following are some salient characteristics and details of the Intel Galileo Gen 2:

Processor: The Intel Quark SoC X1000 processor, which powers the Galileo Gen 2, offers x86 architecture and is compatible with a wide range of software.

Memory: 256 MB of DDR3 RAM is usually included.

I/O Interfaces: There are several I/O interfaces on the board, such as analogue inputs, UART, I2C, and digital I/O pins. It can therefore be connected to a variety of sensors, actuators, and other peripheral devices.

Compatibility: The Arduino shield ecosystem is compatible with the Galileo Gen 2, which enables users to take advantage of a variety of current Arduino shields for extra functionality.

Operating System: Yoto Project Linux distribution optimized for embedded and Internet of Things applications can be run on it.

Connectivity: The board has a mini-PCI Express slot for additional expansion and supports Ethernet connectivity.

Development Environment: Those who are familiar with the Arduino platform can programme the Galileo Gen 2 by using the Arduino IDE.

Use: The board is intended for embedded systems, Internet of Things applications, and other projects that call for a small, flexible development platform.

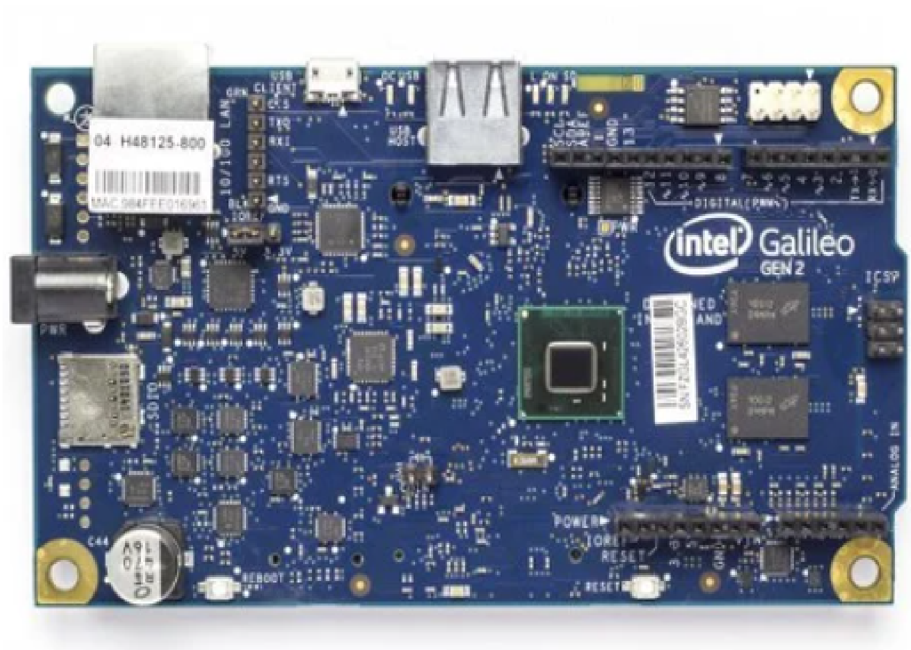


Fig 3.1.3: Intel Galileo Gen 2 Board

3.2 PROJECT DESIGN :

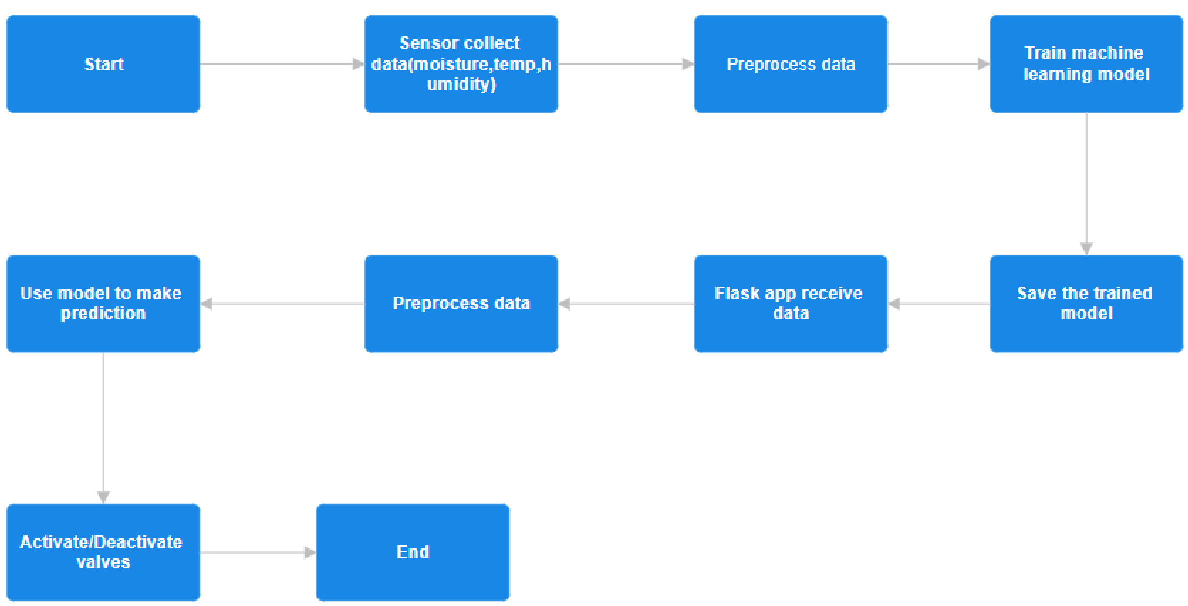


Fig 3.1.4: Flow-Chart

3.3 DATA PREPARATION

3.3.1 Removing the unavailable Values

In our dataset some of the cells were having no values in them dataset some of the cells were having no values in they. All the machine learning algorithms were unable to process the content until all these were removed. This was caused due to the many of the reasons :-

- Due to the failure of the Arduino board in fetching data.
- When an error code gets printed in a data set.
- Due to some environmental factors the sensor is unable to get the values.
- There are some grounding issues of the circuit due to which sometimes the readings miss.
- Sometimes the values are missed due to some issue in sensor initialization.
- Due to the failure of the arduino board in fetching data.
- Some grounding issues of the circuit due to which sometimes the readings are missed.

These wrong readings need to be removed from the dataset. To remove such rows we had used dataframe.dropna() command of the pandas library

3.3.2 DATA VISUALIZATION AND ANALYSIS

3.3.2.1 Humidity Vs Moisture Percentage Graph

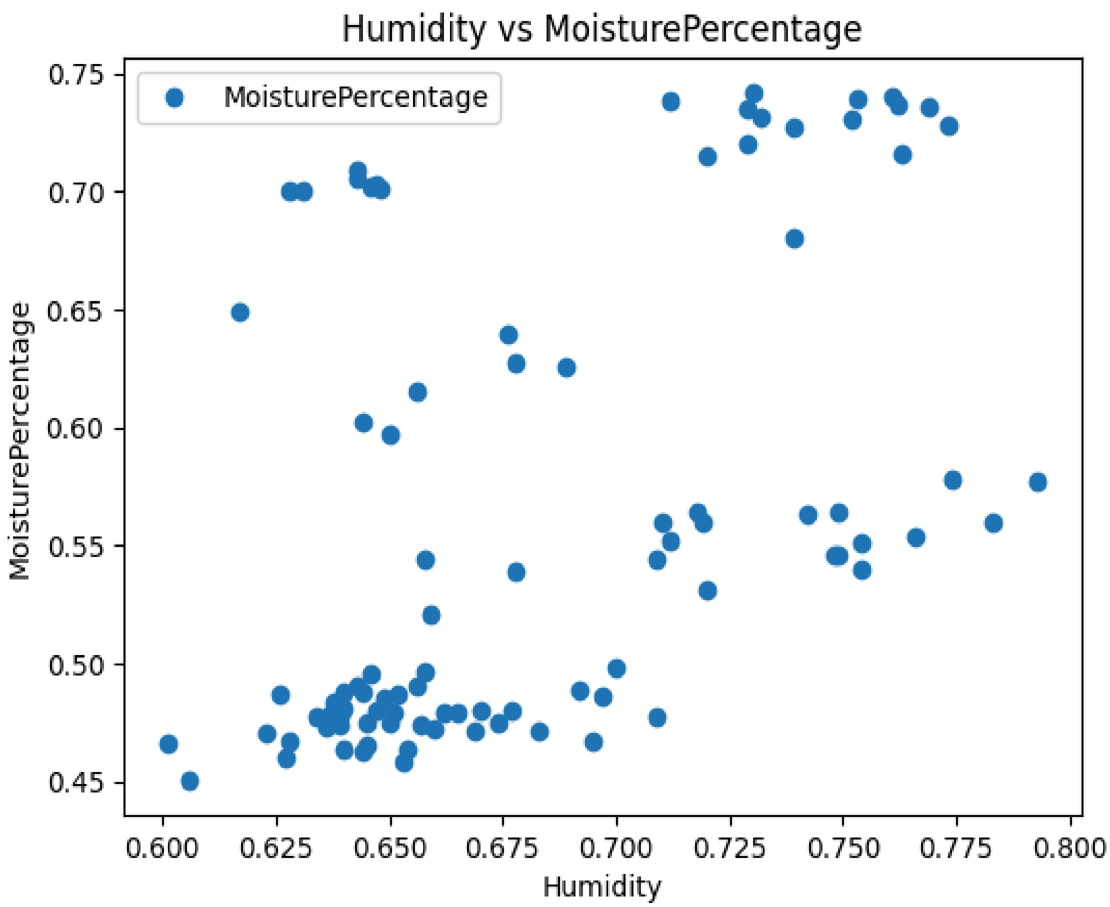


Fig 3.2.1: Humidity V Moisture Graph

3.3.2.2 Heat-Air Temp Vs Moisture Percentage Graph

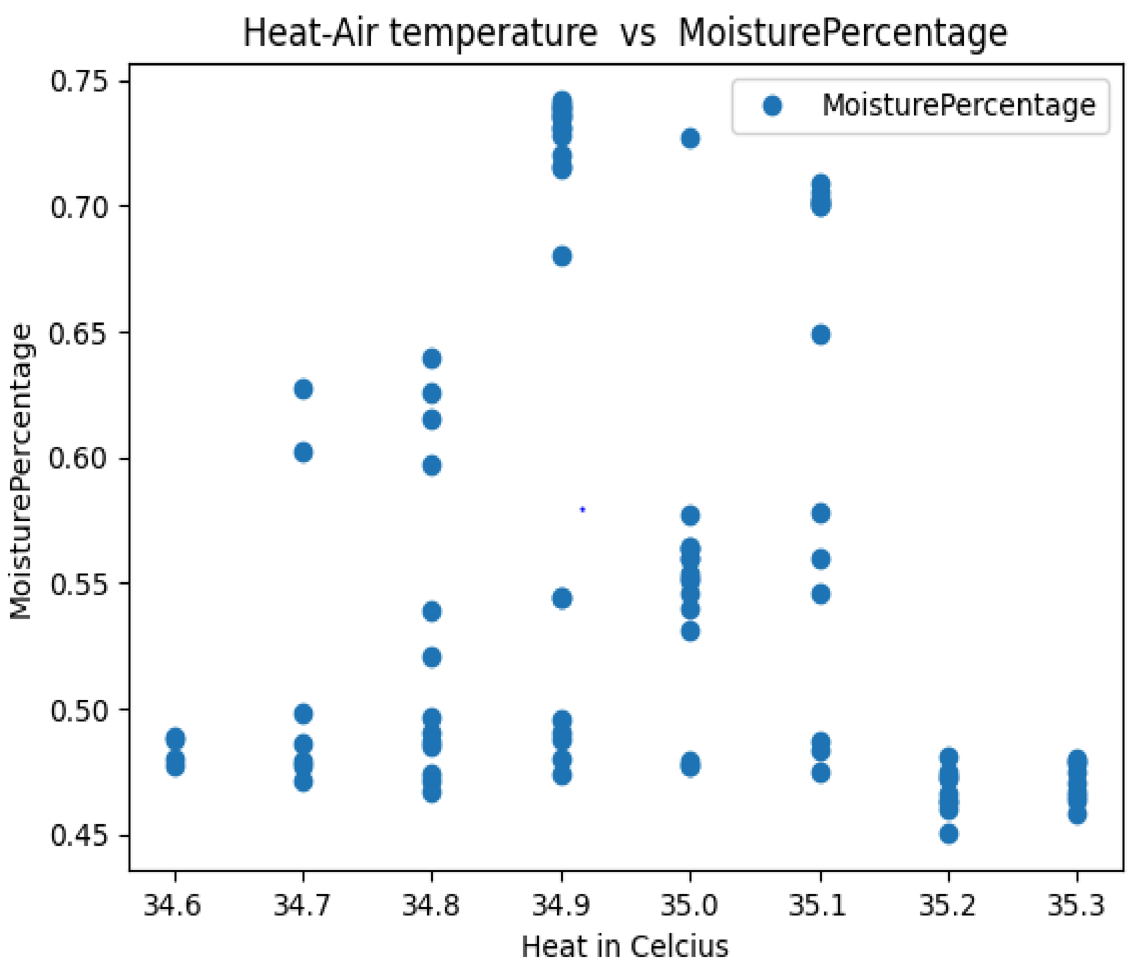


Fig 3.2.2: Heat Air Temp Vs Moisture Graph

3. DATASET ANALYSIS

The dataset contains 100 instances of the data collection from the surrounding of the plant.The whole setup was designed to record the physical conditions in the surrounding of the plant. The information about the attributes is as shown below:

- **Moisture Percentage**

This column contains the moisture content values present in soil.These values are measured using the soil moisture sensor (Hygrometer)

- **Humidity**

This column contains the humidity values in the surrounding area of the sample. These values are measured using the DHT11 Sensor.

- **Temperature**

These values are obtained from the DHT11 sensor and contain the temperature value in the surrounding area of the sample.

- **Irrigation**

These values are calculated based on the other parameters i.e. Moisture content,Humidity and Irrigation on the basis of a threshold value.

MoistureP	Humidity	Heatcelciu	IrrigationNeeded
0.6491	0.617	35.1	0
0.6999	0.628	35.1	0
0.6999	0.631	35.1	0
0.7019	0.646	35.1	0
0.7009	0.648	35.1	0
0.7028	0.647	35.1	0
0.7087	0.643	35.1	0
0.7058	0.643	35.1	0
0.5445	0.658	34.9	0
0.4907	0.656	34.8	1
0.4848	0.649	34.8	1
0.4868	0.652	34.8	1

3.4 PROJECT IMPLEMENTATION

3.4.1 Arduino code

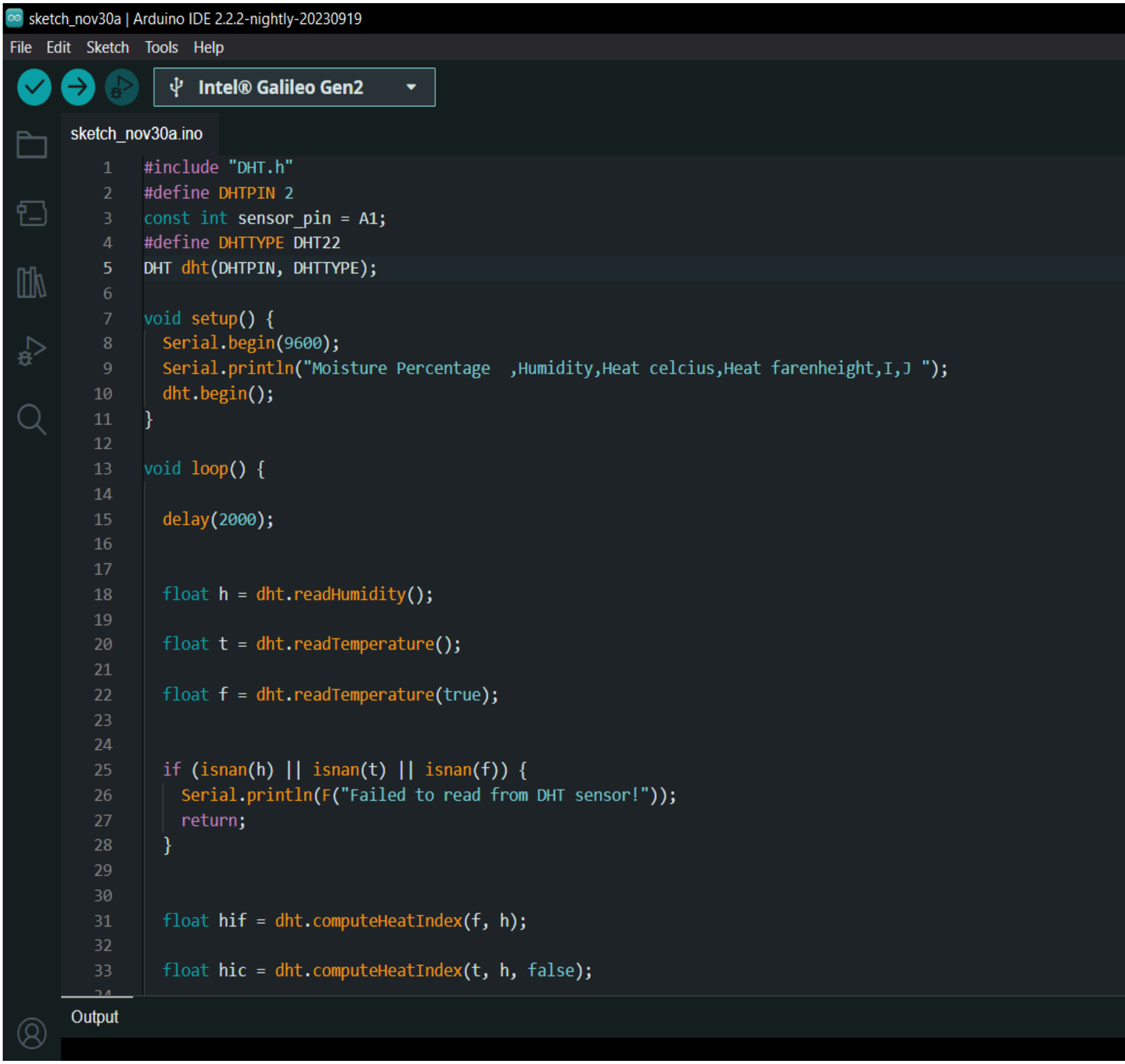


Fig 3.4.1.1: Arduino Code

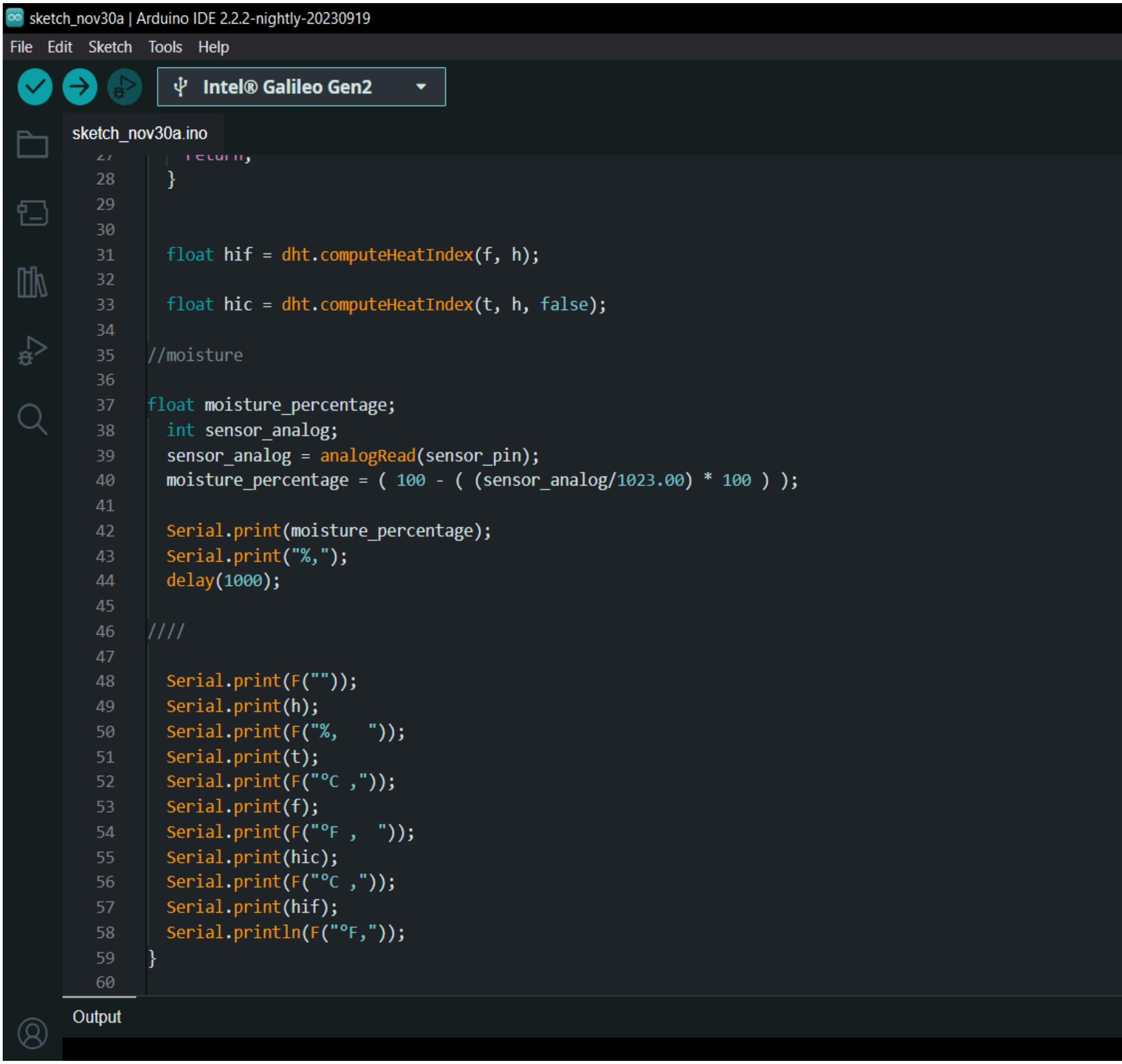


Fig 3.4.1.2: Arduino Code

3.4.2 Flask App code

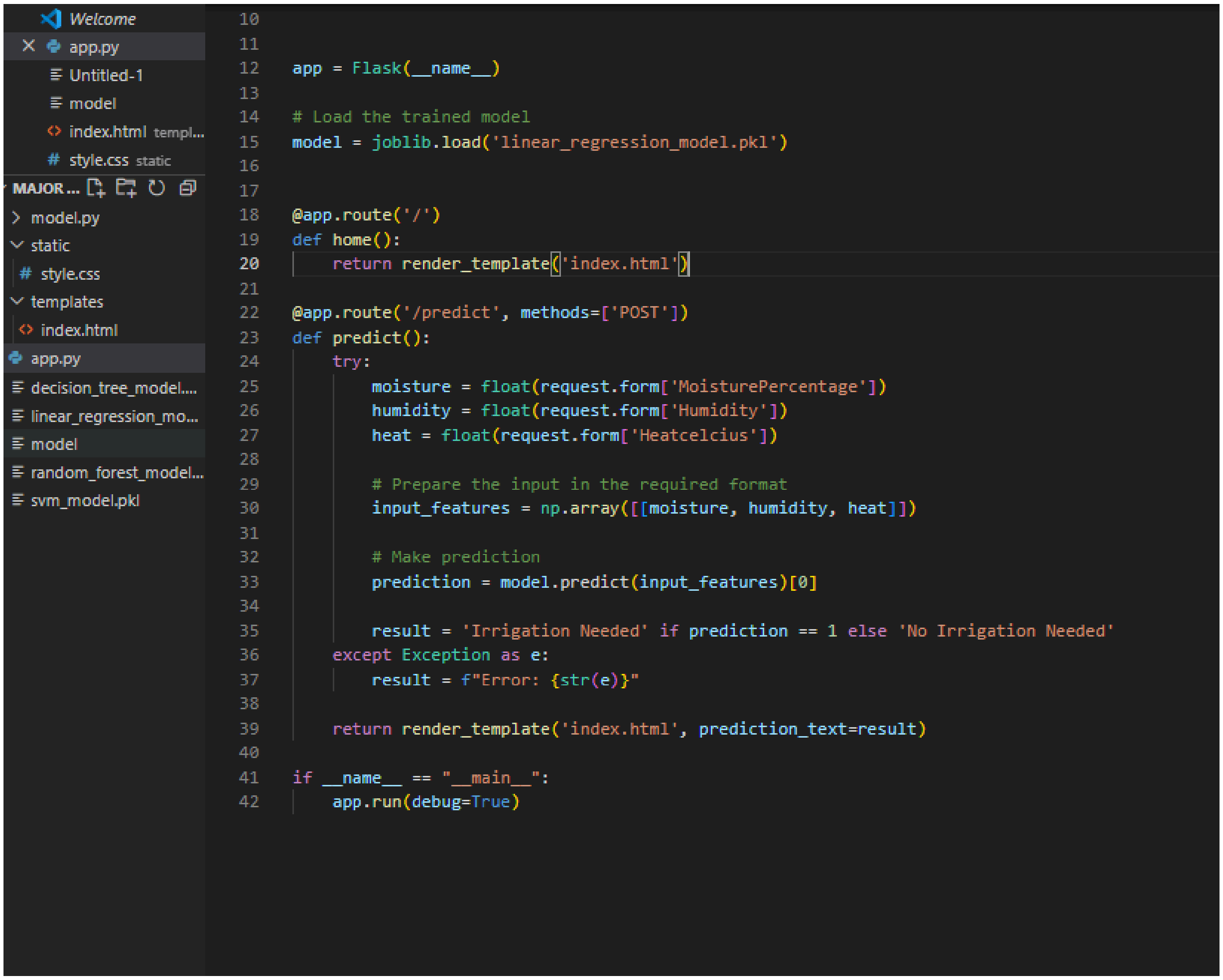


Fig 3.4.2.1: Flask App Code

This code is a Flask application that serves as a simple web interface for making irrigation predictions based on input data. Here's an explanation of the main components and how the code works:

Imports:

OS: Provides a portable way of using operating system-dependent functionality.

Flask: The main Flask framework for building web applications.

request: Allows access to incoming request data in Flask routes.

render_template: Renders HTML templates with Flask.

joblib: Used to load the pre-trained machine learning model**.**

numpy: Library for numerical computations.

Flask App Initialization:

app = Flask(__name__): Initializes a Flask application.

Model Loading: The pre-trained machine learning model is loaded using joblib. Currently, the code loads a linear regression model (linear_regression_model.pkl), but there are commented-out lines to load other types of models like decision trees, SVMs, and random forests.

Home Route:

@app.route('/'): Defines a route for the home page.

def home(): Renders the index.html template.

Prediction Route:

@app.route('/predict', methods=['POST']): Defines a route for making predictions.

def predict(): Handles POST requests containing input data for prediction.

The input data (moisture percentage, humidity, heat in Celsius) is obtained from the form submission using request.form.

The input features are prepared as a numpy array. The pre-trained model predicts the irrigation need based on the input features.The prediction result is rendered along with the index.html template.

Error Handling: Exceptions are caught and appropriate error messages are returned to the user if there are any issues during prediction or model loading.

Running the Application:

if __name__ == "__main__":: Ensures that the Flask app is only run when this script is executed directly (not imported as a module).

app.run(debug=True): Starts the Flask development server with debugging enabled.

This Flask application provides a simple interface for users to input data and get predictions on whether irrigation is needed based on the trained machine learning model.

3.4.2 HARDWARE IMPLEMENTATION

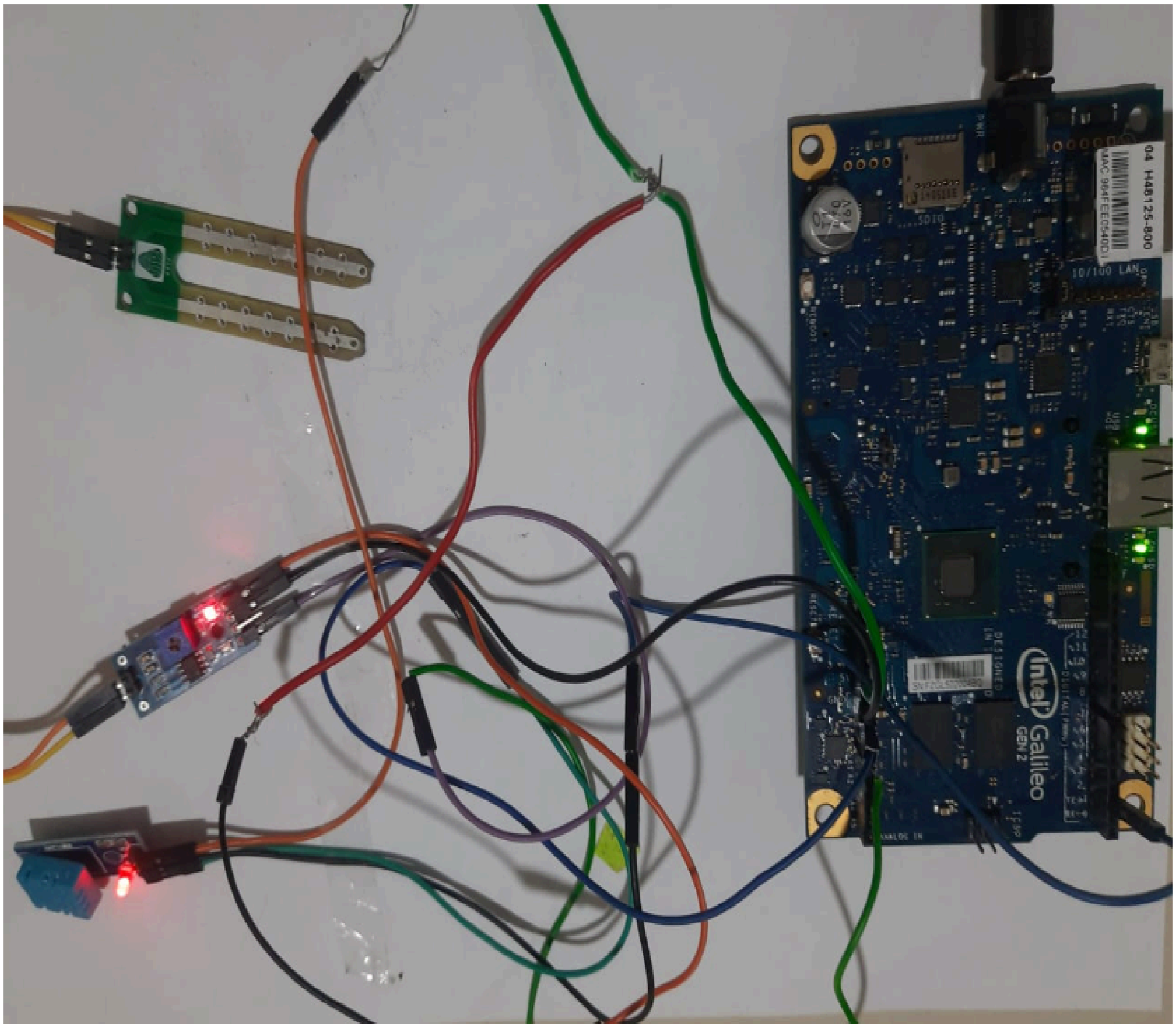


Fig 3.4.2.2: Hardware Implementation

Chapter 04:
Testing

4.1 INTRODUCTION

In agriculture, water is a precious yet costly resource that is becoming more difficult to manage effectively. The goal of this project is to create a smart irrigation system for agriculture that uses less water. It accomplishes this by utilizing Internet of Things and Machine Learning techniques.

On a small farming site, the recommended technique yields greater data and visualization access and lower water consumption. This investigation employed Internet of Things and Machine Learning techniques to propose a mechanized irrigation system that would use less water in agriculture. The installation of affordable sensors that monitor temperature, humidity, and other essential signs can make the autonomous watering system possible.

Precision farming has reached a major milestone with the integration of Arduino and Machine Learning (ML) in our smart irrigation system, which has completely changed agricultural practices. Our system uses the microcontroller capabilities of Arduino to gather data in real time from multiple sensors, including temperature and moisture detectors. Our approach differs from others because we use machine learning algorithms to evaluate this data and forecast the best irrigation times. By responding to shifting environmental factors, this dynamic predictive model makes sure crops get precisely the right amount of water when they need it. The combination of Arduino and ML improves crop yields while encouraging sustainable water use, which makes our smart irrigation system a symbol of modern agriculture's efficiency and resource conservation.

4.2 SENSOR USED IN TEST

4.2.1 Soil Moisture Sensor(Hygrometer) :

A hygrometer, also called a soil moisture sensor, is a crucial tool for environmental monitoring and agriculture. These sensors use a variety of technologies, including resistive, capacitive, and frequency domain principles, to measure the water content of soil. The sensor offers vital information about soil moisture distribution by penetrating the soil at various depths. These sensors are used by farmers and gardeners to optimize irrigation techniques and make sure crops get the right amount of water. By stopping overwatering or underwatering, the sensors help with water conservation efforts and eventually encourage more environmentally friendly agricultural methods. Apart from their application in agriculture, Soil Moisture Sensors are also useful in environmental research, offering important information for climatic studies and evaluations of ecosystem health.

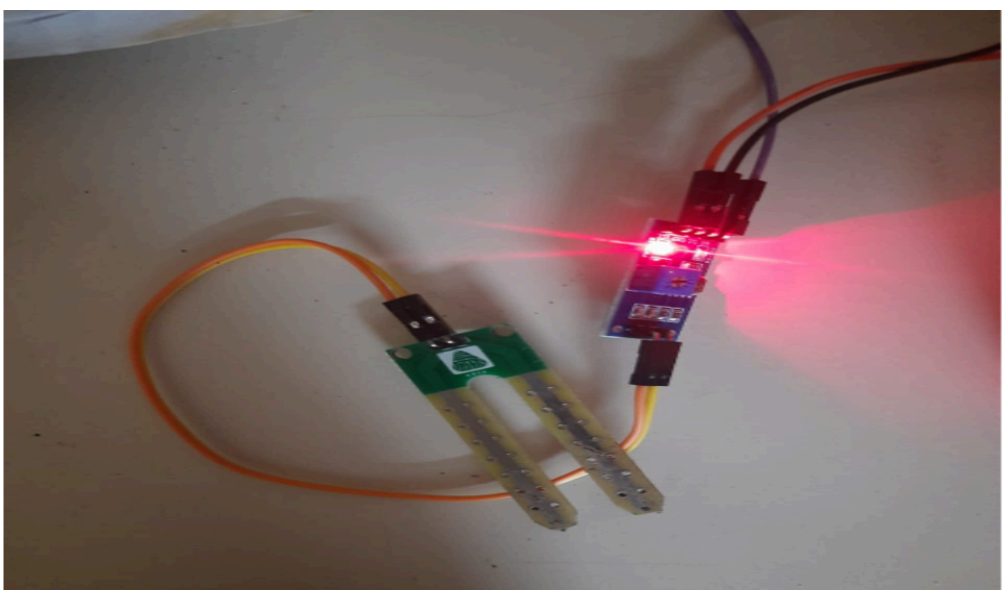


Fig 4.2.1 : Soil Moisture Sensor

4.2.2 DHT 11 Sensor :

DHT11 sensor is a reasonably priced, small device that measures humidity and temperature in a variety of settings. The DHT11 is a widely used, dependable, and straightforward solution for electronics projects and Internet of Things applications. Sensor's digital output facilitates its interface with microcontrollers, rendering it user-friendly for both novice and proficient developers. DHT11 is renowned for its low cost, single-wire interface communication, and broad voltage of 3.5V to 5.5V. The DHT11 is appropriate for applications where a broad indication of temperature and humidity is sufficient, even though it might not provide precision sophisticated sensors.

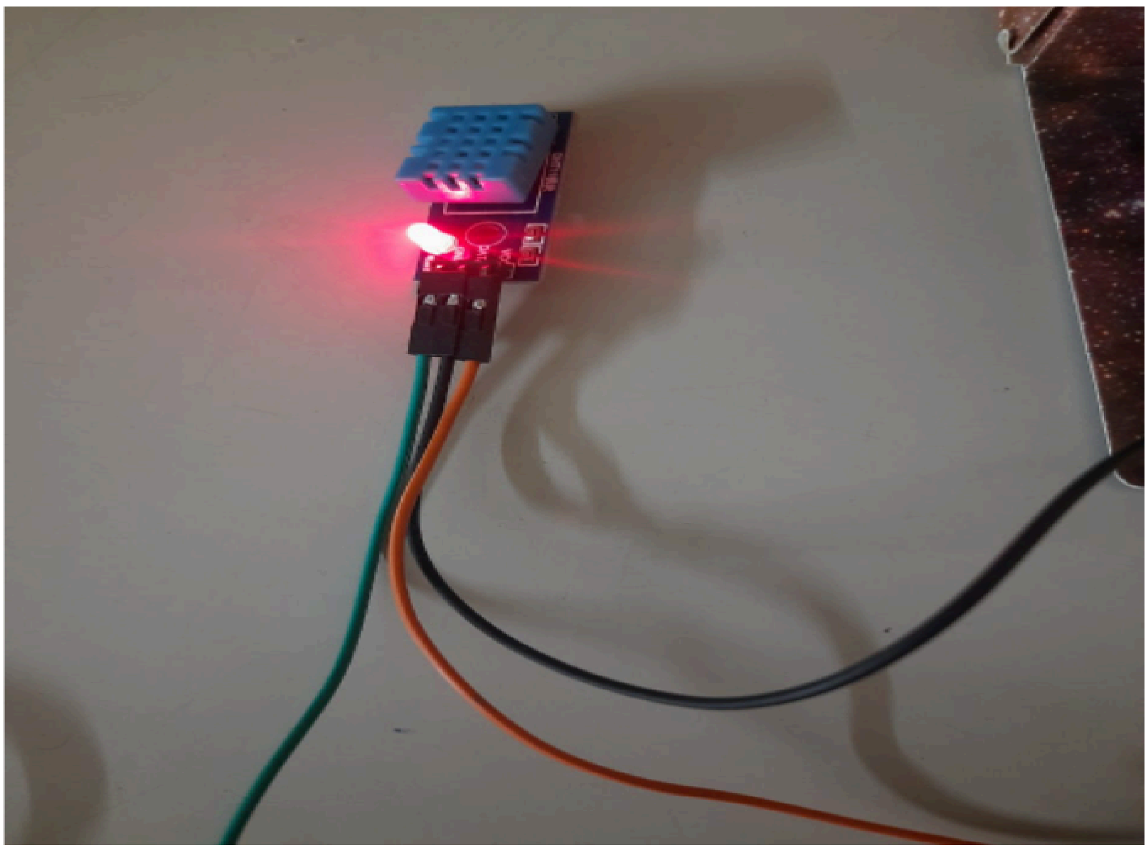


Fig 4.2.2 : DHT 11 Sensor

4.3 TEST SAMPLES

For testing of our hardware implementation we have used samples. We also used these three samples for dataset collection. These samples are going to help us For testing of our hardware implementation

Fig 4.3.1 : Sample 1

Fig 4.3.2 : Sample 2

Fig 4.3.3 : Sample 3

One of the primary goals of this project is to create an automated irrigation system that reduces the amount of water used for farming by utilizing Internet of Things and Machine Learning techniques. Using reasonably priced sensors, this self-contained irrigation system monitors a number of characteristics, such as the temperature of the surrounding area, the amount of water in the soil, and its condition. Data gathered in the field is stored in a database.

Using machine learning and the Internet of Things to build an automated irrigation system that consumes less water for farming is one of the key goals of this project. Using reasonably priced sensors, this self-contained irrigation system monitors a number of characteristics, such as temperature, the amount of water in the surrounding soil, and soil moisture content and quality. Field data is input and stored in a database.

The Internet of Things to build an automated irrigation system that uses less water for farming is one of the main objectives of this project. This self-contained irrigation system monitors many parameters, including temperature, the amount of water in the surrounding soil, and the moisture content and soil quality, using moderately priced sensors. After being entered, field data is kept in a database.

CHAPTER 05:
RESULT AND EVALUATION

5.1 MACHINE LEARNING TECHNIQUES USED

5.1.1 RANDOM FOREST REGRESSION

Random Forest Regression's ensemble approach, which aggregates predictions from several decision trees, lessens overfitting and improves model generalization. This is especially helpful in settings where there are complex and sometimes fluctuating relationships between sensor readings and irrigation requirements. Extensive feature scaling is not necessary because Random Forests are insensitive to the scale of input features. This can be helpful when handling a variety of sensor readings and streamlines the preprocessing steps.

```
Training Accuracy =  0.9688902282967652
Test Accuracy =  0.9084571856537026
```

Fig 5.1.1.1 : Random Forest Regression Accuracy

```
Enter MoisturePercentage: .0522
Enter Humidity: 25
Enter Heatcelcius: 31
Irrigation is not needed.
```

Fig 5.1.1.2 : Random Forest Regression Results

5.1.2 LINEAR REGRESSION

Because linear regression is often computationally efficient, it can be used in situations where predictions must be made in real time or very close to it. It might require fewer resources than more intricate models. Overfitting is less likely with linear regression, particularly when the number of features is small in relation to the size of the dataset. This can be useful in some agricultural settings where limited data is available.

Linear regression is often used as a strong baseline model. Despite its simplicity, it can provide reliable performance for a variety of agricultural applications, particularly when the relationships between variables are roughly linear.

```
Training Accuracy =  0.6854362975761421
Test Accuracy =  0.5925713197235534
```

Fig 5.1.2.1 : Linear Regression Accuracy

```
Enter MoisturePercentage: .5222
Enter Humidity: 52
Enter Heatcelcius: 12
Irrigation is not needed.
```

Fig 5.1.2.2 : Linear Regression Prediction Results

5.1.3 SUPPORT VECTOR MACHINE(SVM)

SVMs are well-known for their high accuracy in classification and regression tasks, making them ideal for predicting crop water requirements based on a variety of input features such as soil moisture, weather conditions, crop type, and growth stage.

SVMs perform well in high-dimensional spaces, which is useful when dealing with large and complex datasets like those found in smart agriculture, where many variables can influence irrigation needs.

```
Accuracy: 0.8947368421052632
```

Fig 5.1.3.1 : SVM Accuracy

```
Enter MoisturePercentage: 0.5225
Enter Humidity: 45
Enter Heatcelcius: 2
Irrigation is not needed.
```

Fig 5.1.3.2 : SVM Prediction Results

5.1.4 Decision Tree

Decision trees have a clear and intuitive structure that is simple to understand and visualize. This makes it simple for farmers and system operators to understand how various factors (such as soil moisture, temperature, and crop type) affect irrigation decisions.

Decision trees can capture and model nonlinear relationships between input and target variables. This is especially useful in agriculture, where the relationship between environmental factors and water requirements can be complicated and nonlinear.

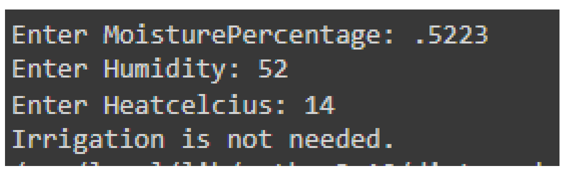


Fig 5.1.4.1 : Decision Tree Prediction Results

5.2 Flask Application

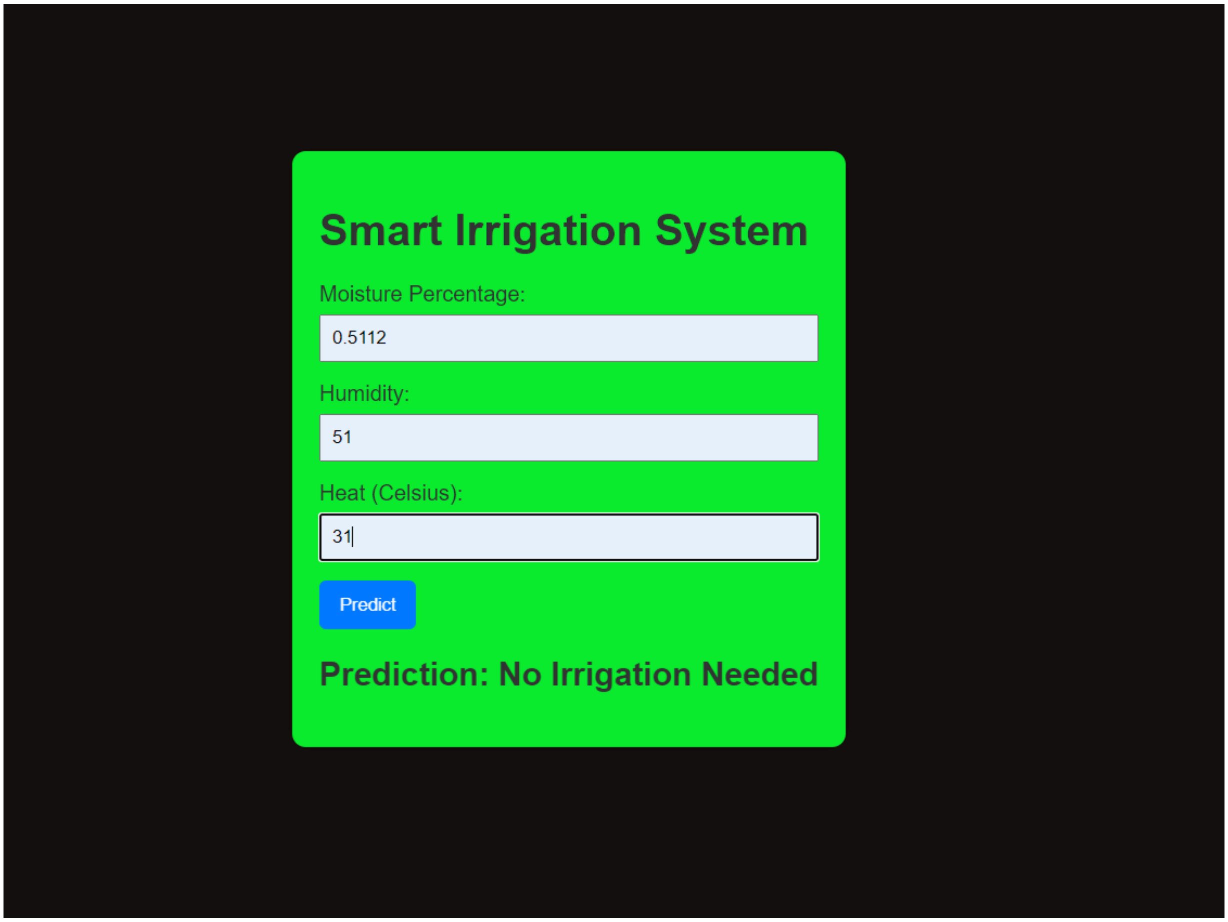


Fig 5.2.1 : Flask Application Results

Chapter 06:
CONCLUSION & FUTURE SCOPE

6.1 CONCLUSION :

In this project a smart irrigation system is implemented. The system can provide precise and timely irrigation that is tailored to the specific needs of the crop and the environment. This can lead to substantial cost savings and environmental benefits, such as reduced water waste and improved water resource management. The system can provide precise and timely irrigation that is tailored to the specific needs of the crop and the environment. The system can monitor soil moisture, temperature, and humidity levels in real-time and adjust the irrigation schedule accordingly. This can lead to substantial cost savings and environmental benefits, such as reduced water waste and improved water resource management. It uses sensors, microcontrollers, and wireless communication technology to optimize water usage in agriculture. The system can monitor soil moisture, temperature and rain etc The system can monitor soil moisture, temperature, and humidity levels in real-time and adjust the irrigation schedule accordingly. The system also has the capability to provide remote access to the data and control functions through the blink app. The system can provide precise and timely irrigation The results of experiments demonstrate that the smart irrigation system can significantly reduce water consumption while maintaining crop health and yield. The system can monitor soil moisture, temperature, and humidity levels in real-time and adjust the irrigation schedule accordingly. The system can provide precise and timely irrigation that is tailored to the specific needs of the crop and the environment. It uses sensors, microcontrollers, and wireless communication technology to optimize water usage in agriculture. This can lead to substantial cost savings and environmental benefits, such as reduced water waste and improved water resource management.

6.2 FUTURE SCOPE :

The smart irrigation system presented in this project has several potential avenues for further research and development. Some of the future scope includes: Integration with advanced sensing technologies: The system can be integrated with advanced sensors, such as thermal cameras, drones, or satellite imagery, to enhance the precision and accuracy of the irrigation management. These sensors can provide additional information about crop health, growth, and stress that can inform irrigation decisions.

Machine learning algorithms: The system can be enhanced with machine learning algorithms that can learn from historical data and optimize the irrigation schedule based on weather patterns, crop growth stages, and other variables. This can lead to even more efficient and effective irrigation management. It can contribute to a more sustainable and efficient agricultural sector that can meet the growing demands of food production while conserving natural resources.

Energy efficiency: The system can be further optimized for energy efficiency by incorporating renewable energy sources, such as solar panels or wind turbines, to power the sensors and microcontrollers. This can reduce the system's carbon footprint and operational costs.

Integration with other smart farming technologies: Overall, the smart irrigation system presented in this project has the potential to revolutionize irrigation management in agriculture. With further research and development The smart irrigation system can be integrated with other smart farming technologies, such as precision farming, automated harvesting, or livestock monitoring, to create a comprehensive smart farming ecosystem. This can lead to greater efficiency, productivity, and sustainability in agriculture. Overall, the smart irrigation system presented in this project has the potential to revolutionize irrigation management in agriculture. With further research and development, it can contribute to a more sustainable and efficient agricultural sector that can meet the growing demands of food production while conserving natural resources.

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