HARVESTING THE FUTURE: SMART FARMING SYSTEMS

Project Report submitted to

Department of Computer Science and Engineering

Dr. B.C. Roy Engineering College, Durgapur, WB

for the partial fulfillment of the requirement to award the degree

of

Bachelor of Technology

in

Computer Science and Engineering

by

Sukrit Basak 12000120019

Md. Sehran Talib 12000120016

Animikh Ghosh 12000120116

under the guidance

of

Supervisor: Prof. Sovan Bhattacharya

Assistant Professor, CSE(Data Science) Department

&

Supervisor: Dr. Chandan Bandyopadhyay

Associate Professor, CSE(Data Science) Department

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DR. B.C. ROY ENGINEERING COLLEGE, DURGAPUR, WB

May, 2024

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DR. B.C. ROY ENGINEERING COLLEGE, DURGAPUR, WB

DECLARATION

We the undersigned, hereby declare that our B.Tech final year Project entitled, **"Harvesting the Future: Smart Farming System"** is original and is our own contribution. To the best of our knowledge, the work has not been submitted to any other Institute for the award of any degree or diploma. We declare that we have not indulged in any form of plagiarism to carry out this project and/or writing this project report. Whenever we have used materials (data, theoretical analysis, figures, and text) from other sources, we have given due credit to them by citing in the text of the report and giving their details in the references. Finally, we undertake the total responsibility of this work at any stage here after.

Signature of the Students

-.-.-.-.-.-.-.-.-.-.-.-.-.-.-.-.-.-.-

Sukrit Basak (12000120019)

-.-.-.-.-.-.-.-.-.-.-.-.-.-.-.-.-.-.-

Animikh Ghosh (12000120116)

-.-.-.-.-.-.-.-.-.-.-.-.-.-.-.-.-.-.-

Md. Sehran Talib (12000120016)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DR. B.C. ROY ENGINEERING COLLEGE, DURGAPUR, WB

RECOMMENDATION

This is to recommend that the work undertaken in this report entitled, **"Harvesting the Future: Smart Farming System"** has been carried out by **"Sukrit Basak, Animikh Ghosh, Md. Sehran Talib"** under my/our supervision and guidance during the academic year 2023-24. This may be accepted in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology (Computer Science and Engineering).

Prof. Sovan Bhattacharya	**Dr. Chandan Bandyopadhyay**	**Dr. Arindam Ghosh**
Assistant Professor,	Head of Department,	Head of Department,
Department of CSE (Data Science)	Department of CSE (Data Science)	Department of CSE

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DR. B.C. ROY ENGINEERING COLLEGE, DURGAPUR, WB

CERTIFICATE

This is to certify that the project report entitled, **"Harvesting the Future: Smart Farming System"** submitted by **"Sukrit Basak, Animikh Ghosh, Md. Sehran Talib"** in partial fulfillment for the award of the degree of Bachelor of Technology in Computer Science and Engineering is a bona fide record of project work carried out by them under my/our supervision. The contents of this report, in full or in parts, have not been submitted to any other Institution or University for the award of any Degree or Diploma.

-------------------------	-------------------------	-------------------------
Prof. Sovan Bhattacharya	**Dr. Chandan Bandyopadhyay**	**Dr. Arindam Ghosh**
Assistant Professor,	Head of Department,	Head of Department,
Department of CSE (Data Science)	Department of CSE (Data Science)	Department of CSE

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DR. B.C. ROY ENGINEERING COLLEGE, DURGAPUR, WB

APPROVAL

This is to certify that, **Sukrit Basak**, **Animikh Ghosh** and **Md. Sehran Talib**, students in the Department of Computer Science & Engineering, worked on the project entitled **"Harvesting the Future: Smart Farming System".**

I hereby recommend that the report prepared by them may be accepted in partial fulfillment of the requirement of the Degree of Bachelors of Technology in the Department of Computer Science and Engineering, Dr. B. C. Roy Engineering College, Durgapur.

-.-

-.-

-.-

Examiners

-.-

Prof. Sovan Bhattacharya & Dr. Chandan Bandyopadhyay

(Supervisor)

-.-

Project Co-ordinator

Date:

-.-

Place:

Dr. Arindam Ghosh

(HOD,CSE)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DR. B.C. ROY ENGINEERING COLLEGE, DURGAPUR, WB

ACKNOWLEDGEMENT

It is our privilege to express our sincere regards to our project supervisor, Prof. Sovan Bhattacharya, Dr. Chandan Bandyopadhyay and Dr. Dola Sinha, for valuable inputs, able guidance, encouragement, whole-hearted cooperation, and constructive criticism throughout our project.

We deeply express our sincere thanks to the Head of Department, Prof. Dr. Arindam Ghosh, for encouraging and allowing us to present the project on the topic **"Harvesting the Future: Smart Farming System"** at our department premises for partial fulfillment of the requirements leading to the award of the B.Tech. Degree.

Furthermore, we would also like to acknowledge the crucial role of our teachers, whose instructions and guidelines acted as a foundation stone for this project.

Sukrit Basak

Animikh Ghosh

Md. Sehran Talib

Abstract

Every aspect of the average person's life has undergone change because of Internet of Things (IoT) technology, which has made everything smart and intelligent. The Internet of Things (IoT) is a network of autonomous devices. In addition to improving agriculture production, the development of intelligent smart farming IoT-based equipment is also lowering waste and increasing cost- effectiveness. The purpose of this report is to suggest an IoT-based smart farming system that helps farmers obtain real-time data (temperature, soil moisture) for effective environment monitoring, allowing them to improve overall production and product quality. Information and communication technologies (ICTs) are used by smart farming systems, an agricultural system that uses them to monitor and control farm operations. Data on crop health, livestock performance, and environmental factors can all be gathered via ICTs. Afterwards, by automating processes and using the data to inform choices, farming operations can become more sustainable and efficient overall.

Keywords: Smart Farming, Internet of Things, Decision Support Systems, Smart sensing, Water control, Temperature measurement, Humidity measurement

Contents

List of Figures

List of Tables

CHAPTER 1

Introduction

Smart Farming Systems use cutting edge technology like automation, artificial intelligence, and the internet of things to improve production and sustainability in agriculture. With a precision agriculture focus, these systems combine real-time data-driven decision-making to maximize crop yield, irrigation, and soil management. Smart Farming uses technology, such the Arduino UNO in a Smart Irrigation System, to automate processes, cut waste, and increase resilience to climate change in an effort to supply the world's food demand while having the least negative environmental impact possible. This all-encompassing strategy offers a technologically sophisticated and sustainable future for food production by establishing an intelligent agricultural environment.

Smart Farming Systems tackle important agricultural prospects and challenges. By 2050, food production must increase by 70% to feed the growing world population, which is driving the development of smart farming technologies. By combining automation, data analytics, and the Internet of Things, these solutions improve precision agriculture while reducing resource waste and environmental impact. By simplifying work, automation improves farm management and frees up farmers to concentrate on making strategic decisions. Furthermore, by utilizing real-time monitoring and predictive analytics, these systems strengthen farmers' ability to quickly adjust to changing weather patterns and uncertainties, promoting long-term sustainability and efficiency in farming techniques.

Smart farming systems integrate cutting-edge technology like automation, artificial intelligence, and the internet of things to transform conventional agriculture. The main objective is to create an intelligent, networked agricultural ecosystem that maximizes resource utilization and boosts crop yields via in-the-moment monitoring and decision-making. One major area of emphasis is precision agriculture, which minimizes waste and its negative effects on the environment by applying inputs like fertilizer and water exactly where they are required. Precision agriculture is demonstrated by the Smart Irrigation System's integration of Arduino UNO, which uses sensor data to make intelligent judgments on water use. By using data analytics to provide real-time information, these systems improve farm management by helping farmers predict crop yields and take immediate action to correct problems, which eventually boosts output and efficiency.

CHAPTER 2

Literature Survey

A. C. Ribeiro et al. [1] proposed a wireless sensor network system for real-time monitoring of soil moisture, temperature, and conductivity. S. Kumar et al. [7] developed an IoT-based smart agriculture system that collects real-time soil data, including pH, nutrient levels, and moisture, to optimize fertilizer delivery and enhance soil health. K. P. Feras et al. [4] in his study presented a machine learning framework that makes use of deep learning and image analysis methods for the early identification and categorization of crop illnesses. H. Zhang and Y. Meng [9] explored the use of unmanned aerial vehicles (UAVs) equipped with sensors and cameras for pest detection and targeted pesticide application, reducing pesticide use and environmental impact. S. K. Jha et al. [6] in his study developed a smart irrigation system that utilizes soil moisture sensors and real-time weather data to optimize water application. D. P. Singh et al. [3] suggested a precision irrigation system based on the Internet of Things that combines machine learning algorithms, weather data, and soil moisture sensors to maximize water efficiency and optimize irrigation schedule. J. Zhang and J. Slaughter [10] reviewed the advancements in robotic harvesting systems for precision agriculture, highlighting their potential to automate labor-intensive tasks, improve harvesting efficiency, and reduce crop losses. C. A. Jones et al. [2] examined the creation and uses of autonomous tractors in precision farming, highlighting their capacity to carry out independent operations including planting, weeding, and harvesting, lowering labor costs. O. Vermesan and P. Friess [8] examined the core ideas of the Internet of Things in agriculture and offers insights into the possible advantages of connecting different farming components. R. Kumar et al. [5] in his research, delved into the integration of sensors, automation, and data analytics, emphasizing the potential for improved resource management and sustainable farming.

Chapter 3

Dataset Preparation

In the development of the Smart Farming Project, it is noteworthy to emphasize that no existing datasets were utilized in the implementation and testing phases. Because of the special features and requirements of the agricultural environment where the project was implemented, it was decided on purpose not to rely on pre-existing datasets. Due to the wide variations in crop varieties, soil composition, etc. among various agricultural areas, smart farming systems are inherently very context-dependent. Thus, the project's top priority was to use on-site sensors interfaced with the Arduino UNO microcontroller to capture real-time data straight from the targeted field. This made it possible to tailor the control and decision-making procedures of the system to the unique features of the local agricultural ecosystem. While existing datasets offer insights, the project required a bottom-up approach to enhance flexibility and tailor the smart farming solution to the unique needs and challenges of the targeted agricultural setting.

CHAPTER 4

Working Principle

The Multi-layer Smart Farming Architecture, featuring the integration of Arduino UNO, unfolds as a sophisticated system designed to optimize agricultural processes through the seamless interaction of four distinct layers: the physical layer, edge layer, cloud layer, and network layer. Each layer plays a pivotal role in ensuring the efficiency, connectivity, and intelligence of the entire Smart Farming System.

The Physical Layer, which is the cornerstone of this architecture, is where tangible components like sensors, actuators, and gadgets communicate with the agricultural environment directly. The Physical Layer of the Smart Farming System includes field-deployed devices such as weather stations and soil moisture sensors. This layer's brain, the Arduino UNO, is a multipurpose microcontroller that gathers data in real time from a variety of sensors. For example, weather stations measure the environmental conditions, while soil moisture sensors measure the hydration levels in the soil. This data is processed by the Arduino UNO, which then provides a localized intelligence that serves as the foundation for well-informed decision-making at higher tiers.

The Edge Layer, a crucial interface that connects the digital and physical domains, is a step up. The Arduino UNO functions as an edge computing device at this point, processing and analyzing data locally. The main benefit of edge computing is that it uses less bandwidth and latency because data is processed locally instead of being routed to a remote server. When it comes to Smart Farming, the Arduino UNO evaluates data from the Physical Layer and acts quickly by applying preset algorithms. For example, it might determine the soil moisture content and automatically start the irrigation system if the moisture content drops below a predetermined level. The entire farming operation is more responsive and efficient because to this real-time decision-making capabilities.

Data can move seamlessly between the Edge Layer and the Cloud Layer. Thanks to the Network Layer's role as a communication bridge. This layer, in the context of smart farming, makes sure that data from the field, processed at the edge layer by the Arduino UNO, is sent to the cloud for additional processing and archiving. In order to build an interconnected system where data flows easily, the network layer is essential. To send data to the cloud, the Arduino UNO may make use of communication protocols like HTTP or MQTT. Additionally, this layer enables bidirectional communication, which enables the edge devices to receive orders, configurations, or updates from the cloud. This ensures synchronization and flexibility in reaction to changing circumstances.

Reaching the Cloud Layer brings us into the domain of massive processing, storing, and analyzing data. Here, data is collected and processed on cloud-based servers from a number of edge devices, each running an Arduino UNO. Large datasets and complicated algorithms can be handled by using cloud computing systems like AWS, Azure, or Google Cloud, which provide the necessary computational power. Advanced analytics, machine learning, and the archiving of historical data are made possible by the cloud layer. By analyzing data trends, machine learning algorithms are able to forecast weather patterns, identify patterns in crop health, and allocate resources as efficiently as possible. Furthermore, the cloud layer facilitates remote management and monitoring, giving farmers access to up-to-date field data from any location with an internet connection.

The synergy between these layers illustrates the comprehensive working of the Multi-layer Smart Farming Architecture. The Physical Layer, empowered by the Arduino UNO, collects raw data from the field. The Edge Layer, also orchestrated by the Arduino UNO, processes this data in real-time, enabling swift and localized decision-making. The Network Layer ensures the seamless transmission of this processed data to the Cloud Layer, where it undergoes extensive analysis and contributes to a wealth of agricultural insights. This interconnected architecture not only enhances the efficiency and productivity of farming operations but also promotes sustainability by enabling precision agriculture and resource optimization.

To achieve precision agriculture and maximize resource utilization for increased crop output, each step is crucial. Here is a brief description of the steps in the methodology:

1. **Define System Requirements and Objectives:** Clearly stating the Smart

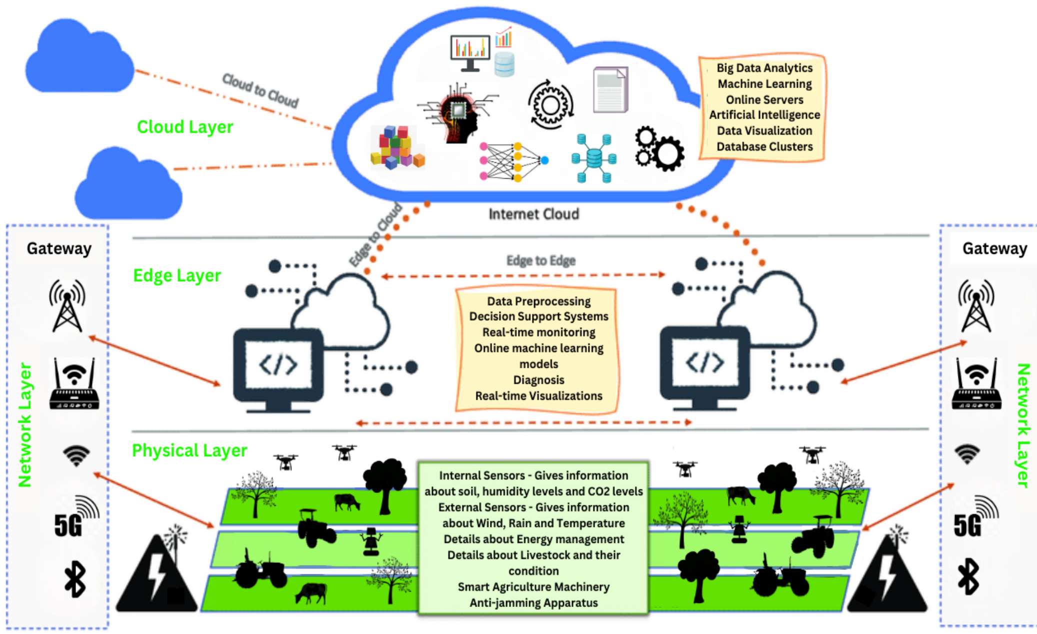

Figure 4.1: *Multi Layer Smart Farming Architecture*

Farming System's objectives and deciding which are the certain parameters to regulate, such temperature, air quality, and water use, are the first step of the project. All of the hardware parts are required to be listed that are needed to make the controlled environment chamber, such as sensors, actuators, and the Arduino UNO.

2. **Select and Acquire Components:** Required Sensors are chosen for measuring soil moisture, temperature, humidity, and atmospheric conditions. Acquire actuators such as water pumps, fans, and heaters for control. The Arduino UNO microcontroller board is obtained, which will serve as the central processing unit for data collection, analysis, and control. The connection of L298N motor driver with microcontroller is shown in Fig. 4.3.

3. **Assemble the Controlled Environment Chamber:** The layout and structure of the controlled environment chamber are planned. Factors such as size, materials, and accessibility are required to be considered. The chamber is constructed, ensuring it provides a controlled environment that can be monitored and adjusted based on the data collected by sensors.

4. **Integrate Soil Moisture Sensors for Automatic Water Control:** Soil moisture sensors are connected with the Arduino UNO. Sensors are connected to the soil in strategic locations within the chamber. A program is developed for the Arduino UNO to read data from the soil moisture sensors. Control logic is implemented to activate water pumps when moisture levels fall below a predetermined threshold. Water pumps and hoses are installed as shown in Figure 4.2 to deliver water to the plants. The system is ensured that it is calibrated to provide the correct amount of water based on real-time soil moisture data.

5. **Implement Atmospheric Monitoring and Control:** Sensors are chosen for monitoring atmospheric conditions such as humidity and gas levels. Connect these sensors to the Arduino UNO. Logic for the Arduino UNO is developed to analyze atmospheric data. Implement control mechanisms for adjusting atmospheric conditions, such as activating fans or adjusting vents. Actuators like fans and vents are integrated into the chamber. Ensurance is done that they respond appropriately to the atmospheric data collected by the sensors.

6. **Integrate Temperature Control System:** Temperature sensors are selected

and Arduino UNO is connected to them. Logic to interpret temperature data is developed and temperature-related actuators are controlled, such as heaters or cooling systems. Heaters or cooling systems are installed within the chamber. These systems are connected to the Arduino UNO and ensurance is done that they respond to temperature variations according to the programmed logic.

7. **Implement Data Logging and Analysis:** A data logging system on the Arduino UNO is developed to record sensor readings and control actions over time. Optionally, the Smart Farming System is integrated with cloud platforms for remote monitoring and data storage. Cloud platform Thingspeak has been utilized. Data analytics algorithms is implemented on the Arduino UNO or the cloud to derive insights from the collected data. This can include trend analysis, anomaly detection, and predictive modeling.

8. **User Interface Development:** A user interface is developed for monitoring and controlling the Smart Farming System. This can be a web-based dashboard or a mobile application. The user interface is integrated with the Arduino UNO or the cloud platform for real-time monitoring and control.

9. **Deployment and Maintenance:** The Smart Farming System is installed in the actual agricultural setting or greenhouse. Ensurance is done that all components are securely in place and the system is ready for operation. Establishment of protocols for addressing any malfunctions or issues is done that may arise during operation. The whole working system of Automatic Water Control System is shown in Fig. 4.4

Figure 4.2: *Water pumps and Hoses are being installed*

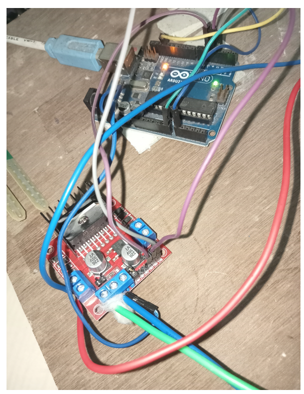

Figure 4.3: *Wire Connection of L298N motor driver with Arduino UNO*

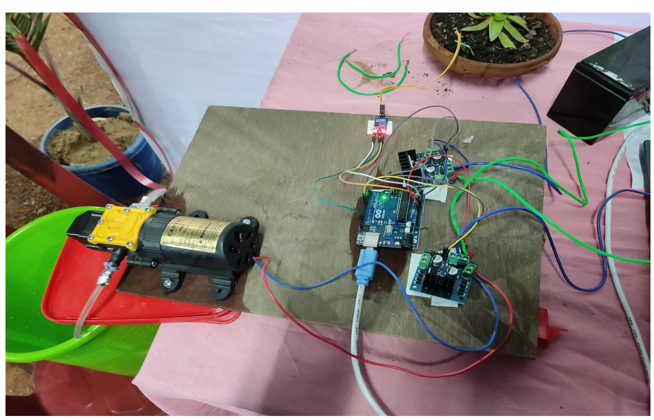

Figure 4.4: *Whole working system of Automatic Water Control System*

CHAPTER 5

Results and Discussion

In this chapter we discussed about the implementation of the Smart Farming System using Arduino UNO yields a range of positive outcomes, enhancing agricultural practices through automation, precision, and data-driven decision-making.

5.1 Results

The proposed irrigation plan uses two different ways to retrieve water: directly from a pipeline and from a storage source such a ground well or reservoir. Depending on the source, the system's use of a DC valve for the latter and a DC pump for the former enables flexible and effective water management.

Using DC Pump

The water flow from a storage source is powered by a 12V, 3.6W DC pump. A DC series motor, whose speed and load torque are inversely correlated with load voltage, controls the DC pump's functioning. The water flow of the pump can be lowered by a decrease in motor speed caused by an increase in load torque. The motor driver's PWM pin, which is controlled by a microcontroller, regulates input voltage to control the motor speed, water flow, and voltage across the load. To maximize irrigation, a soil moisture sensor provides moisture data to the microcontroller. The pipe diameters at the inlet and outlet are 12 mm. Table 5.1 shows the relationship between load voltage and water flow rate for the DC pump.

Table 5.1: *Water flow rate according to load voltage control for storage water*

Input Voltage	Load Voltage	Flow Rate	PWM	Pump Speed
12	12	4 lt/min	100%	High
12	9	3 lt/min	75%	Medium
12	6	2 lt/min	50%	Low
12	3	1 lt/min	25%	Very Low

Using DC Valve

A 12V single-input, three-output valve is used for water flow from a pipeline. Because the three outlets are connected to different supplies from the motor driver, each outlet can be controlled separately. Plants with varying water requirements benefit greatly from this arrangement. For example, rubber plants require higher watering than succulent cacti. Fig. 5.1 shows how the three output pipelines of the valve can irrigate different kinds of plants. PWM control modifies the load voltage to regulate the opening of the valve and the flow of water. The microcontroller receives the data from the moisture sensor and uses it to activate the PWM pins on the motor driver, which controls the valve. Here, the pipes are 20 mm in diameter.

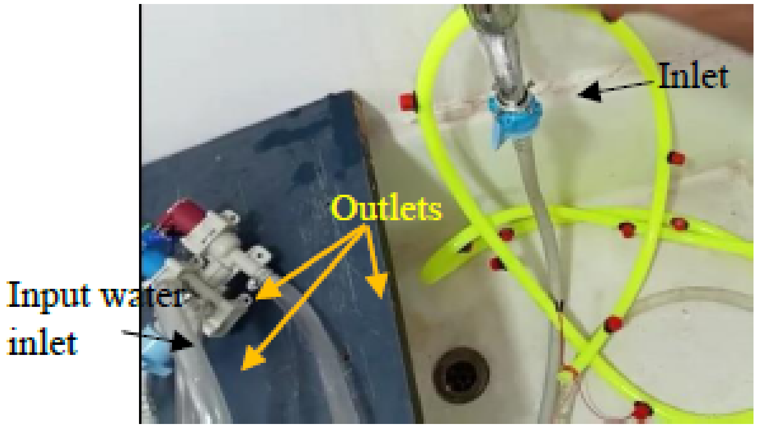

Figure 5.1: *Water Valve arrangement for pipeline water*

Table 5.2: *Water flow rate according to valve opening control for pipeline water*

Input Voltage	Load Voltage	Flow Rate	PWM	Valve Opening
12	12	5.5 lt/min	100%	100
12	9	4.2 lt/min	75%	75
12	6	3 lt/min	50%	50
12	3	1.5 lt/min	25%	25

Fig. 5.2 demonstrates the characteristics of water flow rate with load voltage for both the pump and valve.

Soil Moisture Monitoring

The system uses soil moisture sensors for precise water management. The analog output of the soil moisture sensor is directly connected to the NodeMCU, which converts the readings to digital data. Data is transmitted and visualized using ThingSpeak, an IoT analytics platform that provides a user-friendly interface for

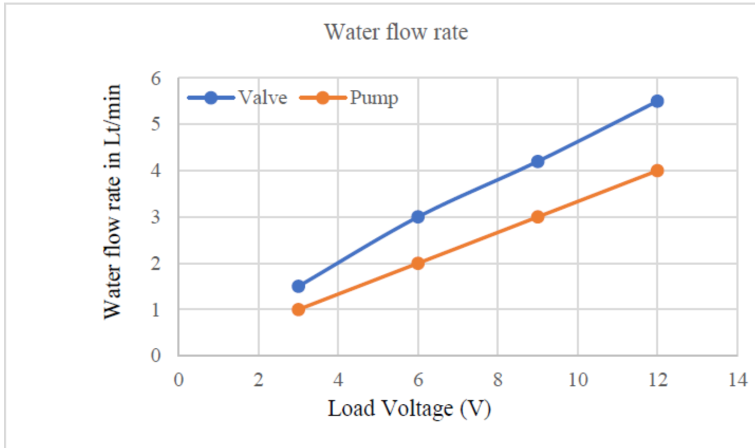

Figure 5.2: *Characteristics of Water flow rate with load voltage*

managing devices and collecting data. The NodeMCU sends HTTP GET requests via WiFi to periodically transmit soil moisture data to ThingSpeak. Real-time graphs from ThingSpeak provide a dynamic view of soil moisture levels, accessible remotely for immediate insights.

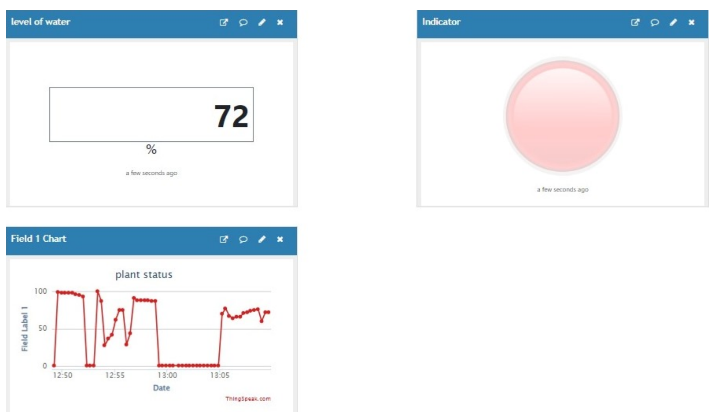

Figure 5.3: *Live Data of Soil Moisture with Date and Time*

Solar Irradiance Measurement

A BH1750 light meter was used to evaluate the intensity of solar irradiance during field testing in order to optimize agricultural solutions. Solar irradiance measurements are displayed graphically in Figs. 5.5 and 5.4. On a sunny day, Fig. 5.5 depicts erratic variations in solar irradiance, whereas Fig. 5.4 depicts a steady decline in irradiance. These evaluations guided system adjustments and highlighted solar energy application in precision farming.

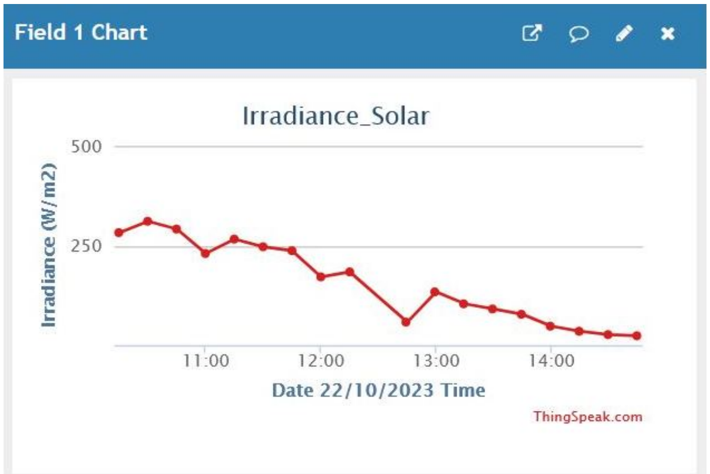

Figure 5.4: *Graphical representation of Solar Irradiance on a Cloudy day*

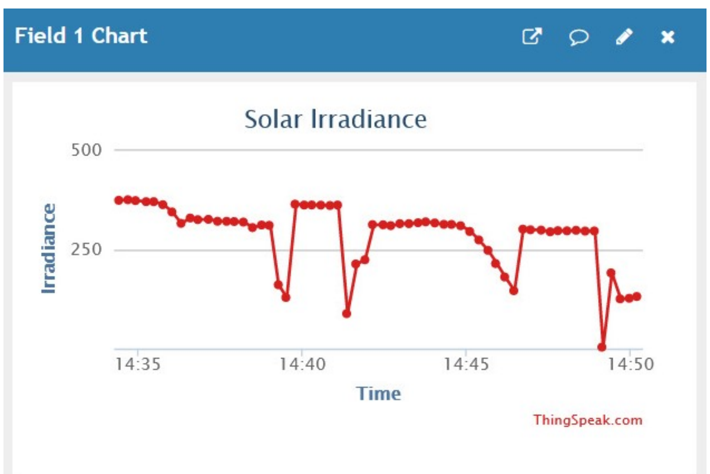

Figure 5.5: *Graphical representation of Solar Irradiance on a Sunny day*

CHAPTER 6

Challenges to Overcome

In this chapter, we have discussed about the pros and cons of implementation of Smart Farming Systems. We will start with detailing about the advantages followed by the disadvantages.

There are many benefits of smart farming. It encompasses a wide range of tools and techniques, including sensors, data analysis, and automation, to monitor and manage crops, livestock, and resources.

Increased crop yield through accurate resource management, lower input costs for fertilizer and water, and improved decision-making with real-time data are some of the advantages of smart farming. By foreseeing possible dangers like pests and diseases, protecting crops, and reducing losses, it reduces risks. Furthermore, Smart Farming guarantees transparency and traceability in the food supply chain, giving consumers and retailers access to details about the origins and production processes of food items. However, obstacles like upfront installation costs, the requirement for specialized knowledge, and possible data security issues could crop up and prevent Smart Farming technology from being widely adopted.

While utilising smart farming in fields it has many benefits, but it also has some drawbacks that need to be considered. It may be necessary to make a sizable upfront investment in sensors, data analytics software, and specialized equipment in order to use smart farming technology. For some farmers, especially those with limited funds, this expense can be unaffordable. Maintaining and operating smart agricultural systems can be challenging and call for a certain degree of technological know-how. For farmers to use these technologies effectively, they might need to make investments in assistance and training. Data security and privacy are challenges that arise from the gathering and storing of vast volumes of agricultural data. Farmers must make sure that their data is shielded from misuse and unwanted access. The implementation of intelligent farming technologies could not be fair to all agricultural scales. Access to and use of these technologies may be difficult for small-scale farmers and people living in underdeveloped nations, which could exacerbate already-existing social and economic disparities.

Despite these drawbacks, smart farming holds immense potential to transform agriculture and address the challenges of feeding a growing population while conserving resources and protecting the environment. Farmers may maximize the positive effects of smart farming while reducing its negative effects by carefully weighing the potential downsides and putting ethical measures into place.

CHAPTER 7

Conclusion and Future Work

To sum up, it can be claimed that smart farming offers the ability to optimize the use of resources, raise agricultural yields, and advance sustainability. Smart farming will be shaped by the cooperation of scientists, technicians, and farmers. It is imperative that we embrace developing technologies and adjust to agricultural demands as they arise in order to ensure a sustainable, efficient, and technology-driven future for global food production. The possibilities of NodeMCU extend beyond soil moisture sensing. In the future, more sensors for light intensity, humidity, and temperature might be added. This expansion would establish a comprehensive environmental monitoring system for plant growth. Affordable solutions could help small-scale farmers as technology becomes more widely available. Before smart farming technologies become widely used and have an impact on the world, they must satisfy the needs of smaller agricultural enterprises.

Bibliography

[1] H. L. V. Nunes M. A. Zúquete J. A. S. Almeida A. C. Ribeiro, A. C. Oliveira and J. A. Sena. Real-time soil monitoring and irrigation management using wireless sensor networks. *IEEE Transactions on Sustainable Computing*, pages 1–10, 2016.

[2] M. C. Godwin C. A. Jones and C. J. Pearson. Autonomous tractors for precision agriculture: A review. *Journal of Agricultural Engineering*, pages 220–230, 2020.

[3] P. Singh D. P. Singh and N. Kumar. Iot-based precision irrigation system for sustainable agriculture. *IEEE Transactions on Sustainable Computing*, pages 180–190, 2019.

[4] M. A. Becerra K. P. Feras, J. A. Vargas-Rojas and L. S. López-Gutiérrez. A machine learning framework for crop disease detection and classification. *Computers and Electronics in Agriculture*, pages 120–130, 2020.

[5] R. Verma R. Kumar, M. K. Jha and J. Gupta. Smart agriculture: An overview on the recent trends and future perspectives. *International Journal of Agricultural Research, Innovation and Technology (IJARIT)*, pages 22–32, 2018.

[6] D. K. Sharma S. K. Jha and A. K. Dwivedi. Smart irrigation system for water conservation in precision agriculture. *Computers and Electronics in Agriculture*, pages 160–170, 2017.

[7] R. K. Gaur S. Kumar and S. K. Pandey. Soil analysis and nutrient management using iot-based smart agriculture system. *Computers and Electronics in Agriculture*, pages 100–110, 2020.

[8] O. Vermesan and P. Friess. Iot-based smart agriculture: Toward making the fields talk. *IGI Global*, pages 1–11, 2014.

[9] H. Zhang and Y. Meng. Uav-based pest monitoring and control in precision agriculture. *IEEE Transactions on Geoscience and Remote Sensing*, pages 140–150, 2019.

[10] J. Zhang and J. Slaughter. Robotic harvesting for precision agriculture. *Annual Review of Plant Diseases and Science*, pages 200–210, 2020.

CHAPTER 8

Paper Details

S. Bhattacharya, D. Sinha, A. Ghosh, S. Basak, Md. S. Talib, C. Bandyopadhyay, Harvesting the Future: Smart Farming System. ICITEEB2024 - International Conference on Innovative Trends in Electrical, Electronics and Bio-Technology Engineering. (Accepted)

CHAPTER 9

Appendix

Code Snippets

```
void setup() {
  pinMode(in3,OUTPUT);//output pin for relay board, this will sent signal to the relay
  pinMode(in4,OUTPUT);
  pinMode(in1,OUTPUT);
  pinMode(in2,OUTPUT);
  pinMode(enA,OUTPUT);
  pinMode(enB,OUTPUT);
  pinMode(A0,INPUT); //input pin coming from soil sensor
}
```

Figure 9.1: *Setup Code of Arduino UNO for Automatic Irrigation System*

```
void loop() {
  water = analogRead(A0);   // reading the coming signal from the soil sensor
  if(water < soilWet ) // if water level is full then cut the relay
  {
    analogWrite(enA, 0);
    digitalWrite(in1, LOW);
    digitalWrite(in2, LOW);
  analogWrite(enB, 0);// low is to cut the relay
```

16

Figure 9.2: *Loop Code of Arduino UNO for Automatic Irrigation System*

sketch_jan16amodified | Arduino 1.8.19

File Edit Sketch Tools Help

sketch_jan16amodified

```
  if(water < soilWet ) // if water level is full then cut the relay
  {
    analogWrite(enA, 0);
    digitalWrite(in1, LOW);
    digitalWrite(in2, LOW);
  analogWrite(enB, 0);// low is to cut the relay
  digitalWrite(in3, LOW);
  digitalWrite(in4, LOW);
  }
  else if(water >= soilWet && water < soilDry)
  {
     analogWrite(enA, 191);
    digitalWrite(in1, HIGH);
    digitalWrite(in2, LOW);
  analogWrite(enB, 100);// low is to cut the relay
  digitalWrite(in3, HIGH);
  digitalWrite(in4, LOW);
  }
  else
  {
    analogWrite(enA, 255);
    digitalWrite(in1, HIGH);
    digitalWrite(in2, LOW);
  analogWrite(enB, 150); //high to continue proving signal and water supply
  digitalWrite(in3, HIGH);
  digitalWrite(in4, LOW);
  }
  delay(100);
}
```

16

Figure 9.3: *Loop Code Continuation of Arduino UNO for Automatic Irrigation System*