IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 3, April 2024

# Greenhouse Crop Monitoring and Recovery of Plants through Automatic Spraying and Watering

**Aniket Ramdas Sandhan[1], AdityaRamrao Rathod[2], Ganesh Rajendra Pathare[3], Adesh Badshaha Bibave[4], Mr. S. R. Tribhuvan[5], Miss. V. D. Vaidya[6]**
Department of Cloud Computing& Big Data[1,2,3,4,5,6]
Padmashri Dr. Vitthalrao Vikhe Patil Institute of Technology and Engineering (Polytechnic), Pravaranagar

**Abstract***: Student safety is a primary concern in our society. Increased rates of student abduction signify the relevance of a proper mechanism to track children. The current system involves students calling the bus driver to ensure to know the current location. There is always an element of uncertainty regarding student whereabouts. Proposed system involves a low-cost solution by allowing students to track bus location via a mobile application. The system involves providing the bus conductor app to update the current stop location, so students are aware of the bus location. This work involves identification of students present in the bus along with tracking of bus.*

**Keywords:** Plant growth, Cultivation, Greenhouse, Microcontroller, Temperature, Humidity, Light, IoT

## I. INTRODUCTION

Plant growth is affected by atmospheric and environmental conditions. Farmers working in greenhouses are unable to properly monitor the humidity level inside the greenhouse . They cannot determine what is happening inside the greenhouse simply by touch or feel. Their day-to-day operations are primarily based on their experiences. If the weather is too dry, they will water the plants, but if it is too wet, they will open the roof of the greenhouse, especially during the day. It is crucial to improve the accuracy of greenhouse crop production in order to achieve optimal growth, higher plant yield at lower costs, good quality, and minimal environmental impact .The use of IoT to control the greenhouse provides great assistance in managing cooling, heating, soil moisture, and other features. Additionally, an IoT-based greenhouse can be controlled from anywhere, while also monitoring environmental elements such as temperature and humidity . These greenhouse environmental conditions can be manually managed by an individual.

Automation is useful for streamlining tasks and reducing the need for manual chores, such as turning switches on/off. However, human errors cannot be completely eliminated or reduced by automation, although they can be minimized to some extent . In a modern environment, everything must be realistically or remotely managed. Furthermore, assuming that greenhouse owners can track and manage their greenhouse from any location, they are not required to physically inspect the conditions regularly. Users should be able to conveniently regulate and manage multiple greenhouses from a single location. The WiFi module and NodeMCU are crucial for transmitting data to the smart system as they eliminate the need for cables or wired connections, thus reducing costs .

The incorporation of smart machines, actuators, sensors, unmanned aerial systems, radio frequency identification (RFID) devices, big data analytics, artificial intelligence, and satellites has facilitated the widespread use of IoT in various agricultural applications, including smart agriculture, frost prevention, and intelligent emergency planning in greenhouses . The introduction of highly effective communication systems has contributed to the widespread adoption of IoT in smart greenhouses and precision agriculture .

Traditional agriculture is characterized by the limited integration of database decision support systems, resulting in unnecessary human involvement, higher labor costs, and vulnerability to catastrophic weather events. IoT provides relief in addressing crop monitoring issues through artificial intelligence, energy and water conservation strategies based on machine learning, and automated agricultural operations. The farmers' inability to engage with IoT technology may be attributed to the lack of established parameters for energy and water allocation, energy consumption, and uncertainty regarding agricultural product selling prices due to fluctuating market prices . Smallholder farmers have little incentive to invest in new technologies such as IoT due to narrow production margins, while large commercial producers can easily afford IoT equipment. Despite the widespread use of IoT systems in smart greenhouses, there is a lack of understanding regarding how this technology could improve greenhouse settings, particularly in tropical climates with extreme temperature fluctuations.

### 1.1 Motivation

The proposed system aims to revolutionize greenhouse agriculture by seamlessly integrating IoT technology for precise monitoring and automated control of environmental factors like temperature, humidity, and light. By reducing manual labor and improving efficiency, it motivates farmers to embrace sustainable practices, optimize yields, and mitigate environmental impact, fostering a more resilient and productive agricultural sector.

### 1.2 Problem Definition and Objectives

Traditional greenhouse farming methods lack efficient monitoring and control systems, leading to suboptimal crop growth and increased operational costs. Farmers struggle to accurately assess and manage environmental conditions such as humidity and temperature, resulting in reduced yields and quality. Additionally, manual intervention is time-consuming and prone to human error, hindering productivity and sustainability efforts.

- Develop an IoT-based system for real-time monitoring of greenhouse environmental parameters including temperature, humidity, and light intensity.
- Implement automated control mechanisms to regulate environmental conditions within the greenhouse, optimizing plant growth and health.
- Design a user-friendly interface for remote access and management of the greenhouse system, facilitating convenience and efficiency for farmers.
- Integrate predictive analytics and machine learning algorithms to provide insights and recommendations for proactive decision-making in greenhouse operations.
- Enhance scalability and affordability of the system to cater to the diverse needs of smallholder farmers and large-scale agricultural enterprises alike.

### 1.3.Project Scope and Limitations

- Development of an IoT-based system for monitoring and controlling environmental parameters (temperature, humidity, light) in a greenhouse.
- Implementation of automated mechanisms for adjusting environmental conditions to optimize plant growth and yield.
- Designing a user interface for remote access and management of the greenhouse system via a mobile application or web platform.
- Integration of predictive analytics to provide insights and recommendations for efficient greenhouse management.
- Testing and validation of the system in real-world greenhouse environments to ensure effectiveness and reliability.

**Limitations As follows:**

- The system may be limited by the availability of reliable internet connectivity, especially in rural or remote agricultural areas.
- Accuracy of environmental sensors and actuators may be affected by calibration issues or sensor drift over time.
- Compatibility with existing greenhouse infrastructure and equipment may vary, leading to potential integration challenges.

## II. LITERATURE REVIEW

Paul D. RoseroMontalvo And et al. Smart Farming Robot for Detecting Environmental Conditions in a Greenhouse , 8 June 2023 reviews to efficiently manage agricultural fields and greenhouses today, farmers have to apply technologies in line with Industry 4.0, such as: robots, Internet of Things devices, machine learning applications, and so on. An unsupervised learning algorithm is implemented to cluster the optimal, standard, and deficient sectors of a greenhouse to determine inappropriate growth patterns in crops . 40 data collection points Central node receives 120 samples Data collected on the basis of parameters sensed by Temprature sensor , Humidity sensor , and CO2 emission .Reached the objective of acquiring valuable data from the greenhouse The proposed data analysis effectively determined the zones of the greenhouse where the environmental conditions affected the crops. To build an autonomous robot with computer vision to give the farmer more information about his crops and the possibility of activating water pumps.

Muhammad Shoaib Farooq , And et al. “Internet of Things in Greenhouse Agriculture: A Survey on Enabling Technologies, Applications, and Protocols” ,11 April 2022. A rigorous discussion on greenhouse farming techniques, IoT-based greenhouse categories, network technologies , the success stories and statistical analysis of some agricultural countries have been presented to standardize IoT-based greenhouse farming Data collected on Cloud Computing Server . The data collected is of parameters like temperature, humidity, the intensity of light, and soil moistness. The current status of the research has indicated that it was feasible to remotely monitor the greenhouse parameters such as CO2, PH, moisture content, humidity, temperature, and irrigation by using IoT sensors and devices. A generic platform is necessary to build for all kinds of crops and plants, quality of service (QoS), integration of explainable artificial intelligence for pest control, and crop growth .

Randa Osama, Nour El Huda and et al. “ Detecting plant’s diseases in Greenhouse using Deep Learning “,16 June 2021. The proposed system is used to speed up the plant growth and detect the plant’s diseases. We used tomatoes to test our proposed system. The detected diseases are early blight, late blight, leaf mold, spider mites, target spot, mosaic virus, septoria, bacterial spot, and yellow leaf curl virus Dataset consists of 9 classes of different diseased tomatoes leaves images and 1 class for healthy tomatoes leaves images. These images are imported from plant village dataset which contain 54,309 images of tomato leaves including healthy and unhealthy tomatoes leaves. In the proposed approach, an automated intelligent system for the greenhouse crop agriculture was developed to make the plant grow faster in a suitable environment. The proposed approach detects certain diseases that could effect plant’s growth. Increasing the accuracy of the result and getting a clear images of the plant with highest resolution of camera

## III. REQUIREMENT SPECIFICATIONS

**SOFTWARE REQUIREMENTS:**

- Language : Python , Embedded C
- Arduino IDE
- Operating system : Windows 7/10/xp, linux
- RAM : 4 GB and higher

**HARDWARE REQUIREMENTS:**

- Arduino UNO
- DC Motor
- Relay model
- Camera Module

**Sensor Integration:**

- The system should integrate various sensors to monitor environmental parameters such as temperature, humidity, soil moisture, light intensity, and nutrient levels in real-time.
- Sensors should be capable of providing accurate and reliable data for different types of crops.

**Crop Health Monitoring:**

- Implement algorithms to analyze sensor data and assess the health of crops.
- Provide real-time alerts or notifications for any deviations from optimal growing conditions, such as pest infestations, diseases, or nutrient deficiencies.

**Automatic Watering System:**

- Integrate an automated watering system that adjusts water supply based on real-time soil moisture levels.
- Allow customization of watering schedules and volumes based on crop type and growth stage.

**Automatic Spraying System:**

- Include an automatic spraying system for pesticides or fertilizers based on detected issues.
- Enable the customization of spraying parameters such as spray frequency, volume, and type of solution.

**Data Logging and Historical Analysis:**

- Store historical data on environmental conditions, crop health, and irrigation/spraying activities for analysis.
- Provide tools for users to analyze trends, make informed decisions, and optimize crop management strategies.

**User Interface:**

- Develop a user-friendly interface accessible via web or mobile applications.
- Display real-time data, alerts, and historical trends in an easy-to-understand format.
- Allow users to remotely control and monitor the system.

**Remote Monitoring and Control:**

- Enable remote access to the system for farmers or greenhouse managers.
- Provide the ability to adjust settings, view reports, and receive notifications remotely.

## IV. SYSTEM DESIGN

### 4.1 System Architecture

The system architecture for Greenhouse Crop Monitoring and Recovery through Automatic Spraying and Watering is designed to optimize the cultivation process, ensuring optimal conditions for plant growth and recovery. At its core, the architecture integrates a network of sensors distributed throughout the greenhouse to monitor key environmental parameters such as temperature, humidity, soil moisture, and light intensity. These sensors continuously collect real-time data, providing valuable insights into the health and status of the crops.

The second layer of the system involves a centralized control unit equipped with advanced data processing capabilities. This unit utilizes machine learning algorithms to analyze the sensor data and make informed decisions regarding the application of water and nutrients. Additionally, it employs computer vision technology to assess the condition of individual plants, identifying signs of stress, diseases, or pests. Based on this analysis, the control unit triggers automatic actions, such as activating the irrigation system or deploying targeted spraying mechanisms to address specific issues detected in the crop.

To facilitate seamless communication and coordination, the third layer of the system incorporates a robust network infrastructure. This enables the sensors, control unit, and actuators responsible for spraying and watering to communicate efficiently. Furthermore, the architecture may include remote monitoring and control capabilities, allowing farmers to access real-time data and make adjustments to the system parameters through a user-friendly interface, either on-site or remotely. Overall, this integrated system architecture optimizes resource utilization, minimizes human intervention, and promotes sustainable and efficient greenhouse crop management.

The below figure specified the system architecture of our project.

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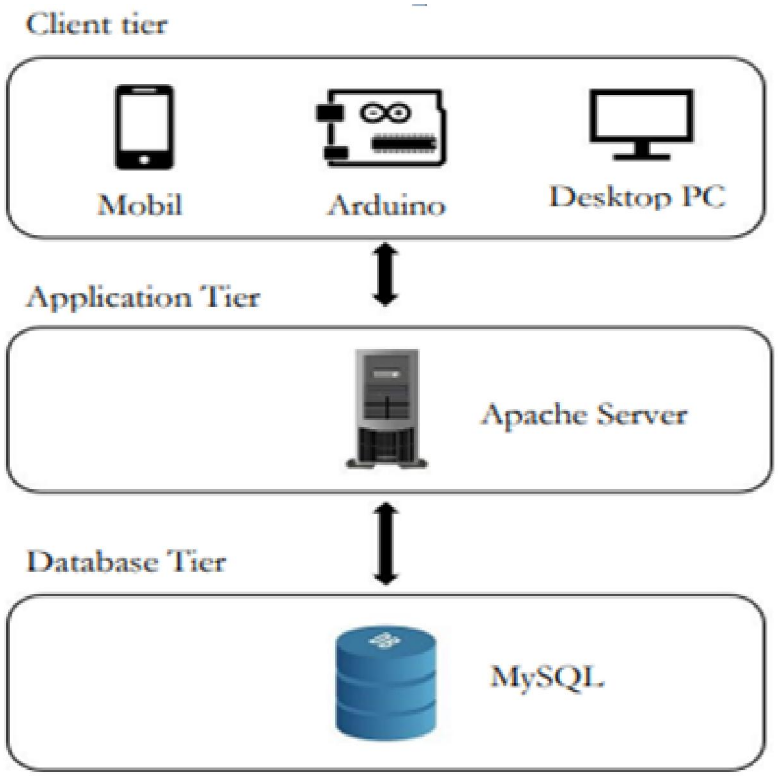


Figure 4.1: System Architecture Diagram

**4.2 UML Diagram**

The below figure specified the circuit diagram of our project.

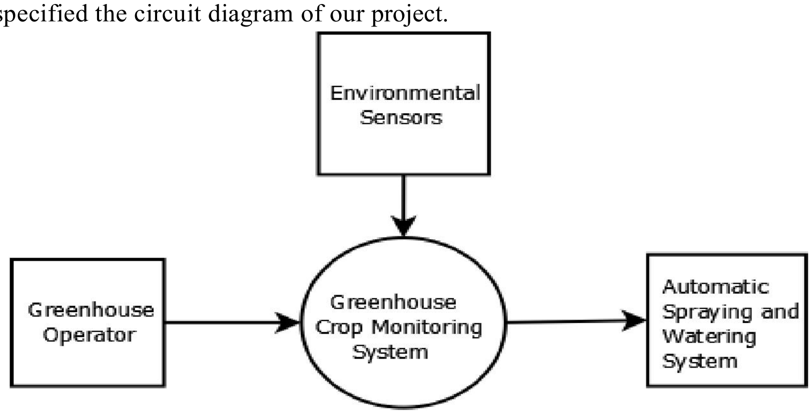


Figure 4.2: DFD Diagram

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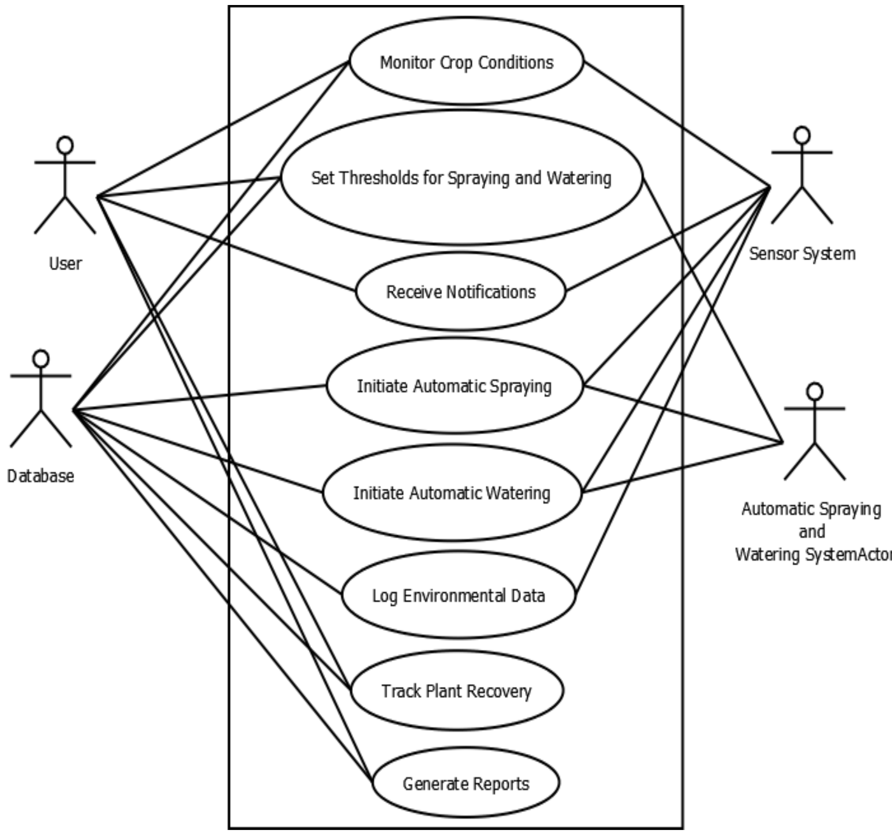


Figure 4.3: Usecase Diagram

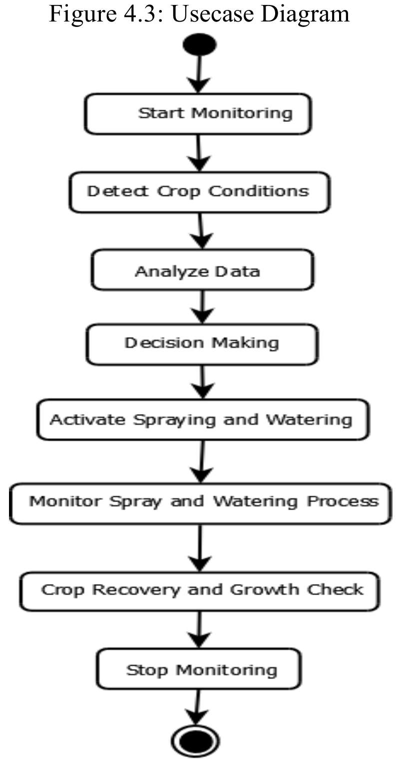


Figure 4.4: Activity Diagram

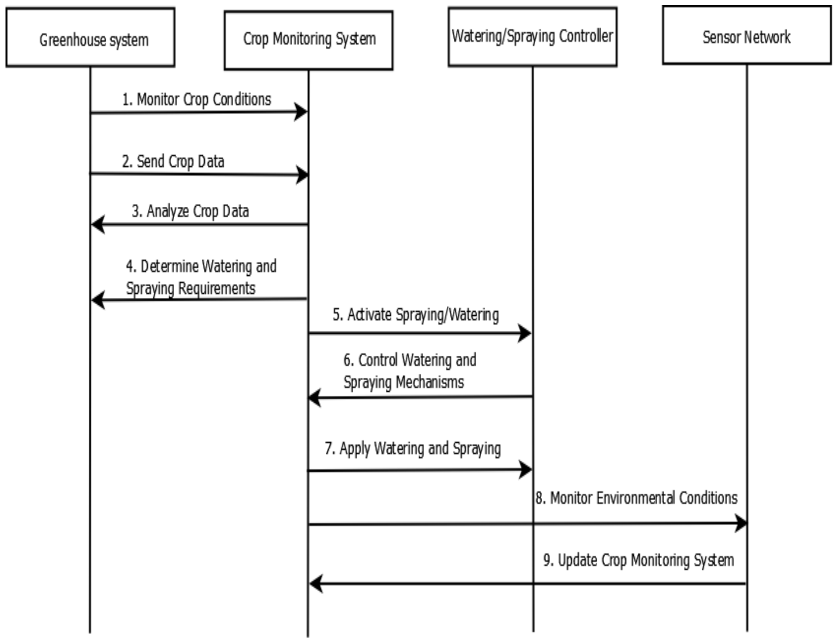


Figure 4.5: Sequence Diagram

## V. RESULT

The proposed project aims to address the critical challenges faced by greenhouse farmers in effectively monitoring and managing environmental conditions for optimal crop growth. By leveraging IoT technology, the system seeks to automate the process of monitoring temperature, humidity, and light intensity within the greenhouse, providing real-time data insights to farmers. Through the integration of sensors, actuators, and microcontrollers, the system enables precise control mechanisms to adjust environmental parameters, thereby optimizing plant health and increasing yield. Additionally, the project emphasizes the development of a user-friendly interface for remote access and management, empowering farmers to conveniently monitor and regulate greenhouse conditions from any location. By enhancing automation and accessibility, the system strives to revolutionize greenhouse agriculture, fostering sustainable practices and improving productivity for farmers.

Figure 5.1: Output of System

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## VI. CONCLUSION

### Conclusion

In conclusion, the development of an IoT-based system for greenhouse crop monitoring and automated control presents a promising solution to the challenges faced by farmers in managing environmental conditions and optimizing plant growth. By leveraging advanced technologies such as sensors, actuators, and machine learning algorithms, the proposed system offers real-time insights, precise control mechanisms, and remote accessibility, empowering farmers to enhance productivity, sustainability, and profitability in greenhouse agriculture.

### Future Work

The future scope for greenhouse crop monitoring and recovery through automatic spraying and watering holds immense potential as agriculture continues to embrace technology-driven solutions. With the increasing global demand for sustainable and efficient agricultural practices, the integration of smart technologies in greenhouse farming is poised to play a pivotal role. Automated systems for monitoring and managing crop health, combined with precision spraying and watering techniques, can optimize resource utilization, reduce wastage, and enhance overall crop productivity. This technology not only offers the advantage of real-time monitoring but also enables farmers to remotely control and adjust environmental conditions within the greenhouse, ensuring optimal growth conditions for different crops.

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