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Research Paper

IOT-BASED SMART FARM ENVIRONMENTAL CONDITION CLASSIFICATION FOR GREENHOUSE AUTOMATION

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ABSTRACT

The Internet of Things (IoT) plays an important role in modern agriculture by improving productivity and reducing manual effort. This project, IoT Based Smart Farm Environmental Condition Classification for Greenhouse Automation, focuses on monitoring and controlling greenhouse environmental conditions using smart sensors and machine learning techniques. Various sensors such as temperature, humidity, soil moisture, and light sensors are used to collect real-time data from the greenhouse environment. The collected data is processed and analyzed using a machine learning classification model to determine the environmental condition and decide whether the water pump actuator should be turned ON or OFF. The system helps farmers maintain optimal conditions for plant growth by automatically controlling irrigation and environmental parameters. A web-based interface is also developed to visualize sensor data and prediction results. This smart greenhouse automation system improves efficiency, saves water, reduces human intervention, and ensures better crop management. The implementation of IoT and machine learning technologies provides a reliable and cost-effective solution for modern smart farming.

The IoT-Based Smart Farm Environmental Condition Classification system is designed to enhance greenhouse automation through real-time monitoring and intelligent decision-making. Traditional farming methods often rely on manual observation, which can lead to inefficient resource utilization and delayed responses to environmental changes. This system integrates IoT sensors to continuously collect data such as temperature, humidity, soil moisture, and light intensity from the greenhouse environment.

The collected data is transmitted to a centralized system where machine learning algorithms are applied to classify environmental conditions into categories like optimal, moderate, or critical. Based on the classification results, automated actions such as irrigation, ventilation, and lighting control are triggered to maintain ideal growing conditions.

I INTRODUCTION

Agriculture plays an important role in providing food and supporting the economy. However, traditional farming methods often face problems such as unpredictable weather conditions, improper irrigation, and lack of continuous monitoring. These factors can reduce crop productivity and quality. To overcome these challenges, modern technologies like the Internet of Things (IoT) are being widely used in agriculture. A Greenhouse is a controlled environment where crops can grow under suitable temperature, humidity, soil moisture, and light conditions. Maintaining these environmental parameters manually is difficult and time-consuming. Therefore, automation and intelligent monitoring systems are required to improve efficiency and crop yield.

The IoT-Based Smart Farm System uses sensors to collect environmental data such as temperature, humidity, soil moisture, and light intensity inside the greenhouse. This data is sent to a processing system where it is analyzed and classified to determine the environmental condition of the greenhouse. Based on the classification results, automated actions such as turning on water pumps, ventilation systems, or lighting can be performed. This project focuses on Environmental Condition Classification For Greenhouse Automation using IoT technology. By continuously monitoring and analyzing sensor data, the system helps farmers maintain optimal conditions for plant growth. This approach reduces manual effort, improves resource management, and increases agricultural productivity. Overall, the proposed system demonstrates how IoT and intelligent data analysis can be used to create a Smart, Automated, and Efficient Greenhouse Farming System.

Greenhouse farming requires continuous monitoring of environmental conditions such as temperature, humidity, soil moisture, and light intensity to maintain optimal plant growth. In traditional greenhouse systems, farmers often monitor these conditions manually, which can be timeconsuming, inaccurate, and inefficient. Due to changing weather conditions and lack of real-time monitoring, it becomes difficult to maintain the ideal environment inside the greenhouse. This can lead to poor crop growth, reduced productivity, and wastage of water and energy resources. To solve this problem, there is a need for an automated and intelligent system that can continuously monitor environmental parameters and classify the greenhouse conditions in real time. Using Internet of Things (IoT) technology, sensors can collect environmental data and send it to a system that analyzes the conditions and automatically controls devices such as water pumps, fans, and irrigation systems.

Therefore, the goal of this project is to develop an IoT-Based Smart Farming System That Classifies Environmental Conditions and Automates Greenhouse Operations, improving crop productivity, reducing manual effort, and ensuring efficient resource management. The main problem addressed in this project is the lack of an efficient, automated, and intelligent system for monitoring and classifying greenhouse environmental conditions, which can help farmers maintain optimal conditions and improve agricultural productivity.

II LITERATURE SURVEY

The Internet of Things (IoT) has emerged as a key technology in modern agriculture, enabling intelligent monitoring and automation of farming processes. IoT-based smart farming systems use sensors, wireless communication, and cloud platforms to collect and analyze environmental data such as temperature, humidity, soil moisture, and light intensity. These technologies help farmers monitor crop conditions in real time and make data-driven decisions to improve productivity and resource efficiency. In greenhouse environments, maintaining optimal climatic conditions is essential for healthy plant growth. Recent studies have proposed IoT-based greenhouse systems that integrate environmental sensors and automated control mechanisms to regulate parameters like temperature, humidity, and irrigation. Such systems can automatically adjust ventilation, lighting, and watering processes, reducing manual effort and improving crop yield. Several researchers have developed smart greenhouse frameworks using microcontrollers, wireless sensor networks, and cloud platforms for real-time monitoring and control. These studies demonstrate that IoT-based automation can significantly reduce water wastage, improve environmental management, and support sustainable agriculture. Therefore, the literature indicates that IoT-enabled environmental condition classification and automation in greenhouses play an important role in improving agricultural productivity, efficiency, and sustainability.

Several researchers have proposed IoT-Based Greenhouse Monitoring and Automation Systems to improve agricultural productivity and reduce manual labor. Smart greenhouse systems use sensors, wireless communication, and cloud technologies to monitor environmental parameters such as temperature, humidity, light intensity, and soil moisture. These parameters help maintain optimal crop growth conditions. Many studies focus on Sensor-Based Environmental Monitoring using wireless sensor networks (WSN). These systems collect real-time data from the greenhouse and send it to a cloud platform or mobile application for analysis and control of devices such as irrigation pumps, ventilation fans, and lighting systems. Recent research integrates machine learning with IoT to automatically classify environmental conditions and make intelligent decisions. Machine learning algorithms analyze sensor data to predict suitable climate conditions and control greenhouse operations automatically, which helps improve crop yield and reduce water usage.

III SYSTEM ANALYSIS

The IoT-Based Smart Farm Environmental Condition Classification system focuses on monitoring and analyzing greenhouse conditions using interconnected sensors and intelligent algorithms. Traditional farming methods rely heavily on manual observation, which often leads to inefficiencies and delayed responses to environmental changes. This system integrates Internet of Things (IoT) devices such as temperature, humidity, soil moisture, and light sensors to continuously collect real-time data from the greenhouse environment.

The collected data is transmitted to a centralized processing unit or cloud platform where machine learning models classify environmental conditions into categories such as optimal, moderate, or critical. Based on this classification, automated control actions like irrigation, ventilation, and lighting are triggered. The system improves decision-making accuracy and reduces human intervention.

Existing system

The existing greenhouse management systems are mostly manual or semi-automated. Farmers rely on periodic monitoring of environmental conditions using basic tools. Some systems use standalone sensors, but they lack integration and real-time analytics. Environmental control actions such as watering and ventilation are often performed manually. There is limited use of data-driven decision-making techniques. These systems do not support predictive analysis or intelligent classification of conditions.

DisAdvantages of Existing system

- Lack of real-time monitoring
- High dependency on manual labor
- Inefficient resource utilization (water, energy)
- No predictive or intelligent decision-making
- Delayed response to environmental changes

Proposed system

The proposed system uses IoT sensors to continuously monitor greenhouse environmental parameters such as temperature, humidity, soil moisture, and light intensity. The data is transmitted to a cloud or local server for processing. Machine learning algorithms classify environmental conditions into predefined categories. Based on classification results, automated control systems adjust irrigation, ventilation, and lighting. The system provides real-time alerts and remote monitoring via mobile or web applications. This ensures optimal plant growth and efficient farm management.

Advantages of Proposed System

- Real-time monitoring and control
- Reduced human intervention
- Efficient use of water and energy
- Accurate environmental classification
- Improved crop yield and quality

IV METHODOLOGY

The methodology of the IoT-Based Smart Farm Environmental Condition Classification system involves several stages starting from data acquisition to automated decision-making. Initially, environmental data is collected using IoT sensors placed strategically inside the

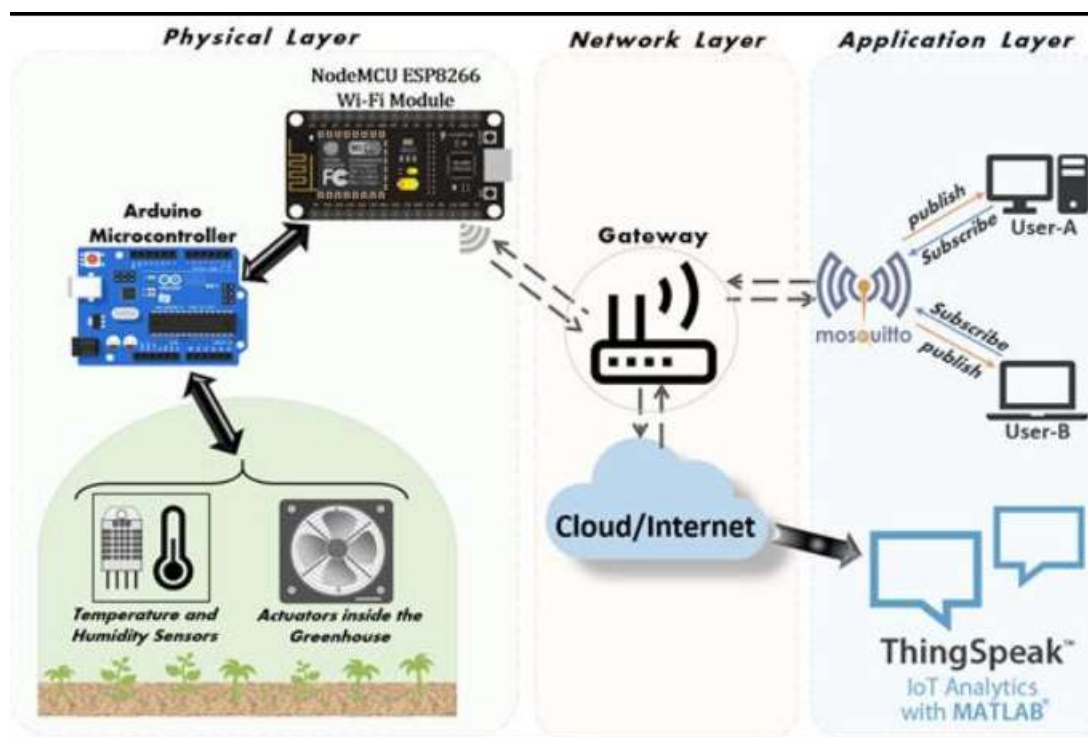
greenhouse. These sensors measure parameters such as temperature, humidity, soil moisture, and light intensity at regular intervals.

The collected data is transmitted through a communication network to a centralized system, which could be a cloud server or an edge device. Data preprocessing techniques such as cleaning, normalization, and filtering are applied to ensure accuracy and consistency. After preprocessing, machine learning models such as Decision Trees, Random Forest, or Support Vector Machines are used to classify environmental conditions into categories like optimal, moderate, or critical.

Based on the classification output, control actions are triggered automatically using actuators such as water pumps, fans, and artificial lighting systems. The system also provides real-time alerts and visualization dashboards for farmers through mobile or web applications. Continuous monitoring and feedback help improve system performance over time. This methodology ensures efficient greenhouse management, optimal crop growth, and resource conservation.

System Architecture

The system architecture consists of multiple layers including the sensing layer, communication layer, processing layer, and application layer. The sensing layer includes IoT sensors that collect environmental data. The communication layer transmits data using wireless protocols such as Wi-Fi or Zigbee. The processing layer (cloud or edge computing) analyzes the data using machine learning models. The application layer provides user interfaces for monitoring and control. Actuators like pumps and fans are triggered based on classification results.



V RESULTS & OUTPUT

Enter Sensor Values

Temperature

0.03

- +

Humidity

0.05

- +

Soil Moisture

0.09

- +

Rainfall

0.11

- +

Flow Rate

0.04

- +

Sensor 1

0

▼

Sensor 2

0

▼

Sensor 3

0

▼

Sensor 4

0

▼

Sensor 5

0

▼

Predict Water Pump Status

☒ Water Pump Actuator will be ON

VI CONCLUSION

The proposed IoT-based system successfully demonstrates the classification of greenhouse environmental conditions using Logistic Regression in Python. By integrating sensors for temperature, humidity, soil moisture, and light intensity, the system can monitor and analyze

realtime data effectively. The Logistic Regression model accurately classifies the conditions, allowing the automation system to make informed decisions about irrigation, ventilation, and shading. Overall, this approach improves crop yield, resource efficiency, and operational convenience while reducing manual intervention in greenhouse management. Using machine learning techniques like Logistic Regression, the system classifies environmental conditions and determines whether they are suitable for plant growth. Based on the classification results, automated actions such as turning fans, irrigation systems, or lighting ON or OFF can be performed. This reduces the need for manual monitoring and ensures that crops always grow under optimal conditions. The proposed system increases efficiency, accuracy, and crop yield while reducing water usage, labor cost, and human errors. It also allows farmers to monitor the greenhouse remotely through a connected platform. Overall, this project demonstrates that integrating IoT and machine learning in agriculture can lead to smart, automated, and sustainable farming practices, making greenhouse management easier and more productive.

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