

Smart Plant Monitoring and Care with AI

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ABSTRACT

Agriculture faces major challenges due to inefficient water usage and lack of real-time monitoring of plant health. The Smart Plant Monitoring and Care with AI system addresses these issues by integrating IoT, sensors, and artificial intelligence to monitor plant health and improve plant care. The system continuously monitors key parameters such as soil moisture, temperature and humidity using sensors connected to an ESP8266 microcontroller. Based on real-time sensor data, the system continuously monitors plant and soil conditions in real time to determine plant health status. Firebase is used for real-time data storage, visualization, and remote monitoring. Additionally, AI-based data analysis enables future prediction of plant growth conditions. The system also uses chatbot for better user assistance. This project provides a cost-effective, efficient, and sustainable solution for modern smart agriculture and precision farming.

Keywords: IoT, Smart Plant Monitoring, ESP8266, Soil Moisture Sensor, Artificial Intelligence, Precision Agriculture

1. Introduction

Modern agriculture requires efficient water management and continuous monitoring of plant health to improve productivity and reduce resource wastage. Traditional irrigation systems rely heavily on manual operation and fail to respond to real-time environmental conditions, leading to inefficient water usage. To overcome these limitations, an IoT-based Smart Irrigation and Plant Monitoring System is developed to provide automated monitoring and irrigation with minimum human intervention. The system uses sensors and microcontrollers to continuously monitor parameters such as soil moisture, temperature, and humidity in real time. Furthermore, Artificial Intelligence (AI) is integrated to optimize irrigation and fertilizer management through predictive analysis, enabling efficient resource utilization, precision agriculture, and sustainable farming practices with minimum human intervention.

2. Literature Survey

Several research studies have been conducted in the field of smart irrigation and precision agriculture using Internet of Things (IoT) and Artificial Intelligence (AI) technologies. Smart irrigation systems integrated with IoT, cloud computing, and sensor networks enable real-time monitoring of environmental parameters such as soil moisture, temperature, humidity, rainfall, and solar radiation. These systems utilize sensors and wireless communication technologies to collect and transmit data for efficient irrigation management and intelligent decision-making. IoT-enabled agriculture systems optimize water utilization by controlling irrigation schedules based on real-time soil conditions, thereby reducing water wastage and improving crop productivity. Cloud-based platforms further support remote monitoring, data visualization, and automated control through dashboards and alert mechanisms.

Recent advancements in precision agriculture focus on the integration of Artificial Intelligence for predictive analysis and smart decision support. AI-based systems analyze real-time and historical agricultural data to predict irrigation requirements and recommend suitable fertilizer management practices. These systems also support soil analysis by evaluating nutrient levels and environmental conditions to improve soil fertility and crop yield. Although existing systems provide automation and monitoring functionalities, many lack complete integration of IoT, AI, cloud storage, and fertilizer prediction within a unified platform. The proposed system addresses these limitations by integrating real-time monitoring, automated irrigation, cloud-based data management, and AI-driven prediction for irrigation and fertilizer management, thereby providing an efficient, intelligent, and sustainable solution for precision agriculture.

3. Proposed System

The proposed Smart Plant Monitoring and Care System is developed to provide an efficient and intelligent solution using Internet of Things (IoT) and Artificial Intelligence (AI) technologies. The system incorporates sensors such as a soil moisture sensor and a DHT11 temperature and humidity sensor for continuous acquisition of real-time environmental data. The collected sensor data is transmitted to the Espressif Systems ESP8266 microcontroller for processing and analysis. Based on predefined threshold parameters, the system evaluates plant and soil conditions to determine plant health status. The processed data is displayed through a web-based interface, enabling real-time monitoring and visualization of plant conditions.

In addition to automation, the system is integrated with Firebase for real-time cloud data storage, synchronization, and visualization. This allows users to remotely monitor environmental conditions through graphical dashboards and analytical reports. Furthermore, the system integrates Artificial Intelligence algorithms to analyze historical and real-time datasets for predictive analysis of plant health conditions. The web platform also includes an AI-based chatbot that provides intelligent assistance and recommendations related to plant care, irrigation, and environmental management. This improves user interaction, system accessibility, and overall operational efficiency.

4. Methodology

The **Smart Plant Monitoring and Care System** is designed to automatically monitor soil and environmental parameters and analyze plant and environmental conditions based on real-time data. The system helps users monitor plant health conditions without continuous manual observation, promoting efficient plant care and healthy growth.

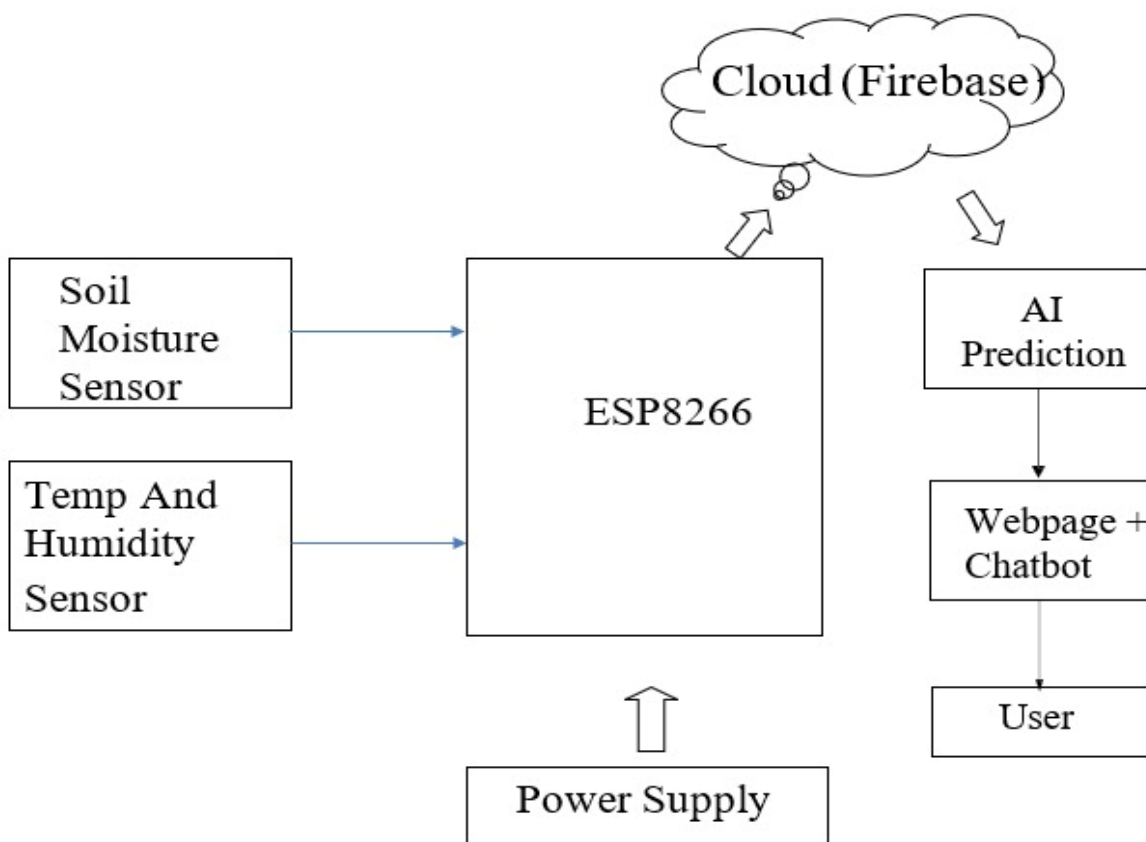
Sensor Data Collection: The setup includes ESP8266, Soil Moisture Sensor, and DHT11 (Temperature and Humidity Sensor). The soil moisture sensor detects the level of water in the soil by measuring resistance — lower resistance indicates more moisture, while higher resistance means the soil is dry. The DHT11 sensor monitors the surrounding temperature and humidity, helping in analyzing the environmental conditions affecting plant health.

Data Processing and Plant Health Analysis: All sensor data is collected by the ESP8266 microcontroller, which processes and analyzes the readings obtained from the soil moisture, temperature and humidity sensors. Based on predefined threshold values and AI-based analysis, the system determines the health condition of the plant. The processed data is then used to display the plant health status on the website as ON or OFF, allowing users to easily monitor plant conditions in real time.

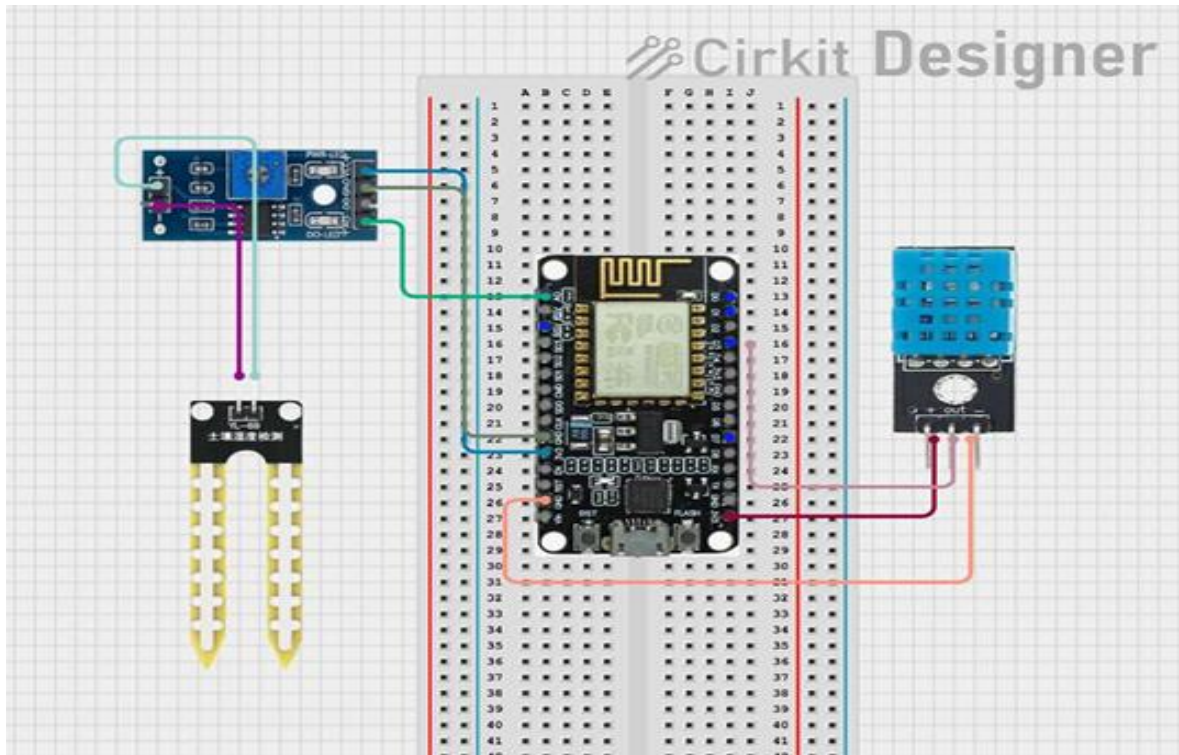
Data Transmission to Cloud: Simultaneously, the ESP8266 sends the sensor readings to Firebase over Wi-Fi. Firebase stores all readings in a real-time database, allowing continuous data logging, monitoring, and analysis. The collected data is further utilized by the AI system to analyze plant conditions and support intelligent decision-making for better plant care.

Monitoring and Decision Support: Users can monitor live data remotely through Firebase using any connected device. The AI-based analysis helps in understanding plant health conditions more accurately and supports better plant care decisions. The system ensures accurate monitoring of plant conditions, while the online monitoring feature provides transparency and remote supervision of plant conditions. In addition, the website includes an AI-based chatbot that assists users by providing guidance related to plant care, environmental conditions, and system usage, making the system more interactive and user-friendly.

Overall Function: This system minimizes water wastage, reduces manual involvement, and helps users continuously monitor plant conditions according to real-time environmental parameters. The combination of sensors, ESP8266 microcontroller, Firebase cloud platform, and AI-based analysis makes the setup reliable, efficient, and suitable for smart agriculture applications.



CIRCUIT DIAGRAM



5.Result and Discussion

The system successfully demonstrates real-time plant health monitoring. Sensor data is accurately displayed on the website using Firebase, allowing users to visualize changes in environmental conditions. The system responds quickly to variations in soil moisture, temperature, and humidity, helping users monitor plant conditions effectively. The stored data can be used for further analysis and improving system performance.

The temperature was within the normal range for healthy plant growth. The soil moisture value indicated that the soil was adequately moist and suitable for plant development. Although the humidity level was moderately low, the overall environmental conditions were stable. Therefore, the system classified the plant status as **Healthy**.

The AI-based chatbot provided real-time analysis and recommendations related to plant care and environmental conditions. This improved user interaction and supported intelligent decision-making with minimum human intervention.


The feature importance analysis showed the contribution of different environmental parameters in predicting plant health conditions. The graph indicated that soil moisture had the highest impact on plant health prediction, followed by humidity, nutrient level, and temperature.

This analysis confirmed that soil moisture is one of the most critical parameters for optimized irrigation management and efficient plant monitoring in precision agriculture systems.

The prediction model achieved good classification accuracy with a high number of correctly predicted plant health conditions. The results demonstrate that the proposed system can effectively analyze sensor data and accurately predict plant health status.

Overall, the developed system provides an intelligent, efficient, and cost-effective solution for smart agriculture through automated monitoring, optimized irrigation management, predictive analysis, and minimum human intervention.

CASE I: Healthy plant



Soil Moisture: 54%

Temperature: 32.3 °C

Humidity: 35%

Plant Health: Healthy

Last Updated: 15:03:33

🔌 Device Status

● Device Online

Plant AI Assistant

✕

how is my plant?

****Plant status (as of 15:03:33)****

| Parameter | Reading | Typical optimal range* | Interpretation |

-----|-----

| Soil Moisture | ****64%**** | 30-70 % | ****Good**** – the soil is moist enough but not soggy. |


| Temperature | ****32.9 °C**** | 18-26 °C (most houseplants) | ****High**** – a bit stressful, especially if this is a cooler-climate species. |

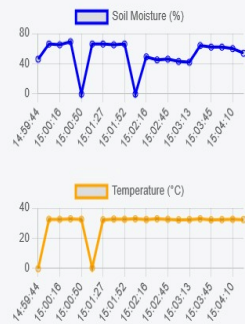
| Humidity | ****35%**** | 40-60 % (depends on species) | ****Low**** – may cause leaf edges to brown or tips to dry out. |

*Optimal ranges vary by species; the values above are for common tropical houseplants (e.g. Ficus, Dracaena, Monstera). If you


Ask about your plant...

Send





CASE II: Unhealthy Plant



Soil Moisture: 0%

Temperature: 32.9 °C

Humidity: 36%

Plant Health: Unhealthy

Last Updated: 16:41:31

🔌 Device Status

● Device Offline

Plant AI Assistant

✕

how is my plant?

****Plant Status (as of 16:41:31)****

- ****Soil Moisture:**** 0% – the soil is completely dry.

- ****Temperature:**** 32.9 °C – above the comfortable range for most houseplants (usually 18-26 °C).


- ****Humidity**** 36% – on the low side for many tropical or foliage plants (40-60% is ideal).

****What's happening?***

Your plant is under a triple-stress situation: it's dehydrated, too hot, and the air is dry. The combination can quickly lead to leaf

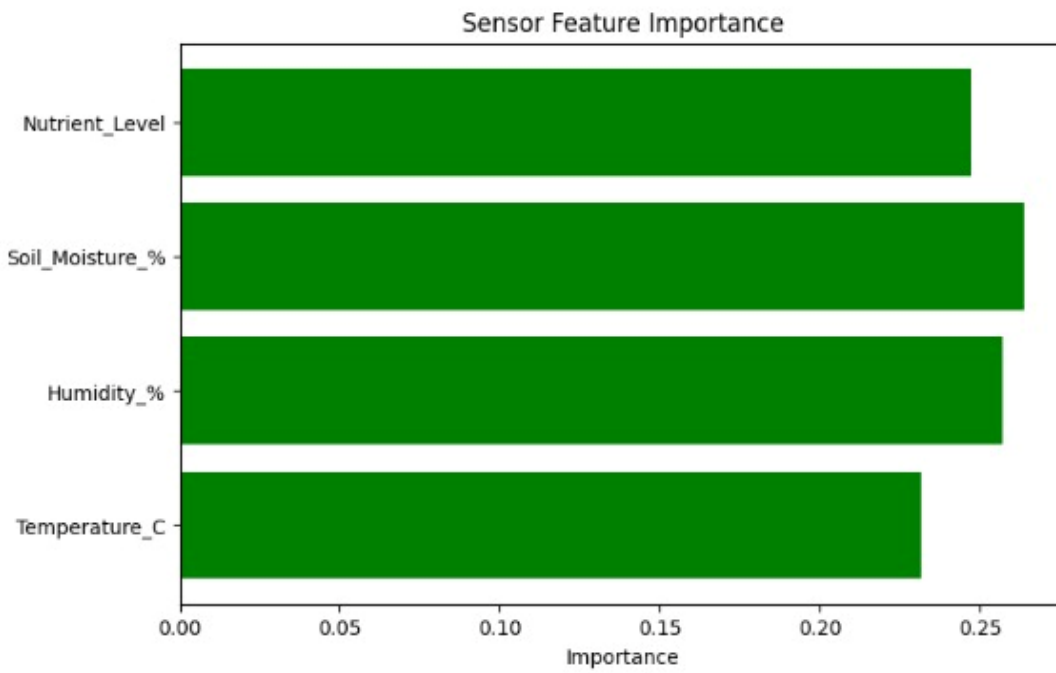
Ask about your plant...

Send

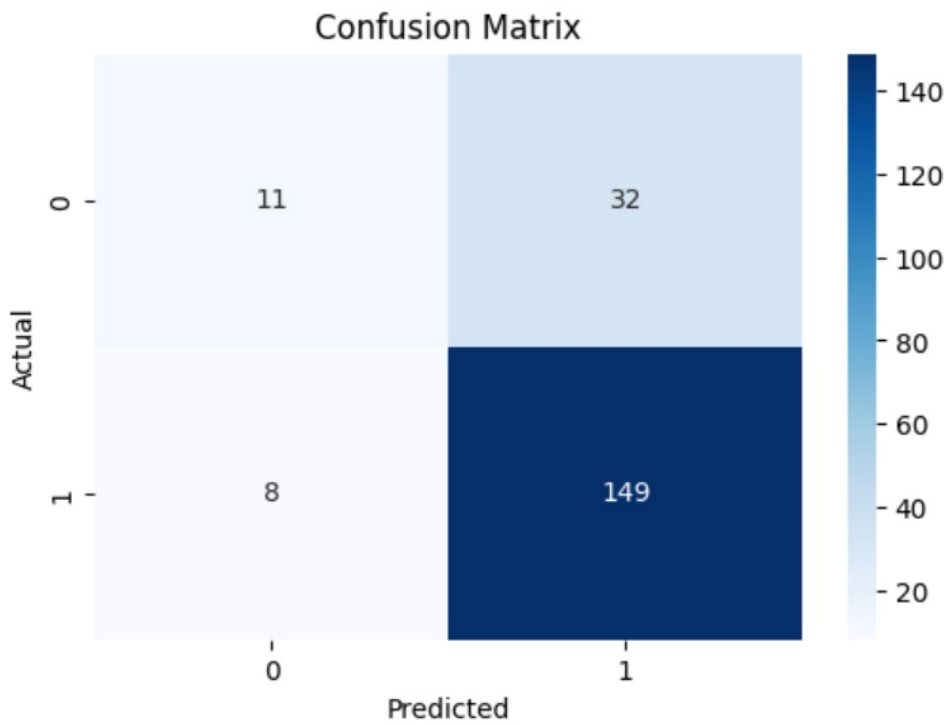




Sensor Features



CONFUSION MATRIX



6. Conclusion

The Smart Plant Monitoring and Care System provides an effective solution for real-time plant monitoring and smart agriculture applications. By integrating IoT technology with automation, the system enables efficient monitoring of plant conditions and reduces manual intervention. The use of cloud platforms enables real-time monitoring and data analysis, making the system more reliable and user-friendly. This project contributes to sustainable agriculture and lays the foundation for future advancements using AI and smart technologies.

7. Future Scope

The system can be further enhanced by integrating Artificial Intelligence and Machine Learning algorithms for predictive analysis. It can forecast irrigation requirements based on historical data and environmental conditions. Additionally, fertilizer prediction can be implemented by analyzing soil nutrient levels and recommending appropriate NPK values for optimal plant growth. Future improvements may include integration with weather forecasting systems, development of mobile applications for user-friendly control, implementation of automated fertigation systems, and use of renewable energy sources such as solar power. These advancements will make the system more intelligent, efficient, and suitable for large-scale agricultural applications.

8. References

[1] The Development of Smart Irrigation System with IoT, Cloud, and Big Data.

<https://iopscience.iop.org/article/10.1088/1755-1315/830/1/012009>

[2] IoT-enabled smart agriculture for improving water management.

<https://www.sciencedirect.com/science/article/pii/S2468227624004691>

[3] Driven Smart Agriculture: An Integrated Approach for Soil Analysis, Irrigation, and Crop-Fertilizer Recommend.

[https://www.researchgate.net/publication/394136058_AI](https://www.researchgate.net/publication/394136058_AI_Driven_Smart_Agriculture_An_Integrated_Approach_for_Soil_Analysis_Irrigation_and_Crop-Fertilizer_Recommendations)

[Driven Smart Agriculture An Integrated Approach for Soil Analysis Irrigation and Crop-Fertilizer Recommendations](https://www.researchgate.net/publication/394136058_AI_Driven_Smart_Agriculture_An_Integrated_Approach_for_Soil_Analysis_Irrigation_and_Crop-Fertilizer_Recommendations)

[4] Smart Irrigation System Based on the Internet of Things and the Cloud

<https://www.sciencedirect.com/science/article/pii/S2772427122000791>