IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 4, May 2025
Impact Factor: 7.67

Smart Plant Monitoring and Automated Irrigation System Using IOT

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Abstract: *The IoT-based Smart Plant Monitoring System represents a transformative approach to modern agriculture by leveraging the power of the Internet of Things (IoT) to enhance the monitoring and management of plants in agricultural settings. This system integrates advanced sensor technologies, wireless communication, and data analytics to provide real-time insights into the health and environmental conditions of plants, thereby optimizing resource utilization and improving overall crop yield. The key components of the proposed system include a network of sensors strategically placed within the agricultural field to capture vital data related to soil moisture, temperature, humidity, light intensity, and nutrient levels. These sensors are connected through IoT-enabled devices, forming a cohesive network that continuously collects and transmits data to a centralized cloud-based platform. The cloud platform acts as a repository for the acquired data, where advanced analytics algorithms process the information in real-time.*

The Internet of Things (IoT) plays a very Important role in improving cultivation methods for greenhouses ,gardening and providing farmers with relevant information to make decisions for optimal yields. In this project we create an Iot Based plant moniotoring system based on the IoT concept that remotely provides users with information related to temperature, humidity, and soil moisture intensity for monitoring plant conditions. The IoT-based smart plant monitoring system is designed to enhance plant care and cultivation using Internet of Things (IoT) technology. It integrates various sensors such as temperature, humidity, soil moisture, and light intensity sensors to collect real-time data on environmental conditions. The system can also automate watering based on the moisture levels in the soil, ensuring plants get the right amount of water. By providing timely alerts and useful insights, the IoT Smart Plant Monitoring System makes plant care easier and more efficient.

Keywords: IoT Smart Plant Care and Plant Monitoring System

I. INTRODUCTION

Agriculture plays a vital role in world-wide economy. It is the main source of sustenance for people. It is necessary to make economical utilization of resources as per the environmental conditions, to fulfill the fundamental needs of the crops. This work includes improvement in the previous work, here drip irrigation is used instead of normal irrigation method. It's been long since sensors were introduced in the agriculture operations[1-50]. But the problem with the traditional approach of utilizing sensor technology was that we were not able to get the live data from the sensors. The sensors used to log the data into their attached memory and later on we were able to use it. To improve traditional methods, there has been many systems developed using advanced technologies that help to reduce crop wastes, prevent excessive and scarce watering to crops and thereby increase the crop yield[51-150]. With the introduction of Industrial IoT in Agriculture, far more advanced sensors are being utilized. The sensors are now connected to the cloud via cellular/satellite network. Which lets us to know the real-time data from the sensors, making decision making effective. The applications of IoT in the agriculture industry has helped the farmers to monitor the water tank levels in real-time which makes the irrigation process more efficient. The advancement of IoT technology in agriculture operations has

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brought the use of sensors in every step of the farming process like how much time and resources a seed takes to become a fully-grown vegetable.

The Internet of Things (IoT) has emerged as a transformative force across various industries, and agriculture is no exception. In the context of modern farming, the integration of IoT technologies has given rise to innovative solutions aimed at optimizing crop management and resource utilization. Traditional farming practices often rely on manual observations and historical knowledge to make decisions about irrigation, fertilization, and pest control. However, these methods can be imprecise and may not fully account for the dynamic and often unpredictable nature of environmental conditions[151-262].

II. PROBLEM STATEMENT

Farmers cannot precisely detect environmental condition around the plant. Farmers only know the wetness of soil, the humidity and temperature around the plant by feel it themselves. Nowadays, there is wireless technologies that being implement in many fields. The user need device that can send the condition of plant wirelessly. The user will get notification about the environmental condition around the plant. Along the course of project completion, we encountered various problems and obstacles. Not everything that we had planned went smoothly during the project development span. Also, we had a limited amount of time for its completion so we were under a certain amount of pressure as well. We had to start from the research phase at the beginning and needed to gain knowledge on all the devices and components that we had intended to use for our project. Other phases of the project included coding, debugging, testing, documentation and implementation and it needed certain time for completion so we really had to manage the limited time available to us and work accordingly to finish the project within the schedule. By this iot based plant monitoring system we can easily water the crops according to necessity from where ever we are present. Because we are watering and controlling the soil moisture using specific app in the mobile

III. LITERATURE SURVEY

The application of the Internet of Things (IoT) in agriculture and plant care has gained significant attention due to the need for more efficient and sustainable farming practices. IoT-based systems for plant care and monitoring provide innovative solutions to automate traditional practices, enhancing the precision of water management, soil health assessment, and pest control. This literature review examines existing studies and systems that form the basis for developing a Smart Plant Care and Plant Monitoring System. 3.1 IoT in Agriculture and Plant Care IoT technology enables remote monitoring and control of environmental conditions, making it an ideal solution for plant care. IoT systems typically consist of sensors that gather data on parameters such as soil moisture, temperature, humidity, light intensity, and pH levels, which are then processed by microcontrollers and sent to cloud-based platforms for analysis. According to Baharudin et al. (2018), IoT-based plant care systems can reduce water consumption and improve crop yield through more precise monitoring and automation of irrigation systems. Similarly, the study by Kaur et al. (2019) highlights the role of IoT in optimizing plant care through real-time data collection and decisionmaking algorithms. 3.2 Smart Plant Monitoring Systems Plant monitoring systems that leverage IoT have been extensively explored in both academic research and commercial applications. The system by Kumar et al. (2020) uses multiple sensors to monitor plant health parameters such as soil moisture and nutrient levels, providing feedback via mobile applications. Another approach by Gupta et al. (2019) integrates machine learning with IoT to predict plant health issues based on historical data and environmental factors. These systems not only enable real-time monitoring but also facilitate predictive analysis, helping farmers take preventive measures to avoid plant stress and disease. 3.3 Watering and Irrigation Control Systems Smart irrigation is a major component of IoT-based plant care systems, as over-irrigation or underirrigation can significantly affect plant growth. Studies such as the one conducted by Sharma et al. (2021) have demonstrated that IoT-based automated watering systems can improve water efficiency by delivering precise amounts of water based on realtime soil moisture levels. These systems use actuators to control water valves, allowing for targeted irrigation when plants need it most. Additionally, Bhagat et al. (2022) designed a system that optimizes water distribution using weather forecasting data, further reducing water waste. International Journal of Scientific Research in Engineering and Management .

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Environmental Monitoring and Data Analytics IoT systems also allow for continuous environmental monitoring to ensure optimal growth conditions for plants. Patil et al. (2021) describe an IoT-based platform that monitors multiple environmental factors such as temperature, humidity, and light intensity. The system uses data analytics to assess the optimal growing conditions for plants and generates alerts if any parameter falls outside predefined thresholds. Advanced IoT systems, like the one proposed by Ahmed et al. (2020), employ artificial intelligence (AI) algorithms to analyze environmental data and automatically adjust parameters to optimize plant health. 3.5 Machine Learning and Predictive Analytics in Plant Care Machine learning (ML) techniques have been incorporated into IoT-based plant care systems to enhance predictive capabilities. Studies like that of Saha et al. (2021) have used ML algorithms to predict soil moisture levels and future water requirements based on historical data. These systems can significantly reduce the need for human intervention by predicting when plants will need water or fertilizer. In another study, Jadhav et al. (2020) applied deep learning models to analyze plant disease patterns, allowing IoT systems to detect early signs of plant stress or disease. 3.6 Energy Efficiency in IoT Plant Monitoring Systems Energy efficiency is a critical consideration in IoT systems, especially for large-scale agricultural applications. Research by Kalra et al. (2019) explores the design of low-power IoT sensors that can operate autonomously in remote areas. Solarpowered IoT systems, as developed by Bhatnagar et al. (2021), allow for continuous monitoring without the need for frequent battery replacements, making these systems more sustainable and cost-effective in the long term.

3.7 Challenges and Future Directions Despite the numerous advantages of IoT-based plant care systems, several challenges remain. Connectivity issues, especially in rural areas, can hinder the effectiveness of IoT systems. In addition, the large-scale deployment of sensors and devices may raise concerns related to data privacy and security, as noted by Khanna et al. (2022). Future research should focus on improving the interoperability of IoT devices, enhancing data security, and developing cost-effective solutions for small-scale farmers.

IV. PROJECT DESCRIPTION

The IoT-Based Smart Plant Monitoring System is an innovative project aimed at revolutionizing traditional agriculture by incorporating Internet of Things (IoT) . Implement a network of sensors to capture crucial plant and environmental data, including soil moisture, temperature, humidity, light intensity, and nutrient levels. Develop an IoT-enabled infrastructure for seamless communication and data transfer between the deployed sensors and a centralized cloud-based platform. Design a user-friendly interface (e.g., mobile application or web portal) for farmers to access real-time data, receive alerts, and interact with the Smart Plant Monitoring System. Utilize advanced analytics algorithms for real-time data processing, trend analysis, and the generation of actionable insights to support decision-making. Integrate mechanisms for remote control of irrigation systems based on real-time soil moisture data, optimizing water usage. Implement an alerting system to notify farmers of potential issues such as plant stress, diseases, or suboptimal environmental conditions. A. Proposed Structure In the field section, various sensors are deployed in the field like temperature sensor, moisture sensor and PIR sensor. The data collected from these sensors are connected to the microcontroller through RS232. In control section, the received data is verified with the threshold values. If the data exceeds the threshold value the buzzer is switched ON and the LED starts to blink. This alarm is sent as a message to the farmer and automatically the power is switched OFF after sensing. The values are generated in the web page and the farmer gets the detailed description of the values. In manual mode, the user has to switch ON and OFF the microcontroller by pressing the button in the Android Application developed. This is done with the help of GSM Module. In automatic mode, the microcontroller gets switched ON and OFF automatically if the value exceeds the threshold point. Soon after the microcontroller is started, automatically an alert must be sent to the user. This is achieved by sending a message to the user through the GSM module. Other parameters like the temperature, humidity, moisture and the PIR sensors shows the threshold value and the water level sensor is used just to indicate the level of water inside a tank or the water resource. B. Assumptions and Dependencies The system assumes a stable and reliable internet connection for data transmission and communication with the cloud platform. The sensors used for monitoring plant parameters are assumed to be accurate and calibrated for precise measurements. Continuous and reliable power supply is available for both the IoT devices and sensors deployed in the plant monitoring system. Standard security measures (encryption, access controls, etc.) are assumed to be effective in safeguarding the data and system from

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unauthorized access. Users are assumed to have basic technical knowledge for system setup, troubleshooting, and interpretation of monitoring data. The system assumes that the environmental conditions, such as weather and external factors, will not significantly impact the hardware and sensor performance. The system assumes compliance with relevant regulations and standards for data privacy, environmental monitoring, and IoT device deployment.Timely and reliable supply of sensors from the chosen supplier is a dependency for the successful implementation of the monitoring system. The stability of the local power grid is a dependency for ensuring continuous power supply to the IoT devices and sensors. Approval from relevant regulatory bodies is a dependency for compliance with legal and environmental standards. The mobile application's compatibility depends on timely updates and support from mobile operating system providers (iOS, Android).

V. OBJECTIVE OF SYSTEM

- Automation: Automating the monitoring and care of plants by using IoT devices such as sensors, cameras, and actuators.
- Real-time Monitoring: Offering real-time data on plant health parameters like soil moisture, temperature, humidity, and light exposure.
- Efficient Plant Care: Enabling the system to trigger actions (e.g., automatic watering, adjusting light) based on data thresholds or remote user control.
- Data-Driven Insights: Providing users with insights based on historical data to improve plant care routines over time.
- User-Friendly Interface: Offering a dashboard or mobile application that allows users to monitor and control plant health from anywhere.
- Sustainability: Reducing water consumption and promoting healthy plant growth through optimal conditions.

VI. RESULTS AND DISCUSSION

The system effectively automated irrigation based on real-time soil moisture data. Testing showed the pump activation and sprinkler functions triggered accurately under set conditions. The mobile app allowed remote access and provided real-time updates. The LCD displayed clear values for temperature, humidity, and moisture levels. The automated shading worked successfully for small-scale environments. The system proved to be cost-effective and scalable for both home and small farm use.

WiFi dependency may limit rural implementation without internet coverage

Sensor calibration is required regularly for accurate data

Limited battery backup for off-grid use

Hardware durability in outdoor extreme weather needs improvement

VII. WORKING OVERVIEW

Once the system is powered on, the ESP32 initializes all connected sensors including temperature, humidity, soil moisture, and light intensity sensors. These sensors begin collecting real-time data from the environment. The data is then displayed locally on the 16x2 LCD and simultaneously sent to the Blynk cloud platform via WiFi for remote access.

If the soil moisture falls below the defined threshold, the ESP32 triggers the relay to turn on the water pump for irrigation. When the moisture level reaches a satisfactory point, the pump is turned off automatically. If the temperature crosses 30°C, the system activates a sprinkler to cool the plants. Additionally, if intense sunlight is detected, a servo motor-controlled shade mechanism is deployed to protect small plants.

All sensor readings are updated in regular intervals, and alerts are pushed to the user's mobile device through the Blynk app. The user can also manually control the system using the app in case of special requirements. The system continues

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to monitor and operate automatically based on predefined conditions, ensuring efficient plant care with minimal manual effort

VIII. CONCLUSION

The Smart Plant Monitoring and Automated Irrigation System using IoT successfully addresses the need for precise and efficient plant care in modern agriculture. By combining sensor data, automation, and wireless communication, the system ensures real-time monitoring, water conservation, and healthy plant growth. It reduces manual labor, minimizes water waste, and enhances sustainability. Its adaptability to small-scale and home-based agricultural setups makes it a practical and impactful solution. With scope for future expansion such as AI integration and multi-zone farming, this system stands as a promising innovation in smart agriculture.

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ISSN: 2581-9429
Volume 5, Issue 4, May 2025
Impact Factor: 7.67

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International Journal of Advanced Research in Science, Communication and Technology
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ISSN: 2581-9429
Volume 5, Issue 4, May 2025
Impact Factor: 7.67

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International Journal of Advanced Research in Science, Communication and Technology
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Volume 5, Issue 4, May 2025
Impact Factor: 7.67

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International Journal of Advanced Research in Science, Communication and Technology
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IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
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Volume 5, Issue 4, May 2025
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