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 11, April 2025 Impact Factor: 7.67

IoT Based Horticulture for Farmers

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Abstract: *This paper presents an IoT Based Horticulture System designed for farmers to monitor and automate crop growth parameters using embedded systems and wireless communication. The proposed system integrates sensors like DHT11 and soil moisture sensors with a NodeMCU (ESP8266) microcontroller to collect data such as temperature, humidity, and soil moisture. These parameters are processed and monitored in real-time through cloud platforms and mobile applications, enabling efficient water usage and optimized crop yield. This system is especially useful in dry regions and for farmers lacking consistent rainfall, as it automates irrigation and climate control. The integration of IoT helps enhance productivity, conserve resources, and empower farmers with actionable insights..*

Keywords: ESP8266, IoT

I. INTRODUCTION

Agriculture remains the cornerstone of India's economy, directly supporting more than half of the nation's population. However, farmers today are facing significant challenges such as unpredictable climate change, diminishing water resources, soil degradation, and labor shortages. To address these issues and ensure sustainable agricultural growth, modern technologies like the Internet of Things (IoT) offer powerful and innovative solutions. IoT-based horticulture systems integrate real-time sensing, data processing, and wireless communication to optimize farming practices, ensuring efficient use of resources and higher crop productivity. This project focuses on developing an IoT-based system for horticulture that measures critical environmental parameters such as soil moisture, temperature, humidity, and nutrient levels. Utilizing smart sensors like DHT-11 for climate monitoring and soil moisture sensors for irrigation management, the system collects and transmits data to a cloud platform via an ESP8266 microcontroller, enabling farmers to monitor and control their fields remotely through mobile devices. Automated irrigation systems reduce water wastage by supplying water only when necessary, thus conserving a vital resource. Furthermore, this innovation can lead to socio-economic upliftment in rural areas, providing farmers with better income opportunities and contributing to the national goal of food security. This project, therefore, demonstrates a significant step forward in bridging the gap between traditional horticulture and the emerging digital revolution in

II. LITERATURE SURVEY

An IOT Based Horticulture an irrigation automation system describes how to monitor a crop field. A system is developed by using sensors and according to the decision from a server based on sensed data, the irrigation system is automated. Through wireless transmission the sensed data is forwarded to web server database. If the irrigation is automated then the moisture and temperature fields are decreased below the potential range. The user can monitor and control the system remotely with the help of application which provides a web interface to user. By Horticulture and one of the oldest ways in agriculture is the manual method of checking the parameters. In this method farmers by themselves verify all the parameter and calculate the reading. The system focuses on developing devices and tool to manage, display and alert the users using the advantages of a wireless sensor network system. It aims at making agriculture smart using automation and IoT technologies. The cloud computing devices are used at the end of the system that can create a whole computing system from sensors to tools that observe data from agriculture field. It proposes a novel methodology for smart farming by including a smart sensing system and smart irrigator system through wireless communication technology. This system is cheap at cost for installation. Here one can access and also

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control the agriculture system in laptop, cell phone or a computer.

III. IOT (INTERNET OF THINGS)

IoT refers to a network of interconnected devices that collect and exchange data through the internet. In this project, IoT enables real-time monitoring of horticultural parameters and automates actions like irrigation and ventilation. The data collected is transmitted through Wi-Fi and processed by microcontrollers. This allows farmers to monitor farm conditions remotely and respond via mobile applications or cloud dashboards. IoT in agriculture can drastically reduce water waste, improve crop quality, and support data-driven decisions.

IV. WORKING

The project uses IoT technology to automate horticultural practices, improving efficiency and sustainability.An ESP8266 microcontroller connects multiple sensors to the internet for real-time monitoring.DHT11 sensors measure temperature and humidity levels around the plants.A soil moisture sensor checks the moisture content in the soil to prevent over- or under-watering.A DC water pump irrigates the plants automatically when the soil moisture drops below a set threshold.An exhaust fan is triggered when humidity or temperature exceeds safe levels, ensuring proper ventilation.Relays are used to control high-voltage devices (like the pump and fan) based on sensor data.All sensor readings are collected by the ESP8266 and transmitted via Wi-Fi.Data is displayed and controlled remotely using the Arduino Cloud or mobile applications. The Arduino IDE and Proteus 8 Professional software are used for coding and simulation. A mobile app or web dashboard provides real-time monitoring of parameters.The system alerts farmers about critical changes like low moisture or high temperature. Automation reduces manual labour, saves water, and ensures better crop health. Historical data collection enables farmers to optimize farming practices over time. It offers remote control, meaning farmers can manage irrigation even when away from the farm. The use of DC adapter and DC jack powers the entire system reliably. The sensors and devices are low-power and cost-effective, suitable for rural areas. System scalability allows adding more sensors or automation features easily.Early pest or disease detection becomes possible with additional sensor integration. The architecture is designed to be affordable, efficient, and user-friendly. In future, AI models can be used to predict the best planting schedules based on collected data .Overall, the system combines automation, IoT connectivity, and smart farming practices .It focuses on making farming sustainable, productive, and technology-driven. The aim is to reduce resource wastage, increase crop yield, and improve farmers' income. Precision agriculture techniques are implemented using real-time environmental data. It empowers farmers to make data-driven decisions easily and quickly. Maintenance and operation of the system require minimal technical expertise. The project supports the vision of smart farming in line with modern agricultural trends. It ultimately ensures better quality crops with optimal resource utilization.

V. EXISTING SYSTEM

In traditional horticulture practices, farmers primarily rely on manual methods to monitor and manage their crops. Parameters such as soil moisture, temperature, humidity, and nutrient levels are observed through physical inspection and experience-based judgment. Irrigation scheduling is often done at fixed intervals without real-time assessment of soil conditions, leading to inefficient water usage and sometimes crop damage. Although some basic automated irrigation systems have been introduced, they typically operate on simple timers rather than actual field data, resulting in suboptimal resource utilization. Additionally, farmers must be physically present to oerate or monitor these systems, which increases labor costs and limits the scalability of operations, especially in large agricultural fields.

Previous technological solutions introduced sensor-based systems for monitoring soil and environmental factors, but these lacked integration with cloud storage, mobile accessibility, or real-time alerts. Data collected from the fields required manual downloading and analysis, which delayed decision-making. Moreover, such systems were expensive, complex, and not easily adaptable for small-scale farmers, thus limiting widespread adoption. Overall, the existing horticulture management systems still involve significant human intervention, lack remote monitoring capabilities, and do not fully leverage advancements in IoT and automation technologies. This creates a strong necessity for developing a smarter, cost-effective, and scalable system that provides real-time monitoring, automated irrigation and remote

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accessibility to improve crop yield, water conservation, and farming efficiency.

VI. PROPOSED METHOD

The proposed system aims to develop an IoT-based smart horticulture framework that automates the monitoring and management of agricultural fields in real-time. It integrates sensors such as soil moisture, temperature, humidity, and light sensors with a Wi-Fi-enabled microcontroller (ESP8266) to continuously gather environmental data. This information is transmitted wirelessly to a cloud platform, where it can be accessed remotely by farmers through a mobile application or web dashboard. Based on sensor data, the system can automatically control irrigation pumps via relays, ensuring optimal watering only when necessary, thus conserving water and improving crop health. It also features customizable alerts for environmental changes, enabling early detection of issues like drought stress or pest attacks. The historical data stored in the cloud facilitates predictive analytics and smarter farming decisions over time. By reducing manual intervention, improving resource efficiency, and making the system affordable and scalable, the proposed IoT solution significantly enhances the productivity, sustainability, and profitability of horticultural practices.

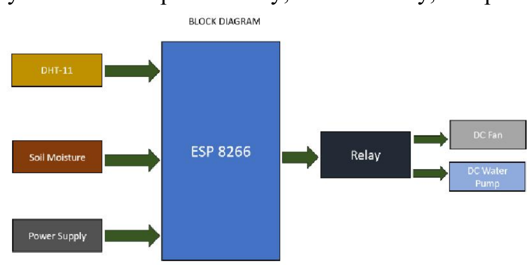

Figure 1 Block diagram

VII. SOFTWARE EMPLOYED

For the development and implementation of the IoT-based horticulture system, several software tools were employed to ensure efficient programming, simulation, and cloud integration. The primary software used is the Arduino Integrated Development Environment (IDE), which was utilized to write, compile, and upload the embedded C programs onto the ESP8266 microcontroller. The Arduino IDE provides an extensive set of libraries and a user-friendly environment to facilitate sensor interfacing, wireless communication, and device control. Proteus 8 Professional simulation software was used to model and simulate the electronic circuit before actual hardware implementation. Proteus allowed for virtual testing of the sensor modules, microcontroller connections, and relay circuits, reducing hardware debugging time. Additionally, Arduino IoT Cloud was employed to connect the ESP8266 to an online platform where real-time sensor data could be monitored remotely. Arduino Cloud services enabled the creation of dashboards for data visualization and remote device control using mobile applications and web interfaces. Together, these software tools enabled a seamless workflow from programming and simulation to real-world IoT deployment, ensuring the project’s successful design, validation, and operation.

VIII.RESULTS & DISCUSSION

The prototype system was developed by interfacing various environmental sensors such as soil moisture sensors, temperature and humidity sensors (DHT11/DHT22), and water pump modules with the microcontroller (e.g., NodeMCU ESP8266/ESP32). All components were carefully connected through a PCB board for reliable communication. The microcontroller was programmed using the Arduino IDE, with libraries supporting sensor integration and Wi-Fi connectivity.

After uploading the source code and establishing network connectivity, the system was linked to the designated cloud platform or messaging application to receive commands and send data.

Upon powering the system, the sensors continuously monitored the environmental conditions such as soil moisture

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level, ambient temperature, and humidity. The data collected by the sensors was transmitted wirelessly to the cloud server or mobile application interface. Based on pre-set threshold conditions, the microcontroller autonomously activated irrigation pumps whenever soil moisture dropped below the critical level.

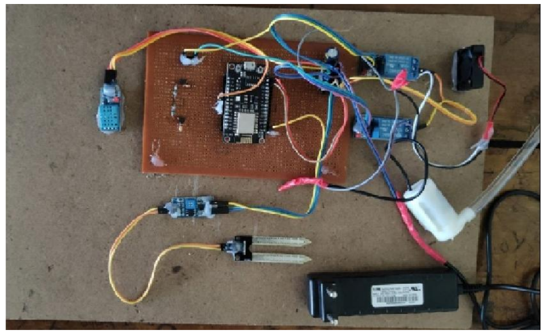

Figure 2 Output of Project

Figure 3 Commands

IX. CONCLUSION

The IoT-Based Horticulture for Farmers project successfully demonstrated the application of smart technologies to enhance agricultural practices through real-time monitoring and automation. By integrating sensors with the ESP8266 microcontroller and employing cloud-based data access, the system enabled efficient management of soil moisture, temperature, and humidity, thereby optimizing irrigation and environmental control. The automated activation of water pumps and ventilation fans based on sensor data proved to conserve water, reduce labor, and improve crop health. Farmers could monitor field conditions and control equipment remotely through a smartphone, promoting ease of operation and timely interventions. This project highlights the significant role IoT can play in achieving sustainable farming practices, ensuring better resource management, and increasing agricultural productivity. Future enhancements could include the integration of AI-based predictive analytics, multi-sensor networks, and energy-efficient designs to further support precision agriculture and smart farming initiatives.

X. FUTURE SCOPE

• Integration with AI and Machine Learning
• Customized Solutions for Different Crops and Regions
• Focus on Sustainability and Environmental Impact
• Collaboration with Agricultural Research
• Policy Support and Investment
• Market Growth and Economic Opportunities
• Advancements in Sensor Technology

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