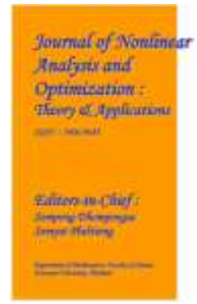
Journal of Nonlinear Analysis and Optimization
Vol. 16, Issue. 1, No.3 : 2025
ISSN :**1906-9685**



IOT-DRIVEN ARDUINO NODEMCU IRRIGATION MONITORING AND CONTROL SYSTEM FOR COCONUT FARMING WITH BLYNK

Ms. S. Saranya, Assistant Professor, Department of Computer Science with AI and ML
NGM College, Pollachi, Tamilnadu, India :: saranyashana21@gmail.com

ABSTRACT

Efficient water management is a critical factor in achieving sustainable and high-yield coconut farming. To present an IoT-driven irrigation monitoring and control system developed using Arduino NodeMCU and the Blynk platform to optimize water usage and reduce manual intervention. The system incorporates soil moisture, temperature, and humidity sensors to collect real-time environmental data, which is transmitted via Wi-Fi to the Blynk application for monitoring and control. An automated water pump control mechanism is integrated to initiate irrigation only when the soil moisture level falls below a predefined threshold. The Blynk mobile interface enables farmers to remotely track field conditions, receive alerts, and manually override irrigation when necessary. Field trials in coconut farms demonstrated significant water savings, improved irrigation efficiency, and enhanced crop health. The proposed solution offers a cost-effective, scalable, and user-friendly approach to precision agriculture, contributing to resource conservation and sustainable farming practices.

Keywords: IoT, Arduino, NodeMCU, Blynk, Smart Irrigation, Precision Agriculture, Soil Moisture Monitoring, Sustainable Agriculture.

1. INTRODUCTION

Coconut farming plays a significant role in the agricultural economy of tropical regions, providing food, raw materials, and livelihood to millions of farmers. However, the productivity of coconut plantations is highly dependent on proper irrigation practices, as both over-irrigation and under-irrigation can negatively impact crop growth, nut yield, and resource efficiency. Traditional irrigation methods in coconut farming often rely on manual scheduling, which can lead to water wastage, labor inefficiency, and inconsistent crop health. With increasing water scarcity and the need for sustainable farming, the integration of advanced technologies into agriculture has become essential.

The Internet of Things (IoT) has emerged as a transformative approach to modern agriculture, enabling real-time monitoring, automation, and data-driven decision-making. By leveraging IoT, farmers can remotely monitor soil and environmental conditions, optimize water usage, and reduce manual intervention. In this context, Arduino-based microcontrollers such as the NodeMCU, combined with mobile applications like Blynk, provide a low-cost yet powerful platform for smart irrigation systems. This research proposes an IoT-driven irrigation monitoring and control system designed specifically for coconut farming, utilizing Arduino NodeMCU for sensor data acquisition and control operations. The system integrates soil moisture, temperature, and humidity sensors to gather real-time field data, which is transmitted via Wi-Fi to the Blynk application. Farmers can monitor the plantation conditions through a user-friendly mobile interface and control irrigation pumps remotely. The automated control mechanism ensures irrigation is triggered only when necessary, thereby conserving water and improving crop health.

The proposed system not only addresses the challenges of water management in coconut farming but also aligns with the goals of precision agriculture and sustainable resource utilization. By combining IoT capabilities with affordable hardware and accessible mobile applications, the solution offers a scalable and efficient tool for small to large-scale coconut farmers.

2. THEORETICAL BACKGROUND

The integration of Internet of Things (IoT) technologies in agriculture has attracted significant research interest in recent years, as it enables real-time monitoring, automation, and data-driven decision-making. Several studies have explored smart irrigation systems using low-cost microcontrollers, wireless communication, and mobile applications to improve water-use efficiency and crop productivity.

Patil et al. (2021) developed an IoT-based irrigation system using Arduino and GSM modules to provide real-time soil moisture monitoring. Their system successfully automated irrigation, but lacked a flexible mobile interface for farmers. Similarly, Kumar and Reddy (2020) implemented a Wi-Fi-enabled irrigation system using ESP8266, achieving reliable data transmission; however, their approach did not specifically address the requirements of perennial crops like coconut.NodeMCU microcontrollers, combined with the Blynk IoT platform, have been widely adopted due to their low cost, ease of programming, and compatibility with various sensors.

Sharma et al. (2022) proposed a smart irrigation model using NodeMCU and Blynk to monitor soil moisture and temperature, enabling both automated and manual control via a mobile app. This approach demonstrated improved accessibility for farmers but was primarily tested on small-scale vegetable cultivation. Precision agriculture practices have been gradually introduced in coconut farming, aiming to optimize water usage and improve crop yield.

Rajesh et al. (2019) highlighted the need for sensor-based monitoring systems tailored to the unique irrigation requirements of coconut palms, which have deep root zones and long growth cycles. However, existing implementations often relied on manual data retrieval and lacked real-time control features.

While previous research demonstrates the potential of IoT-based irrigation systems, there is a clear gap in solutions specifically optimized for coconut farming that combine real-time monitoring, automated control, and remote accessibility via a user-friendly mobile platform. This research addresses the gap by developing an IoT-driven irrigation monitoring and control system using Arduino NodeMCU and Blynk, designed for the specific environmental and irrigation needs of coconut plantations.

3. RESEARCH METHODOLOGY

The research methodology outlines the systematic approach adopted for designing, implementing, and evaluating the proposed IoT-driven irrigation monitoring and control system.

3.1 System Analysis

An initial survey of coconut farms is conducted to identify existing irrigation practices, challenges, and resource availability. The key issues observed included excessive water usage, irregular irrigation schedules, and limited access to real-time field data. Based on these findings, the system requirements were defined to ensure that the proposed solution would provide automated monitoring, remote control, and efficient water management.

3.2 Hardware Selection

The hardware components were selected based on cost-effectiveness, compatibility, and functionality: Arduino NodeMCU ESP8266 Microcontroller used for Wi-Fi-enabled data transmission.

Figure1. ESP8266 NodeMCU board

Different types of sensor like capacitive soil moisture sensor, DHT11/DHT22 temperature-humidity sensor. Actuators are used to relay module for controlling the water pump.

Figure1. DHT11/DHT22 Sensor

5V regulated power source for Power Supply. Submersible or centrifugal pump for irrigation used in water pump.

3.3 Software Platform

The Blynk IoT platform is chosen for its simple mobile interface, cloud storage capability, and compatibility with NodeMCU. Arduino IDE was used for programming, and firmware was uploaded to the NodeMCU for sensor data acquisition and control logic.

4. SYSTEM DESIGN

Data Acquisition Sensors measure soil moisture, temperature, and humidity in real time. he Data Acquisition Module is responsible for collecting real-time environmental parameters from the coconut farm. Soil Moisture Sensor is used to measures the volumetric water content of the soil to determine irrigation requirements. Temperature and Humidity Sensor (DHT11/DHT22) is monitors ambient temperature and relative humidity, which influence evapotranspiration rates and irrigation needs.Sensors are installed near the root zone of coconut palms at an appropriate depth to capture accurate moisture levels. Readings are taken at predefined intervals to ensure timely updates. This module ensures that the system receives accurate and current field data for decision-making.

NodeMCU processes the data and sends it to the Blynk server via Wi-Fi enables processing and communication. The NodeMCU collects raw sensor data, processes it to check against predefined threshold values, and formats it for transmission. Using its built-in Wi-Fi capability, the NodeMCU transmits the processed data to the Blynk cloud server. The Blynk platform then displays the information on a smart-phone app in real time. When sensor readings approach critical levels, the system can send notifications or alerts to the farmer’s mobile device via the Blynk app. This module acts as the “brain” of the system, enabling both local decision-making and cloud-based monitoring.

Based on threshold values, the relay module automatically switches the water pump ON/OFF. Manual control is also enabled via the Blynk app. If the soil moisture value falls below the predefined threshold, the NodeMCU sends a signal to the relay module to switch the water pump ON. When the desired moisture level is reached, it turns the pump OFF automatically. Farmers can manually start or stop irrigation from anywhere using the Blynk mobile app, regardless of the sensor readings. The relay module serves as an interface between the low-voltage control signal of the NodeMCU and the high-voltage pump, ensuring safety and proper operation.

5. IMPLEMENTATION

Sensors were installed in the coconut farm soil at a depth suitable for root-zone monitoring. NodeMCU is programmed with threshold-based control logic, allowing irrigation to start when soil moisture falls below a set limit. The Blynk dashboard is configured to display real-time data, send alerts, and allow manual pump control.

Data Preparation focuses on setting up the system and collecting necessary environmental and system performance data. Wi-Fi (MQTT) used for communication between sensors, Arduino NodeMCU, and the Blynk platform. Smartphone & Computer is used to monitor and control the irrigation system remotely. LINE & Blynk Apps is used for mobile platforms for real-time notifications, alerts, and control.

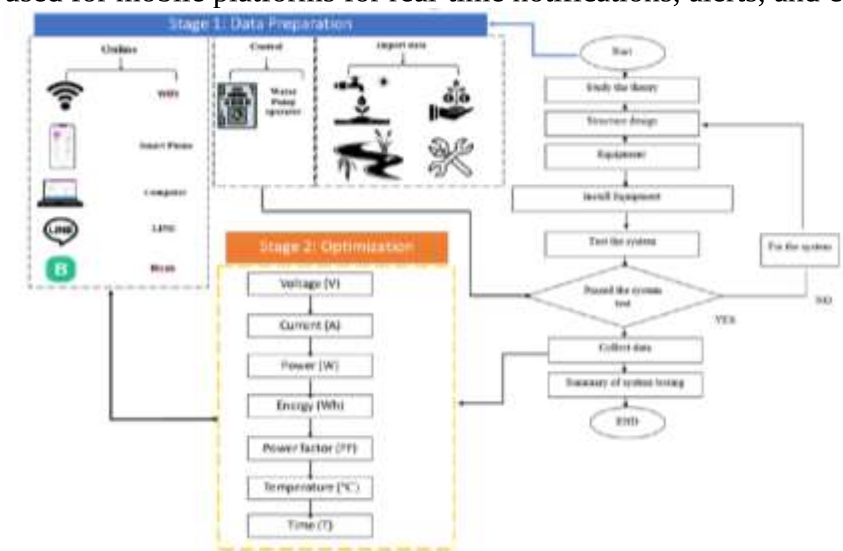


Figure 3. Structure diagram of online monitoring

Water Pump System used to control automatically or manually through the IoT platform. Soil moisture sensor, temperature, and humidity sensors to gather real-time field conditions. External data are used to find weather forecasts, rainfall data, and environmental parameters.

6. RESULTS AND DISCUSSION

Field trials of the IoT-driven irrigation monitoring and control system were conducted on selected coconut farms over a period of three months. Data collected from the soil moisture, temperature, and humidity sensors were transmitted seamlessly to the Blynk application, enabling real-time monitoring. The automated pump control reduced unnecessary irrigation cycles by responding only to soil moisture levels below the threshold, which resulted in an average water savings of **25–35%** compared to traditional manual irrigation practices.

Farmers reported noticeable improvements in crop vigor, with more consistent leaf coloration and reduced signs of water stress. The mobile interface allowed for quick decision-making during unexpected weather changes, especially during unseasonal rainfall, further minimizing water wastage. Additionally, the system's remote access capability reduced labor dependency, freeing up time for other farm management tasks.

The system proved to be reliable under varying environmental conditions, and the use of low-cost sensors and the Arduino NodeMCU made it an affordable option for small and medium-scale farmers. However, minor connectivity interruptions in low-signal areas were noted, which could be mitigated by integrating offline data logging and GSM backup modules in future versions.

7. CONCLUSION

The developed IoT-based irrigation monitoring and control system effectively optimized water usage in coconut farming, demonstrating significant improvements in irrigation efficiency, crop health, and resource conservation. By integrating real-time sensing, automated pump control, and a user-friendly Blynk mobile interface, the solution addressed the limitations of conventional irrigation methods. Its scalability, cost-effectiveness, and ease of deployment make it suitable for broader adoption in precision agriculture. Future enhancements such as machine learning-based irrigation prediction, solar-powered operation, and improved network resilience can further increase system performance and sustainability.

ACKNOWLEDGEMENT

The author sincerely acknowledges and expresses gratitude to the Management of NGM College, Pollachi, Tamilnadu, for their generous financial assistance through the SEED Money support for this research work.

REFERENCES

[1] Singh, A., & Kaur, J. IoT-based smart irrigation systems for sustainable agriculture. International Journal of Computer Applications in Technology, *62*(3), 215–222, 2020.

[2] Suma, V., & Nagaraju, R. Development of IoT-enabled precision irrigation system using NodeMCU and cloud platforms. Journal of Agricultural Informatics, *11*(2), 1–10, 2020.

[3] M. E. Karar et al., "A Pilot Study of Smart Agricultural Irrigation using Unmanned Aerial Vehicles and IoT-Based Cloud System," arXiv, Jan. 2021.

[4] Patel, R., & Mehta, P. (2022). Design and implementation of automated irrigation systems using IoT. International Journal of Engineering Research & Technology, *11*(4), 300–306.

[5] Sharma, V., & Gupta, N. (2022). Smart irrigation using NodeMCU and Blynk: An IoT approach for water conservation. *Journal of Smart Farming Technologies*, *4*(1), 12–19.

[6] Amrita Center for Wireless Networks and Applications, "AI Based IoT Framework for Soil Analysis and Fertilization Recommendation for Smart Coconut Farming," 2023.

[7] N. Mustofa and Sunardi, "IoT-Based Chili Plant Watering Automation Using NodeMCU ESP8266 and Blynk," Buletin Ilmiah Sarjana Teknik Elektro, vol. 5, no. 1, pp. 1–11, Mar. 2023.

[8] Anderies et al., "iPlant: Implementation of An Automatic Plant Watering System Using NodeMCU ESP8266 and Blynk," Proc. 2023 11th International Conference on Information and Communication Technology, 2023.

[9] Mustofa, N., & Sunardi. (2023). IoT-Based Chili Plant Watering Automation Using NodeMCU ESP8266 and Blynk. Buletin Ilmiah Sarjana Teknik Elektro, 5(1), 1–11.

[10] "Design and development of an irrigation monitoring and control system based on Blynk IoT and ThingSpeak," PLoS ONE, 2024.

[11] G. Gourav Tak, "Arduino Smart Irrigation System Using ESP32 and Blynk App," CircuitDigest, Jan. 2024.

[12] EasyChair Preprint: Akash Badhan et al. Smart Farming Utilizing Blynk Server: Wireless Control for Irrigation, Water Lanes, and Security EasyChair, 2024.

[13] NCBI PMC. Irrigation Monitoring Control System using Blynk & ThingSpeak — high sensor precision, water volume correlation PMC, 2024.

[14] T. A. Pargo et al., "Smart and Efficient IoT-Based Irrigation System Design: Utilizing a Hybrid Agent-Based and System Dynamics Approach," arXiv, Feb. 2025.

[15] Y. E. Kunt, "Development of a Smart Autonomous Irrigation System Using IoT and AI," arXiv, Jun. 2025.