OPTIMIZING WATER MANAGEMENT FOR COCONUT CROPS IN DROUGHT-PRONE REGIONS USING INTELLIGENT IRRIGATION SYSTEM

Project Reference No.: *48S_BE_0220*

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Keywords:

Biodiversity, Fertility, Irrigation, Performance, Sustainability, Threshold, Optimizing.

Introduction :

Water is essential for sustainable farming, especially in water-scarce regions. Coconut plantations, a key crop in tropical areas, require consistent and adequate water supply, but traditional irrigation methods often lead to inefficiencies such as overwatering or under-watering, reducing productivity. Intelligent irrigation systems provide a modern solution by utilizing real-time data from soil moisture sensors, weather forecasts, and environmental conditions to optimize irrigation schedules. These systems automate watering based on field needs, reducing water waste, saving labor, and enhancing plant health.

Advances in technologies like the Internet of Things (IoT), wireless sensor networks, and machine learning have enabled the development of adaptive irrigation systems. These systems are particularly beneficial for crops like coconut palms with deep root systems and specific water needs at various growth stages. By monitoring parameters such as soil moisture, temperature, humidity, and rainfall predictions, intelligent irrigation ensures precision watering, conserving resources while maximizing yield. Implementing intelligent irrigation systems is vital for sustainable agriculture, as it tackles the

pressing issue of water management. By optimizing water usage, these systems not only conserve this precious resource but also boost crop yields and reduce operational costs. Moreover, they contribute to environmental sustainability by minimizing waste and pollution. This project contributes to the broader goal of precision agriculture and supports sustainable farming practices by combining automation, sensor technology, and environmental intelligence for the efficient cultivation of coconut crops.

Objectives :

- To design a model that determines the optimum water requirements for coconut crops to achieve maximum yield while minimizing water usage.
- To provide an effective method of water resource management specifically tailored for drought-prone regions.
- To achieve optimal crop yield while minimizing water wastage and promoting long-term environmental sustainability in agriculture.
- To monitor the system's performance in real-time, analyzing watersaving efficiency and crop growth. Maintaining soil fertility and promoting biodiversity are essential for sustainable agriculture.

Methodology :

Materials:

The system is equipped with a variety of sensors, including soil moisture sensors (such as capacitive or resistive types), DHT11 for temperature and humidity sensing, and rain sensors. These sensors are interfaced with microcontrollers like Arduino Uno, which process the data. Additionally, a Water Level Sensor ensures there is sufficient water in the reservoir, while a relay connects the pump to power via digital pins (D8), VCC, and GND. Sensor data is transmitted to the cloud using a Wi-Fi module, allowing users to monitor live environmental conditions and watering status remotely. The system also triggers notifications for critical conditions such as extreme temperature or humidity, and dry soil conditions. These devices wirelessly transmit data to a cloud platform, where irrigation decisions are made based on predefined thresholds, ensuring efficient and informed water management.

Fig. 1. Hardware setup of the project

Methods:

The process begins with sensor data collection, where a soil moisture sensor checks if the soil is dry, and a DHT11 sensor measures the surrounding air temperature and humidity. This data is then processed by an Arduino microcontroller, which reads all sensor values. If the soil moisture level falls below a certain threshold and water is available, the Arduino activates the pump through a relay to irrigate the soil. Once the moisture level is restored, the pump is automatically turned off.

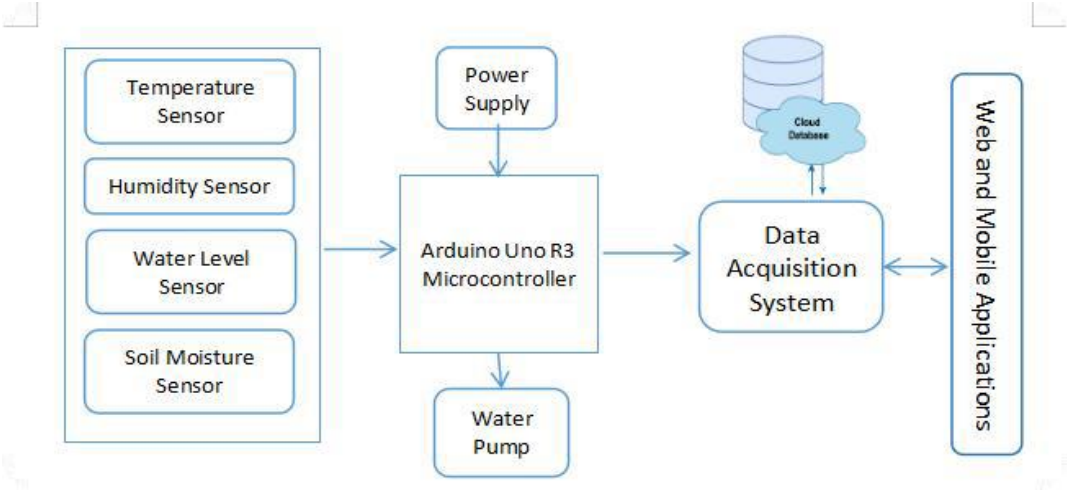

Fig. 2. Block Diagram of the Prototype

The system also integrates with the cloud using a Wi-Fi module, allowing sensor data to be sent and stored remotely. This enables users to monitor live environmental conditions and watering status in real-time. Furthermore, the system can trigger notification alerts for critical conditions like extreme temperature or humidity, and dry soil conditions, ensuring timely interventions and efficient water management.

Results and conclusion

The results of this project demonstrate the effectiveness of an intelligent irrigation system for coconut plantations, which automatically waters plants based on real-time weather and soil conditions. The system incorporates a smart water timer that automates irrigation according to a set schedule, utilizing a soil moisture sensor to stop watering when the soil reaches a specific humidity level. If the humidity falls below a predetermined threshold, the timer restarts watering, ensuring optimal soil conditions. Integration with a weather station further enhances the system's responsiveness, allowing it to detect weather conditions and adjust the water timer accordingly.

In conclusion, this project successfully designs and implements an intelligent irrigation system tailored for coconut plantations. By leveraging real-time environmental data to automate irrigation based on crop requirements, the system significantly enhances water-use efficiency and supports sustainable agricultural practices. Additionally, the system offers real-time monitoring of

soil moisture and weather conditions, user-friendly dashboards for data visualization, and notifications and alerts to manage irrigation schedules effectively.

Project Outcome & Industry Relevance

To foster critical thinking and problem-solving skills, students engaged to undertake academic projects in their final year under faculty guidance. These projects encourage self-learning, teamwork, and application of theoretical knowledge to real-world problems

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Sl. No.	Project Outcome
1	Conduct investigations of complex problems
2	Modern tool usage
3	The engineer and society
4	Environment and sustainability
5	Project management and finance

Industry Relevance

This project is relevant to the coconut farming industry, which faces challenges such as inefficient irrigation practices and resource scarcity. By leveraging advanced technologies like IoT, cloud computing, and smart sensors, the system aligns with global trends in sustainable agriculture.

Working Model :

Yes, the project involved the development of a physical working model. The system was implemented using real-time sensors, an Arduino microcontroller, and cloud integration to demonstrate automated irrigation based on environmental conditions. The working prototype successfully showcased the functionality of soil moisture-based watering, sensor data acquisition, and cloud monitoring**.**

1. Project Outcomes and Learnings:

- Innovative ideas are evolved.
- Skills or abilities of students improved.
- Knowledge on various aspects of project management were developed.

- Improved teamwork spirit and Confidence level of the students was boosted.
- Implementation and deployment of the project for social benefits.

2. Future Scope

The smart irrigation system can be further improved by integrating solar power to promote sustainable energy use and reduce electricity dependency. Incorporating advanced data analytics and machine learning will allow for intelligent prediction of water needs and optimized irrigation scheduling. Climate adaptation features will make the system resilient to environmental challenges such as drought and temperature stress, particularly for coconut crops. Additionally, expanding IoT capabilities will enable real-time remote monitoring and control, empowering farmers with actionable insights for efficient water management.