

IOT based Smart Agriculture-plant watering system with ESP32 and blynk platform

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Abstract— This article presents a real-time agricultural monitoring system based on the NodeMCU microcontroller coupled with IoT-based sensing technology. The system tracks key environmental parameters such as soil moisture, temperature, humidity, and light intensity using DHT11, LDR, and soil moisture sensors. Sensor data is processed and communicated through Wi-Fi to a cloud platform (ThingSpeak) for remote monitoring and visualization. Seamless connectivity is enabled by the NodeMCU ESP8266, allowing real-time updates and alerts. Data analytics on the cloud platform provides insights into precision farming and irrigation planning. The system prevents wastage of water and increases crop yield through timely interventions. Power efficiency and modularity enable the solution to be scalable for large-scale farms. Low-cost hardware and open-source platform implementation ensure cost-effectiveness for small-scale farmers. Performance testing ensures accurate sensor readings and efficient cloud transmission of data. The proposed system demonstrates a viable solution for smart agriculture.

Index Terms—NodeMCU, Smart Agriculture, IoT (Internet of Things), Automation

I. INTRODUCTION

Smart farming is crucial in maximizing the use of resources, particularly water, and maximizing crop yields. Conventional farming is not equipped with real-time feedback and is hence inefficient and over-irrigation susceptible. With the advent of IoT, embedded systems can offer smart monitoring solutions. This paper presents a low-cost, easy-to-implement monitoring system through NodeMCU that can potentially allow farmers to monitor field conditions through wireless transmission to the cloud. The aims are to maximize water efficiency, offer data transparency, and implement automation in small- and medium-scale farms.

II. SYSTEM ARCHITECTURE

The architecture of the proposed system is on a microcontroller-sensor-cloud system, specifically designed to monitor environmental conditions in real-time. NodeMCU ESP8266 is the central controller that communicates with three major sensors: the soil moisture sensor, DHT11, and LDR. Each sensor is tasked with collecting corresponding data pertinent to plant health and water requirements. The NodeMCU periodically reads the sensor values and uploads them to the ThingSpeak IoT platform via HTTP over Wi-Fi. The data is then presented on ThingSpeak in the form of graphs and widgets, allowing users to easily understand field conditions. A block diagram describes the major components and their intercommunication: sensors (input units), NodeMCU (processing unit), and ThingSpeak (cloud output). The system is dependent on a 5V regulated power supply and modular connectivity allowing for the ease of replacement or upgrading of components. The architecture is kept as simple as possible and has low power consumption, making it very flexible for use in rural farms. This real-time feedback loop allows farmers to take proactive steps based on real-time data. The system also has the possibility of being expanded to include actuators for automated irrigation.

III. HARDWARE COMPONENTS

The hardware revolves around the NodeMCU ESP8266, which is a Wi-Fi microcontroller that is small in size, programmable, and simple to integrate. It has digital and analog I/O pins that can be used to interface sensors. The soil moisture sensor is used to measure the water content in the soil, which is useful in deciding irrigation requirements. It gives analog voltage proportional to moisture content. The DHT11 sensor gives digital temperature and humidity readings with moderate accuracy and low response time. An LDR (Light Dependent Resistor) is used for measuring

light intensity, where resistance changes with the intensity of the surrounding light. These three sensors are interfaced to the I/O pins of the NodeMCU, and power is supplied through USB or a battery-powered 5V power supply. The components are soldered on a breadboard for prototyping, which offers flexibility in circuit designing. All hardware components used are low-cost, and hence the solution is cost-effective for local farming communities. The sensors are chosen based on their application to agricultural parameters, accuracy, and ease of availability. Each sensor was properly calibrated and tested before deployment.

IV. SOFTWARE IMPLEMENTATION

The software development was performed with the Arduino IDE, which presents a neat interface for code writing, uploading, and debugging onto the NodeMCU. Libraries for Wi-Fi connectivity and DHT11 interfacing were incorporated to facilitate sensor interfacing and data sending. The principal program initialises sensor objects and establishes Wi-Fi connectivity with a local router. The system upon connection reads data from the sensors every 15 seconds, interprets the data, and sends it over HTTP GET requests to ThingSpeak. Each parameter is sent to a distinct field on the platform, where it is stored and presented in graphical form. Error handling functions were added to manage sensor read failure and Wi-Fi disconnection. The software also incorporates time-stamping and data averaging for enhanced reliability. ThingSpeak offers a real-time dashboard accessible using any browser, where farmers can observe data remotely. The code is modular and open-source, thus enabling customization for various crops or field conditions. The data collected can further be interpreted to identify long-term trends and predict outcomes.

V. RESULTS AND DISCUSSIONS

The system was deployed and tested in a small agricultural field with varying soil conditions and environmental conditions. The soil moisture sensor accurately reflected changes in soil humidity following irrigation events, thereby proving its applicability in the determination of water levels. The DHT11 sensor provided stable readings of temperature and humidity, and the LDR reflected appropriately on changes in natural light during the day. Data was accurately transmitted and displayed on

ThingSpeak in near real-time, with minimal latency. Graphs plotted on the cloud platform reflected clear changes in sensor readings, which correlated well with actual field conditions. The system responsiveness was also maintained even under Wi-Fi signal fluctuations, thereby proving its robustness. The findings aid to confirm the reliability of the system for routine monitoring operations. Interviews with local users indicated that the system could lead to significant water savings if deployed in conjunction with an automatic irrigation valve. Moreover, simplicity of the interface proved it to be accessible to the non-technical users to analyze data efficiently. Minor limitations include limited sensor range and cloud latency under poor network connectivity.

VII. CONCLUSION

This project effectively demonstrates an Internet of Things (IoT)-based monitoring system specifically designed for agricultural use with NodeMCU and low-cost sensors. It enables farmers to remotely monitor critical field parameters such as soil moisture, temperature, humidity, and sun exposure. With the use of cloud technologies, the system enables data-driven decision-making that can greatly improve irrigation efficiency and crop yields. Affordable and modular, it is particularly ideal for small-scale and remote farming operations. Future enhancements can be the integration of solenoid valves for auto-irrigation, GSM modules for areas where there is no Wi-Fi coverage, and solar panels for self-sustenance. Adding machine learning for predictive irrigation and crop disease detection would further expand the system's capabilities. This prototype is the basis for scalable smart farming solutions that enable sustainable agriculture and technology empowerment in rural areas.

ACKNOWLEDGMENT

We hereby express our sincerest appreciation to our project supervisor and academic team for their valuable advice and support throughout the construction of this project. We further express our appreciation to our institution for offering the required support and resources. We also wish to thank our peer community and open-source community whose support was key to the successful deployment of this work..

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