AGRODEW: A Smart Agriculture and Environmental Monitoring System for Automated Irrigation

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***Abstract*— AGRODEW is a smart agriculture and environmental monitoring system developed to automate irrigation and support efficient field supervision through real-time sensing and wireless communication. The proposed system integrates soil moisture, temperature, humidity, and water-level sensing with an ATmega328P-based control unit, a relay driver, and GSM or Wi-Fi communication for remote dashboard access. When the soil moisture falls below a predefined threshold, the controller activates the relay and turns on the irrigation pump or solenoid valve; once the desired moisture level is restored, the actuator is turned off automatically. This threshold-based control reduces water wastage, lowers manual effort, and improves irrigation responsiveness. The system architecture is low-cost, modular, and suitable for both small farms and scalable field deployments. Experimental observations from the project prototype indicate stable sensing, reliable actuator control, and timely data transmission to the mobile dashboard. The work demonstrates a practical embedded solution for precision irrigation and establishes a foundation for future enhancements such as cloud analytics, AI-assisted scheduling, and solar-powered operation.**

***Index Terms*—Smart agriculture, automated irrigation, environmental monitoring, embedded systems, soil-moisture sensing, GSM/Wi-Fi dashboard.**

I. Introduction

AGRICULTURE faces increasing pressure to deliver higher productivity under tighter water and energy constraints. Recent reviews and global assessments emphasize that improved land and water management, precision irrigation, and data-driven monitoring are now central to sustainable agricultural practice [1], [2]. In parallel, IoT-enabled irrigation, platforms have demonstrated that real-time sensing and remote control can improve water-use efficiency while reducing labor Intensity [3], [6].

A practical challenge, however, is that many farming environments still need systems that are inexpensive, modular, and easy to maintain without advanced infrastructure. AGRODEW was developed to address this need through a compact hardware-software stack that senses field conditions, actuates irrigation automatically, and pushes live data to a mobile interface. The design targets day-to-day irrigation support rather than heavy cloud analytics, which makes it suitable for prototype-scale and low-resource deployment.

The paper contributes a low-cost soil-moisture-driven irrigation architecture built from commonly available embedded components, integrates multi-parameter monitoring with GSM/Wi-Fi-enabled remote visibility, and reports implementation evidence from controlled prototype testing.

II. Related Work

Recent literature shows strong momentum toward sensor-assisted irrigation and smart farming. Lakhiar *et al.* review precision-irrigation technologies and note that the most effective systems deliver the right amount of water at the right time through feedback-based control [2]. Et-taibi *et al.* present a cloud-connected irrigation platform for distributed farms and show how centralized data access improves operational oversight [3]. Morchid *et al.* further demonstrate an embedded, event-driven irrigation design that supports real-time responses to changing field conditions [4]. Sreeram *et al.* summarize current soil-moisture monitoring technologies and highlight calibration, placement, and long-term reliability as persistent engineering concerns [5]. Gupta *et al.* and Shahab *et al.* report integrated IoT architectures that combine environmental sensing, automation, and remote analytics for better resource management [6], [7].

These studies establish the value of connected irrigation, but many published systems emphasize cloud intelligence, large-scale analytics, or broader agronomic optimization. AGRODEW instead focuses on a simpler but highly deployable configuration: threshold-based irrigation control, isolated relay actuation, and remote visibility through a farmer-facing dashboard. This makes the platform useful as a cost-conscious academic and field prototype while still aligning with current smart-agriculture directions.

III. System Design and Control Strategy

A. Architecture Overview

AGRODEW is organized around five functional blocks: power conditioning, sensor acquisition, controller logic, communication, and actuation. The controller receives measurements from soil-moisture, temperature, humidity, and water-level sensors, evaluates irrigation demand, and drives a relay interface connected to a solenoid valve or water pump. A communication module forwards measurements and actuator status to the dashboard, enabling remote monitoring and manual override. The overall architecture used in the project documentation is shown in Fig. 1.

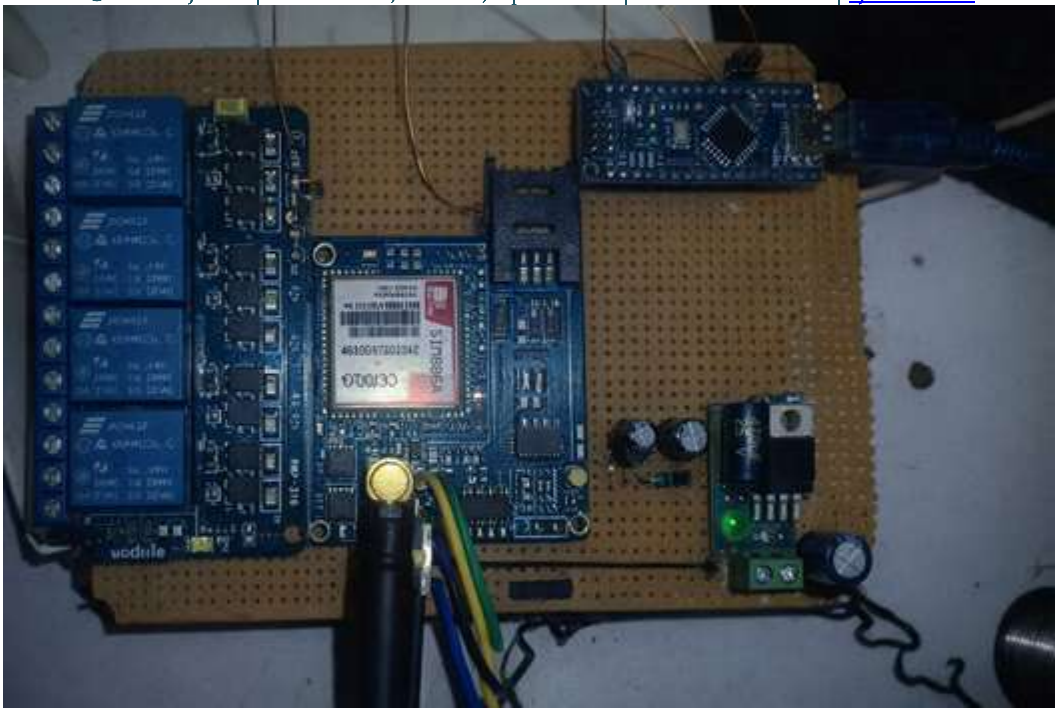

Fig. 1: AGRODEW system circuit Daigram. The controller receives sensor inputs, issues control signals to the actuator stage, and exchanges data with the remote dashboard.

B. Hardware Modules

The sensing layer uses DHT11/DHT22 for temperature and humidity, a soil-moisture probe for irrigation demand, and a water-level sensor for source awareness. The control layer is centered on an ATmega328P-based unit. The actuation stage includes a relay driver with PC817 optocoupler isolation, BC547 transistor switching, and a 1N4007 flyback diode to protect against back electromotive force. The communication layer supports GSM-based or Wi-Fi-based uplink, with dashboard visualization through a mobile interface. Dual regulated supply rails of +5 V and +12 V support the logic and actuator sections, respectively.

C. Control Logic

The operating sequence is shown in Fig. 2. The firmware repeatedly samples the sensors, compares soil-moisture readings with the configured lower threshold, and energizes the relay when dry-soil conditions are detected. Irrigation continues until the upper moisture target is reached, after which the pump is switched off. Using separate lower and upper thresholds reduces relay chatter and unnecessary switching. During each cycle, the controller also sends updated telemetry to the dashboard for visualization and manual intervention if required.

IV. Prototype Implementation

The firmware was developed in the Arduino environment using standard embedded C/C++ libraries for sensor reading and serial communication. Sensor acquisition and relay decisions are executed inside a periodic loop, while telemetry packets are forwarded to the GSM/Wi-Fi interface for dashboard refresh. For prototype discussion, the control thresholds were configured around a lower moisture trigger of 40% and an upper cutoff near 70%, which is consistent with the project's documented operating logic.

The user-facing software presents live readings, actuator state, and manual override options. Although the prototype can operate autonomously, remote visibility is important for practical deployment because it allows the farmer to verify soil condition, pump status, and communication health without being physically present at the field site.

The prototype is intended for drip-based or localized irrigation scenarios where periodic actuation and rapid feedback are more valuable than complex centralized infrastructure.

V. Results and Discussion

Prototype evaluation was carried out under controlled conditions intended to simulate practical agricultural use. The observed behavior is summarized in Table I. The system responded quickly to dry-soil detection, maintained stable

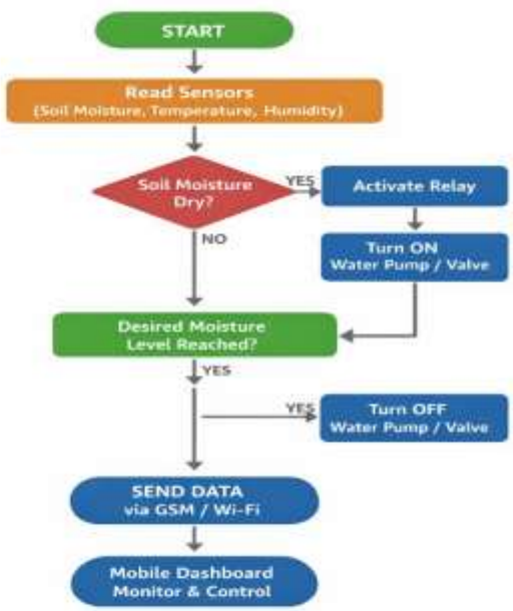

Fig. 2: Operational flow of AGRODEW irrigation control. Sensor sampling, threshold comparison, relay actuation, and remote data upload are executed cyclically.

TABLE I: Summary of Observed Prototype Behavior

Test aspect	**Observed outcome**
Dry-soil response	Pump triggered within approximately 2–3 s after the moisture threshold was crossed.
Telemetry latency	Sensor values reached the dashboard with latency below 5 s during testing.
Relay switching	Stable ON/OFF operation without visible switching noise or component failure.
Environmental sens- con- ing	Temperature and humidity readings remained sistent across repeated measurements.
Remote visibility	Dashboard reflected live sensor states and actuator status correctly.

relay operation, and delivered timely dashboard updates. These findings indicate that a threshold-based approach remains useful for low-cost irrigation support when combined with reliable sensing and protected actuation hardware.

AGRODEW offers three practical strengths. First, it automates irrigation only when required, which helps reduce overwatering and labor dependence. Second, it exposes live field data to the operator through a remote dashboard. Third, it is modular: communication modules, thresholds, and sensors can be upgraded without redesigning the entire architecture. At the same time, the prototype still inherits common limitations reported in the literature, including moisture-sensor calibration drift, dependence on network quality for remote telemetry, and the absence of crop-specific irrigation intelligence [5], [7].

Future development can therefore proceed in three directions. The first is data intelligence, such as predictive irrigation scheduling or AI-assisted crop advisory. The second is energy optimization through solar-assisted operation and low-power scheduling. The third is sensing expansion through pH, gas, imaging, or additional water-quality modules [6].

VI. Mobile Application Interface

The AGRODEW mobile application serves as the primary interface for farmers to monitor and control the smart agriculture system remotely. The app is designed with simplicity and accessibility in mind to ensure ease of use for non-technical users.

App Features:

- Live Sensor Dashboard: Real-time display of soil moisture, temperature, humidity, and water level readings.
- Manual Override: Buttons to manually turn the water pump ON or OFF from anywhere via Wi-Fi/GSM.
- Threshold Configuration: Allows the user to set custom moisture thresholds for automatic pump activation.
- Notification Alerts: Push/SMS notifications sent to the farmer when sensor values cross danger thresholds.
- Historical Data Graphs: Visual trend charts of sensor data over time for informed decision-making.

Multi-Farm Support: Ability to monitor multiple field units from a single app interface.

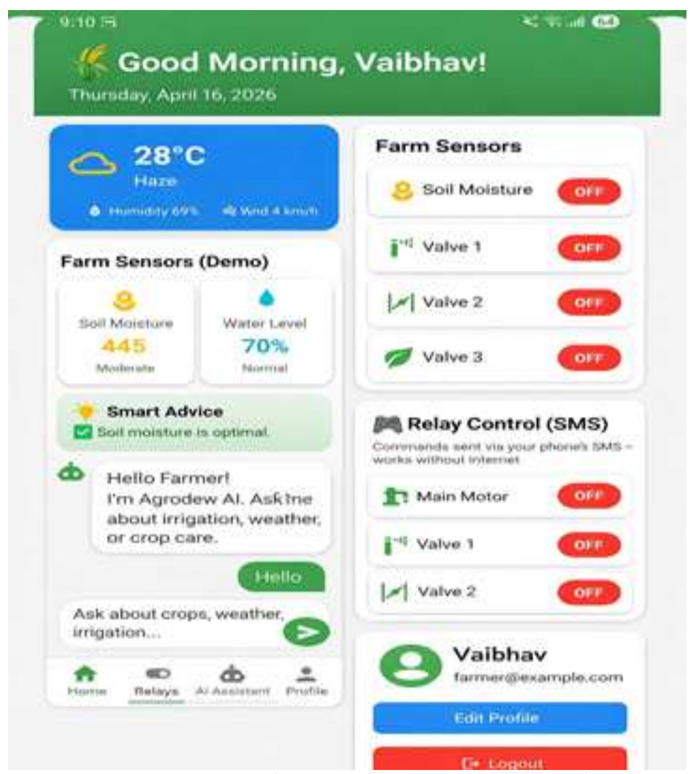

Fig 3: Mobile application interface, implemented with AI chat-bot for smart advice.

VI. APPLICATIONS AND FUTURE SCOPE

AGRODEW is applicable to automated irrigation in agricultural plots, greenhouse monitoring, water-resource supervision, and other scenarios where remote sensing and threshold-based control are required. The same architecture can be extended to additional sensing tasks such as pH measurement, gas detection, and expanded environmental logging.

Future work can improve the system with cloud-native data storage, predictive irrigation scheduling, solar-powered operation, and AI-assisted analytics. Integration with weather forecasting and long-term data trends could further optimize pump operation and make the platform more adaptive to crop and climate conditions.

VIII. CONCLUSION

This paper presented AGRODEW, a smart agriculture pro- totype that combines environmental sensing, relay-based irri- gation control, and remote monitoring in a compact embedded platform. The design emphasizes affordability, modularity, and operational simplicity. Controlled testing showed that the sys- tem can react quickly to dry-soil events, maintain dependable relay actuation, and provide near-real-time dashboard visibil- ity. While the present prototype uses straightforward threshold logic, it establishes a strong base for future precision-irrigation enhancements such as predictive control, solar-powered auton- omy, and richer sensor fusion. For academic and small-scale deployment contexts, AGRODEW demonstrates that practical smart irrigation can be implemented effectively without high system complexity.

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