SMART IRRIGATION SYSTEM

GROUP 13

ICT 216

(ROBOTICS)

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Abstract

This project introduces a Smart Irrigation System using MATLAB and Simulink to automate water supply based on environmental conditions. By analyzing real-time soil moisture and temperature values, the system optimally controls the water pump to ensure plants are irrigated only when necessary. This not only conserves water but also promotes sustainable farming practices. The model is fully simulated in Simulink and features a user-friendly dashboard interface for real-time interaction and visualization.

Introduction

Agriculture consumes over 70% of the world's freshwater resources. Traditional irrigation methods often lead to excessive water use, affecting sustainability. In this context, **smart irrigation** techniques that rely on real-time sensor feedback can drastically improve efficiency.

This project focuses on the development of a **Simulink-based Smart Irrigation System** that uses simulated sensor data to control a water pump intelligently. It serves as a proof of concept for implementing such systems in real-world farms with actual sensors and microcontrollers.

Problem Statement

Manual irrigation is time-consuming, inefficient, and often leads to overwatering or underwatering. Existing automated systems are expensive and not adaptable to local conditions. There is a need for a **low-cost, easily configurable, and data-driven irrigation system** that minimizes water usage while maximizing agricultural yield.

Objectives

- Design a MATLAB-Simulink model that simulates a smart irrigation system.
- Integrate simulated sensors for soil moisture and temperature.
- Implement control logic to automate irrigation based on sensor values.
- Visualize system behavior in real time using Simulink dashboards.

- Log and analyze simulation data for performance evaluation.

Literature Review

Several smart irrigation systems have been proposed in the literature, often using microcontrollers (Arduino, Raspberry Pi) and IoT platforms (ThingSpeak, Blynk). These systems commonly rely on:

- Soil moisture sensors (resistive/capacitive)
- Weather forecast integration
- Solar-powered pumps
  This project builds upon those ideas but focuses on the **simulation phase**, laying the foundation for physical implementation.

System Architecture

The system architecture includes the following elements:

- **Inputs**: Soil moisture and temperature sensors
- **Processing**: Logical controller implemented in Simulink
- **Output**: Water pump ON/OFF signal
- **User Interface**: Dashboard with gauges, knobs, and indicators

Component Description

Soil Moisture Sensor (Simulated)

Simulated using a signal generator that mimics dry and wet cycles using sine/random signals.

Temperature Sensor

Simulated with a sinusoidal profile to reflect daily variations in temperature.

Control Logic

Relational and logical operators determine whether to activate the pump based on threshold comparisons.

Water Pump

Modeled using an actuator block, representing ON/OFF states and flow rate.

Simulink Dashboard

Includes:

- Gauges (moisture, temperature)
- LED indicators (pump status)
- Toggle switch (manual override)
- Knobs (set threshold values)

Simulink Model Design

The model consists of:

- **Signal Generators**: Provide synthetic environmental data.
- **Comparators**: Check if values fall below thresholds.
- **Switches**: Direct logic flow based on sensor conditions.
- **Actuator Control**: Activates the pump using logical outputs.
- **Timers**: Prevent overwatering and manage irrigation intervals.
- **Dashboard**: Enhances user interaction.

Simulation Parameters:

- Time step: 0.01s
- Simulation duration: 60s
- Logging interval: 1s

(Insert screenshot of Simulink model here)

Simulation Results

Simulation was performed under various scenarios:

1. **Dry soil with high temperature** → Pump activated.
2. **Wet soil** → Pump remains OFF.
3. **Temperature below threshold** → No irrigation, even if soil is dry.

Graphs:

- Moisture vs. Time
- Pump Status vs. Time

- Temperature Profile

(Data visualizations to be added from Scope/Data Inspector)

Discussion

The model behaved as expected under different conditions. Logical control efficiently triggered irrigation only when necessary. The use of timers ensured safety and water conservation. The dashboard offered real-time feedback, making it suitable for educational and prototype development purposes.

Limitations and Future Scope

Limitations:

- Simulated environment; no real sensor data
- No integration with external databases or weather services

Future Enhancements:

- Hardware integration (Arduino, ESP32)
- Remote monitoring using ThingSpeak or Firebase
- Solar-powered actuator design
- Multi-zone irrigation with multiple sensor nodes

Conclusion

This project successfully demonstrated the design and simulation of a Smart Irrigation System using MATLAB and Simulink. It validated the use of sensor-based logic and control systems to reduce water waste in agriculture. With hardware integration, this model can be deployed as a real-world precision agriculture solution.

References

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