ADDIS ABABA SCIENCE AND TECHNOLOGY UNIVERSITY

UNIVERSITY FOR INDUSTRY

COLLEGE OF ENGINEERING

DEPARTMENT OF ELECTRO-MECHANICAL ENGINEERING

WORKSHOP FOR MECHATRONICS

Title: Design and Simulation of an Automated Sensor-Based Irrigation System

SECTION: **B**

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Submitted to: Mr. Abera

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EXECUTIVE SUMMARY

Water is a vital resource in agriculture; however, conventional irrigation methods often result in excessive water usage, increased labor, and reduced crop productivity. This project presents a smart automated irrigation system designed and simulated to supply water based on real-time environmental conditions, ensuring efficient and timely irrigation.

The system continuously monitors key parameters such as soil moisture, temperature, light intensity, water level, and water flow using multiple sensors. An Arduino Uno microcontroller processes the sensor data and controls the irrigation pump through relay modules, delivering the required amount of water only when necessary. The entire system was designed and tested using Proteus simulation software, confirming correct operation under varying soil and environmental conditions.

To enhance user interaction and flexibility, the system integrates a Blynk web-based dashboard that displays real-time gauge measurements and provides Auto and Manual control switches for the irrigation pump. This allows users to remotely monitor system performance and manually override automatic operation when required. The system is powered using solar energy, making it suitable for remote and off-grid agricultural areas.

The modular design of the proposed system allows easy expansion for larger fields and different crop types. Overall, the project demonstrates that smart irrigation technology can significantly reduce water consumption, minimize manual effort, lower operational costs, and improve crop health, offering an efficient and economical solution for modern agricultural water management.

INTRODUCTION

Agriculture consumes a large portion of the world's freshwater, yet much of it is wasted through inefficient irrigation methods. Conventional practices like manual watering or fixed schedules often lead to over- or under-watering, increasing costs, reducing yields, and negatively affecting soil health.

This project addresses these challenges by developing an automated, sensor-based irrigation system that waters plants only when necessary. The system continuously monitors soil moisture, temperature, and light conditions, and makes real-time decisions for water delivery.

In addition to automatic control, the system features a Blynk dashboard, allowing users to monitor sensor readings remotely and manually operate pumps using an Auto/Manual switch. The design is modular and scalable, capable of supporting larger fields or different crops. Simulation in Proteus validates the system's functionality, providing a cost-efficient and sustainable solution for modern agriculture, with potential for future enhancements like predictive irrigation using weather data or AI.

STATEMENT OF THE PROBLEM

Agriculture continues to rely heavily on traditional irrigation methods such as manual watering, furrow, and surface irrigation. These methods often depend on fixed schedules or the farmer's judgment rather than actual soil and crop conditions. This leads to several issues:

1. Inefficient water usage: Water is frequently wasted due to over-irrigation or evaporation.
2. Lack of real-time monitoring: Traditional methods do not measure soil moisture, temperature, or sunlight, leading to poor irrigation decisions.
3. Labor-intensive operation: Manual watering requires continuous supervision, increasing labor costs and effort.
4. Uneven crop growth and reduced yield: Overwatering or underwatering can damage crops and reduce productivity.

OBJECTIVE

General Objective

The overall objective of this project is to design and simulate a smart irrigation system that promotes efficient water usage without compromising crop growth and health.

Specific Objective

1. Arduino Code Development: Develop automation logic to control water supply based on real-time soil moisture, temperature, and light sensor data. Ensure proper decision-making to activate pumps only when needed.
2. Proteus Simulation: Design and simulate the smart irrigation system in Proteus. Verify system performance and sensor integration in a controlled virtual environment.
3. Integration of Code and Simulation: Connect Arduino code with the simulated circuit in Proteus to demonstrate full system functionality. Test responses of the system to different environmental conditions (dry soil, wet soil, high temperature, etc.).
4. Blynk Dashboard Implementation: Set up a dashboard to display real-time sensor readings (soil moisture, temperature, light). Include Auto/Manual switch to allow remote control of pumps for flexibility in operation.

MATERIALS AND SYSTEM REQUIREMENTS

Hardware Components

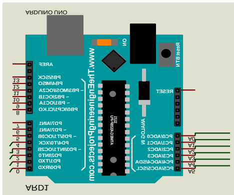
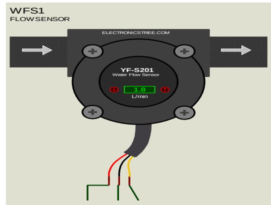
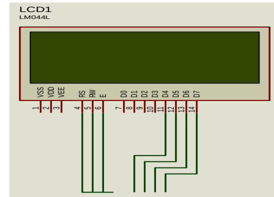
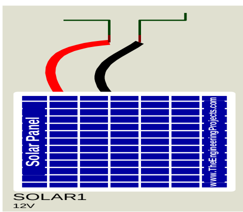
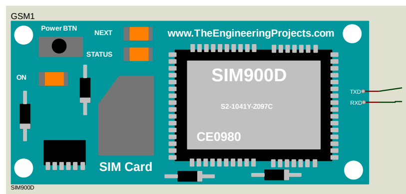
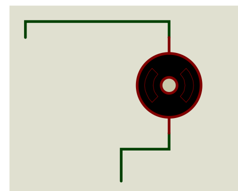
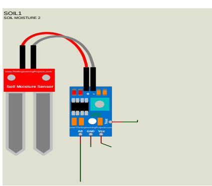
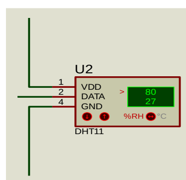
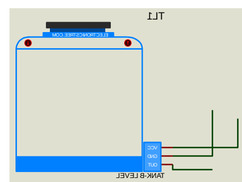
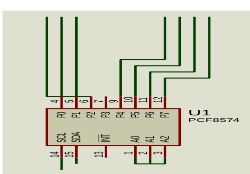
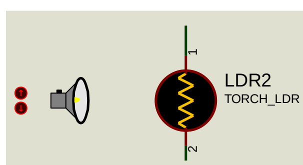
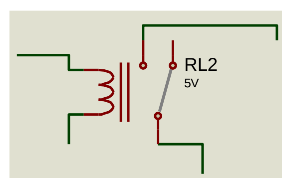
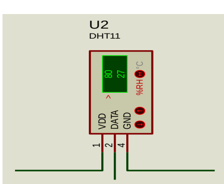
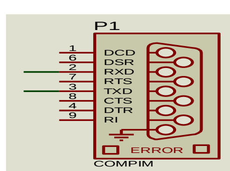
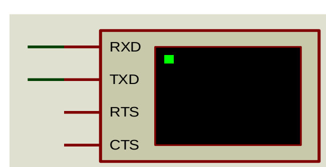
 Arduino Uno:	 Flow sensor	 LCD
 Solar Panel	 SIM900D	 Motor
 Soil Moisture sensor	 LM50(Temperature sensor)	 Tank-B Level
 PCF8574	 Torch LDR	 Relay
 Tempreture sensor	 COMPIM	 VSM Terminal

Table 1: Materials required

Software Requirements: The project uses Proteus 8 Professional, Arduino IDE, Arduino programming language, DHT Sensor Library, Wire Library, LiquidCrystal_I2C Library, and the Blynk App/Library.

METHODOLOGY

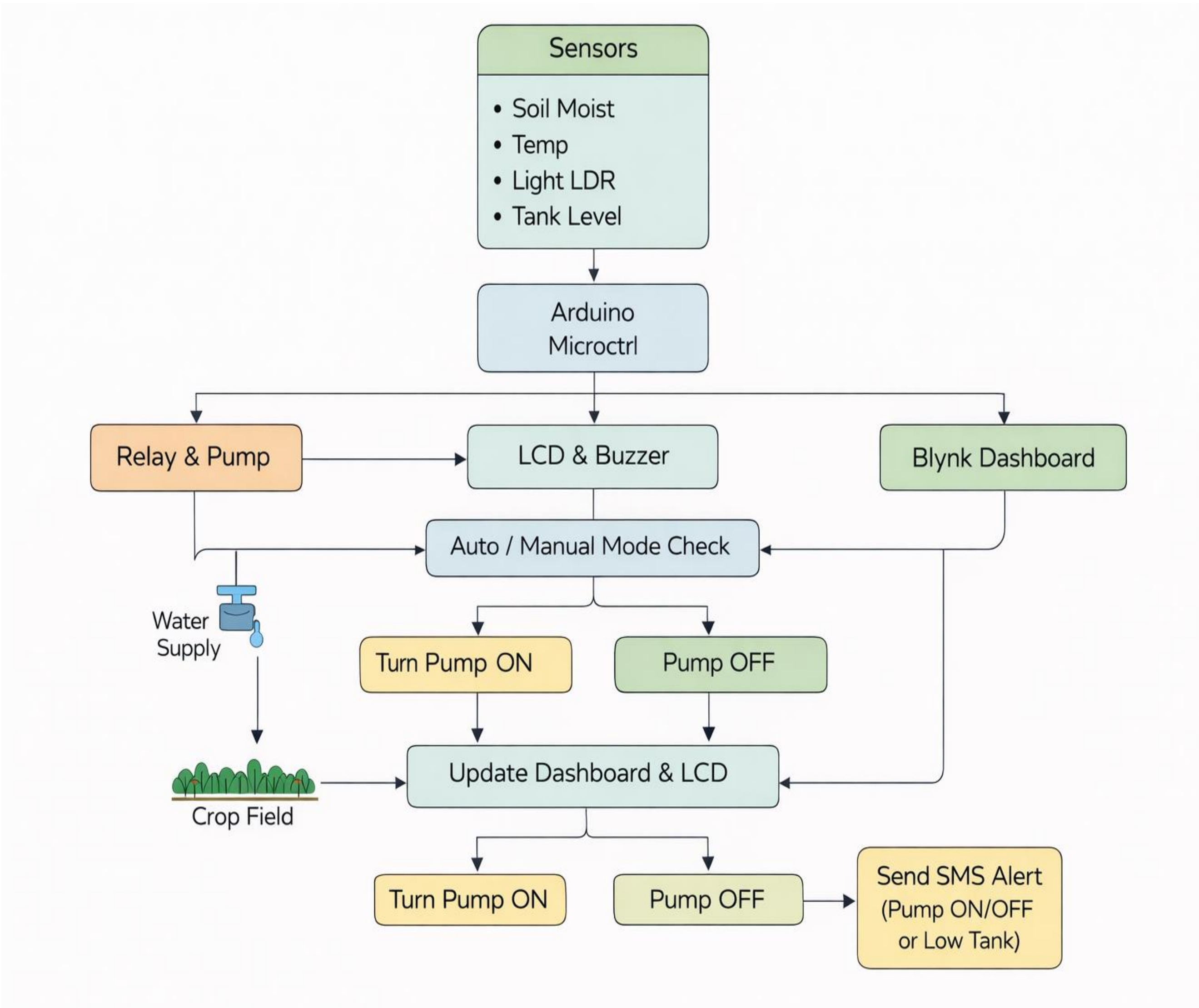


Figure 1: System Architecture Diagram

Figure 1 Describes Sensors collect environmental data and send it to the Arduino. The Arduino processes this data and activates the pump through the relay. The LCD shows local readings, and the Blynk dashboard provides real-time monitoring and Auto/Manual pump control. Solar panels power the system for sustainable operation.

Flow Chart:

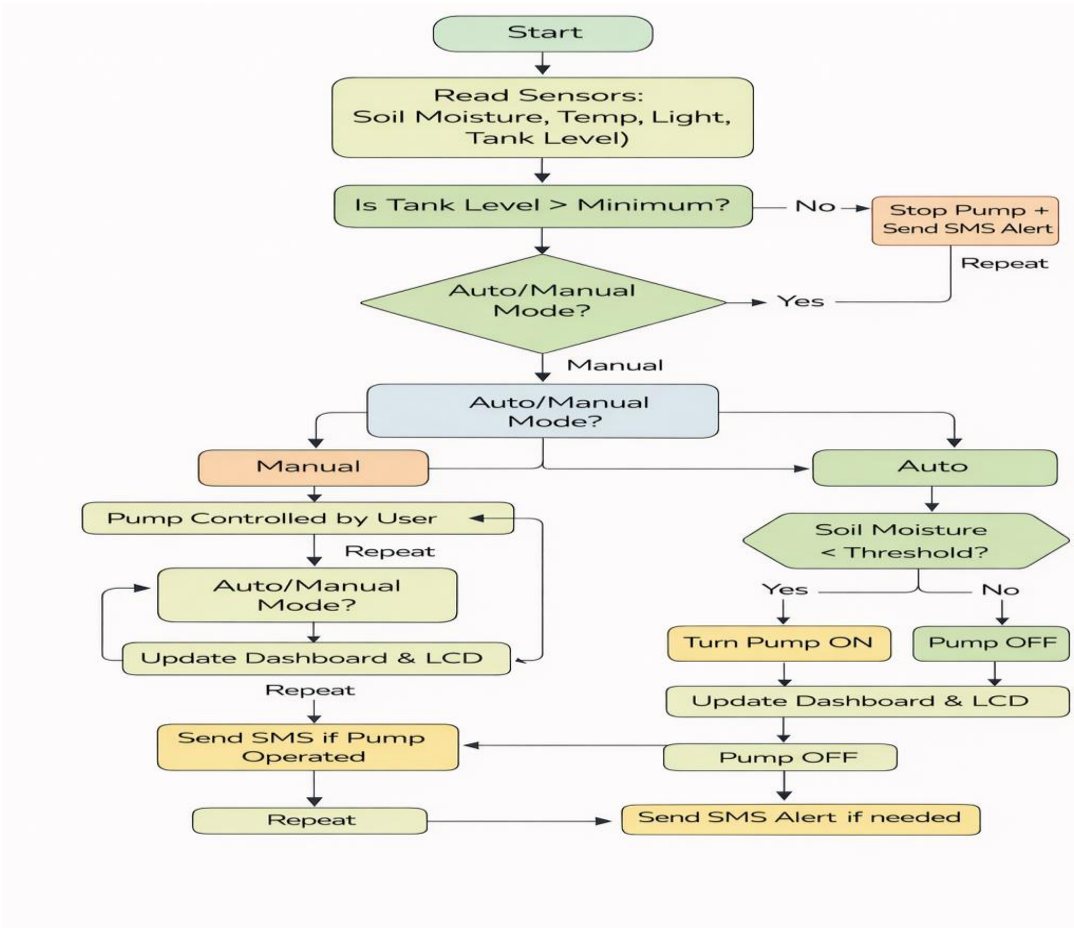


Figure 2: Flow chart of the smart irrigation system

Figure 2 shows the working of a smart irrigation system that reads soil moisture, temperature, light, and tank level data. If the tank level is low, the pump is stopped and an SMS alert is sent. When sufficient water is available, the system operates in manual or automatic mode: in manual mode the user controls the pump, while in automatic mode the pump turns ON or OFF based on soil moisture level. The system continuously updates the dashboard and LCD and sends alerts when needed to ensure efficient irrigation.

RESULTS AND DISCUSSION

Condition	Soil Moisture (ADC)	Temperature (°C)	Tank Level (ADC)	Pump Status
Dry Soil	750	28	900	ON
Moist Soil	500	29	900	OFF
Low Tank Level	600	30	150	OFF
Manual Pump ON (Override)	650	28	900	ON

Table 2 : Results of proteus simulation

Observations

The pump turns ON automatically when the soil moisture falls below the threshold and the tank has sufficient water, and it turns OFF once the soil moisture reaches the desired level. Low tank levels prevent pump operation to avoid damage, while the Manual mode allows the user to control the pump remotely.

Dashboard Figures

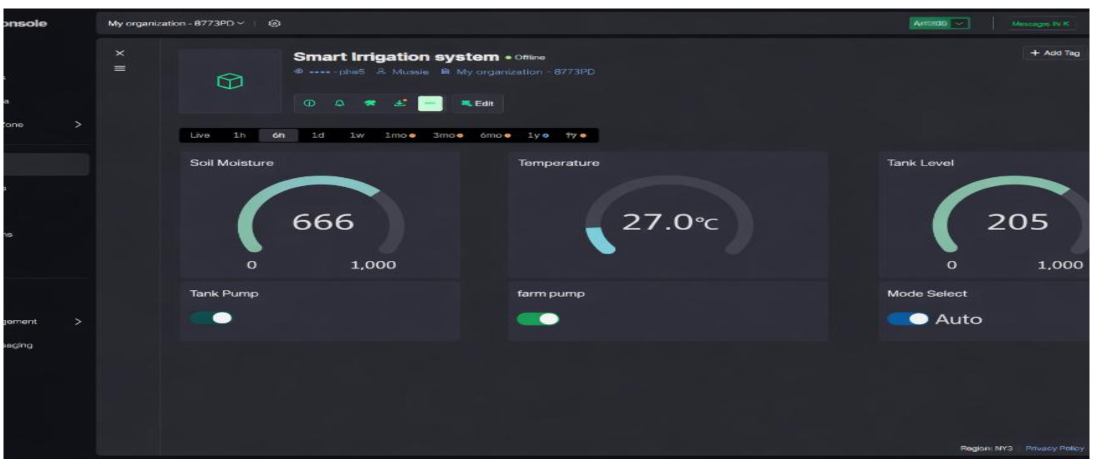


Figure 3: Blynk Dashboard

Figure 3 Shows the dashboard displays real-time soil moisture, temperature, and light values. The Auto/Manual switch allows remote control of the pump, enabling users to override automatic operation if needed.

Proteus Simulation

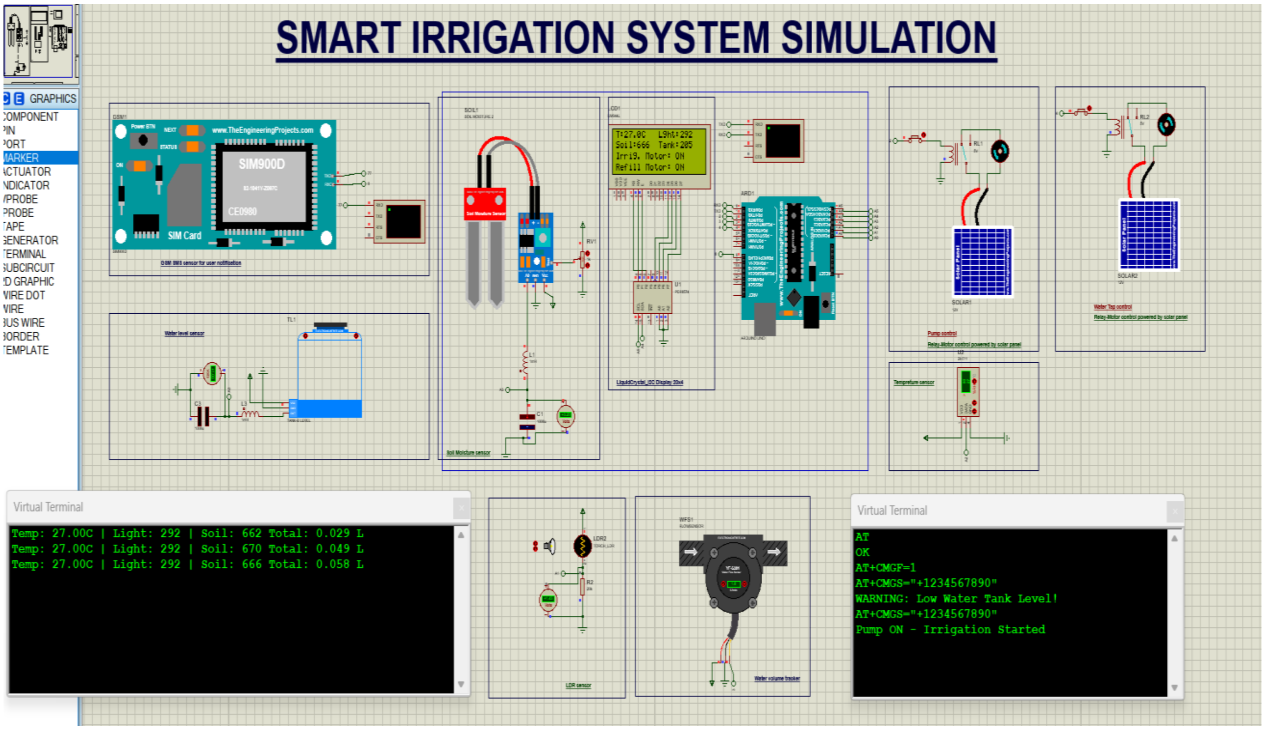


Figure 4: Proteus Simulation of the Smart Irrigation System

Figure 4 describes the Proteus simulation shows the Arduino microcontroller connected to the sensors, relay, pump, and LCD, validating the sensor readings and automatic pump control, while continuously monitoring the tank level, soil moisture, and temperature sensor data to ensure proper system operation.

Discussion of Results

The Smart Irrigation System demonstrates effective water management by delivering irrigation only when soil moisture falls below the set threshold, preventing overwatering and conserving resources. The inclusion of an Auto/Manual mode adds operational flexibility, allowing users to either rely on automated control or manually operate the pump as needed. Although minor fluctuations in sensor readings were observed, careful threshold calibration ensured consistent and reliable performance throughout the simulation. The solar-powered design enhances the system's suitability for remote or off-grid agricultural areas, reducing dependence on external electricity. Additionally, the simulation results indicate strong scalability, allowing the integration of multiple sensors and pumps for larger fields or multiple irrigation zones, making the system adaptable for diverse farming requirements.

CONCLUSION

The Smart Irrigation System developed in this project demonstrates an effective and modern approach to agricultural water management. By using soil moisture, temperature, and tank level sensors connected to an Arduino microcontroller, the system ensures that crops are irrigated only when necessary, preventing overwatering and conserving water resources. The integration of Auto/Manual modes allows users to either rely on automated control or manually operate the pump when needed, providing flexibility and convenience. Real-time monitoring through the Blynk dashboard enables remote supervision, while the LCD and buzzer offer immediate local feedback on system status. Proteus simulation validated the sensor readings, pump operation, and overall logic of the system, confirming reliable and efficient performance. The solar-powered design ensures energy efficiency and makes the system suitable for off-grid applications. Furthermore, the modular architecture allows scalability, making it possible to expand the system for larger agricultural fields or multiple irrigation zones. Overall, this project illustrates the practical benefits of low-cost, sensor-based automation in agriculture, offering a sustainable, efficient, and user-friendly solution to modern irrigation challenges.

APPENDIX

A. Hardware and Software Used

Arduino Uno, Soil Moisture Sensor, LM50 Temperature Sensor, LDR (Light Sensor), Water Level Sensor, Flow Sensor, Relay Module, DC Water Pump, LCD (20×4 with I2C – PCF8574), SIM900D GSM Module, Solar Panel, Rechargeable Battery, Buzzer, connecting wires and passive components. Proteus 8 Professional, Arduino IDE, Arduino Programming Language (C/C++), Wire Library, Liquid-Crystal I2C Library, Blynk IoT Platform.

B. Blynk Web Dashboard (Auto & Manual Control)

The system includes a Blynk web dashboard for remote monitoring and control. Gauge widgets display real-time sensor values such as soil moisture, temperature, and water flow. Two switches are provided:
Auto Mode Switch – Enables automatic irrigation based on sensor data
Manual Mode Switch – Allows the user to manually control the pump
Only one mode operates at a time to prevent conflict between automatic and manual control.

C. Proteus Simulation Summary

The complete system was simulated in Proteus, including sensors, Arduino, relay-controlled pump, LCD, solar-powered supply, and GSM module. The simulation verified correct pump operation under dry and wet soil conditions.

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