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GSM Based Water Pump and Irrigation Control Using Arduino UNO

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ABSTRACT

Growing world population has underlined the need of innovative ideas in agriculture by stressing the issues of water and food shortages. Still, agriculture is not without its difficulties; among other things, bad irrigation techniques result significant water loss. Dealing with these issues calls for automated systems to ensure effective agricultural water management.

A totally automated irrigation system programmed to constantly monitor soil moisture levels, this system uses an Arduino UNO microcontroller. Should the moisture level drop below a specified threshold, the system activates a water pump to irrigate the fields. Once the needed level of soil moisture is restored, the pump shuts off by itself. This strategy optimizes water use and minimizes the need for human involvement.

By using such technological advances, farmers can more effectively manage water resources, therefore boosting crop production and conserving water. Moreover, by saving time and effort, this method offers a sustainable solution to the agricultural issues caused by a rising population.

I. INTRODUCTION

A. Overview:

The agriculture industry today battles several problems, including significant ones that result material and financial losses. Inadequate crop health and quality are among the main contributors to these losses. Prompt identification of crop-related problems helps to prevent these issues; yet, for farmers with large fields, maintaining constant vigilance is both difficult and exhausting.

Most of now, crop maintenance and monitoring are done manually. Many people look for other sorts of employment, thus declining staff has made this increasingly challenging. Automation is increasingly helping to guarantee the future viability of agriculture. Irrigation is among the main areas needing technological intervention since overwatering is a major cause of crop underperformance.

Automated plant watering systems could give farmers hope. These systems reduce the burden of manual labor and guarantee consistent moisture levels across fields. Many farmers all around the world find it very difficult to adequately irrigate their fields, occasionally facing insurmountable obstacles. Lack of political support increases these challenges and drives farmers to rely on outside assistance from individuals or organizations able to assist.

B. Aim of The Project:

This study intends to use sensors to identify soil dryness and ensure efficient water delivery to plants depending on their specific needs. Sensor-based technology, which continuously tracks soil moisture levels and assesses when irrigation is needed, simplifies plant care for the project.

C. Review of Related Works:

1. Wireless Sensor Network with GPRS Module (2014): Zigbee technology was used by this system to build a distributed wireless network consisting of soil moisture and temperature sensors. A gateway device's responsibilities included processing the collected data, controlling actuators, and transmitting the data to a web application. Designed especially to meet agricultural demands, the system had duplex communication driven by solar energy.
2. GSM-Based System: The GSM-based system let users control its operation via SMS messages using GSM technology. Specific instructions let users perform straightforward tasks like turning the system ON or OFF. This approach permitted semi-automated irrigation control. .
3. Mobile Application for Remote Control: Users could control and track irrigation systems remotely using a smartphone-based app. The answer comprised an Android app, a MySQL database, an Arduino-based system, and analog sensors. PHP scripting enabled communication between the Arduino and the database; the HTTP protocol handled data transfer. For irrigation systems, this software significantly enhanced control and monitoring capabilities.

4. Automated System with Web Integration: Drishti among others built a prototype in 2016 using the ATmega328 microcontroller. Among the key components were a moisture sensor and a water pump. When soil moisture levels fell below a defined threshold, the system supplied the required amount of water to plants. The microcontroller was programmed to water the plants twice day with a buzzer alerting users. Data was stored and sent to a web browser over Ethernet using Arduino IDE software. Water distribution across several irrigation methods, including drip and sprinkler systems, was also controlled by a wireless sensor network combined with DTMF (Dual Tone Multiple Frequency) signaling. This progress made to scalable agricultural technologies.

D. Proposed System:

The proposed system seeks to find soil water shortage by means of sensor data alone. This automated irrigation system's main benefits include its capacity to deliver water only when soil moisture levels drop below a defined level. Especially in crowded cities where space is limited, this approach has significant potential for use in rooftop gardens, therefore making rooftop gardening the most practical choice. Moreover, these technologies can efficiently control residential lawns, so lessening the need for human supervision. .

The automated irrigation system is designed to achieve the following objectives:

1. Water Conservation: By means of unplanned water use prevention, the system significantly lowers water waste. This not only enables farmers to reduce their water expenses but also supports global initiatives for water conservation.
2Effective Irrigation Management: The system operates irrigation activities only when soil moisture levels fall below the designated level. The system determines whether to activate or deactivate the pump. Farmers may now save time since they no longer have to run the pump manually. This efficiency allows them to focus on other important tasks, take well-deserved breaks, and eventually improve their production and overall quality of life.

II. PROBLEM STATEMENT

The primary goal of the "Automated Plant Irrigation System" project is to create a system that can automatically monitor soil moisture levels and regulate the operation of a water pump based on the detected moisture content. In modern agriculture, employing effective irrigation technologies plays a crucial role in optimizing crop cultivation. These systems are particularly beneficial as they reduce the need for manual labor while ensuring plants receive adequate irrigation.

The proposed model involves three key steps:

1. **Soil Moisture Measurement:** The initial step focuses on assessing the soil's moisture levels. This is accomplished through the use of specialized sensors designed to accurately monitor and determine the amount of moisture present in the soil.
2. **Evaluating Moisture Levels:** In this phase, the data collected from the sensors is analyzed to assess the soil's condition—whether it is dry or adequately moist. This evaluation helps the system determine if irrigation needs to be initiated.
3. **Pumping Motor Control:** The final phase involves managing the operation of the water pump based on moisture readings. If the sensors detect that the soil is dry, the pump is activated to supply water to the plants. On the other hand, if the soil moisture is adequate, the pump is switched off to avoid overwatering.

By utilizing this automated irrigation system, the reliance on manual effort is greatly diminished. The system ensures that plants receive the necessary amount of water to support their growth and maximize productivity.

III. RESEARCH AREA AND DISCUSSION

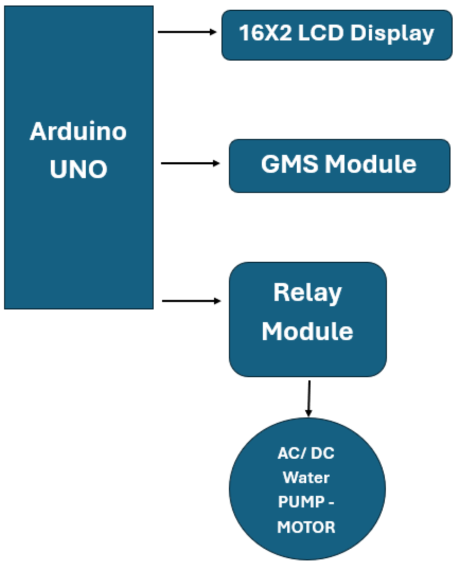
Sometimes farmers in agriculture find it difficult to use their fields with complicated, costly irrigation tools. Adopting simpler and more reasonably priced irrigation systems will help to improve their living conditions. The mentioned studies control water flow by looking at temperature, humidity, and soil moisture levels in particular sites among other factors. Relying only on these standards, however, could not give a complete picture of the general condition of the field.

Installing many sensors for continuous soil condition monitoring is advised to get around this limitation. Wireless sensor networks (WSNs) offer a fairly efficient answer for this purpose. Avoiding costly Wi-Fi technologies such as GSM and GPS will help the system remain affordable. Instead, cheap ZigBee-based gadgets are recommended. In remote farming areas, these innovative gadgets can operate on batteries. Including low-energy microcontrollers, sensors, and wireless modules will help to further boost battery efficiency. Battery-powered devices can conserve energy under challenging environmental conditions by staying in power-down mode when not actively in use.

Moreover, reducing the need for agricultural water and enhancing water management strategies depend on tackling climate change. By including modern technology solutions and taking environmental factors into account, farmers can optimize irrigation techniques, improve water efficiency, and adjust to evolving climate conditions. These projects enable farmers to improve their living conditions and promote sustainable agriculture.

IV. MATERIALS AND METHODS

1. **Arduino Uno:** The Arduino Uno features an ATmega328P microcontroller and comes with 14 digital input/output pins, six of which are capable of Pulse Width Modulation (PWM). Additionally, it includes six analog input pins for versatile functionality.
2. **Soil Moisture Sensor:** The term "soil moisture" can be interpreted differently depending on the field of expertise. For instance, farmers, water resource specialists, and meteorologists might each have their own distinct definitions of soil moisture, tailored to their specific needs and applications.
3. **Relay Module:** A relay is an electromechanical switch that operates using a low electrical current to control larger electrical devices. It enables the switching of high-voltage or high-current devices with minimal current input. For example, an Arduino cannot directly manage high voltages or currents, making a relay essential for such tasks.
4. **DC Motor:** A direct current (DC) motor is a device that transforms electrical energy into mechanical motion. It achieves this through the use of magnetic fields created by electrical currents, which propel the rotor connected to the motor's output shaft. The motor's design ensures that both its speed and torque are determined by the electrical input provided.
5. **Water Pump:** This project employs a 12-volt submersible pump powered by an 18-watt motor, capable of lifting water to a maximum height of 1.7 meters. To ensure optimal functionality, the pump must remain completely submerged in water during operation. Additionally, it is important to keep the bucket filled with water at all times, as running the pump without water can result in damage to the equipment.
6. **Resistor:** A resistor is an electrical component designed to restrict the flow of current within electronic circuits and electrical networks. It functions as a passive device, playing a crucial role in controlling current levels and ensuring circuit stability.
7. **Breadboard:** A breadboard is a versatile tool used for creating and testing prototype circuits temporarily. It serves as a surface-mounted device that simplifies circuit design experiments without requiring permanent connections.
8. **Jumper Wires:** Jumper wires are basic connectors fitted with pins at both ends, allowing two points in a circuit to be linked without requiring any soldering.
9. **Power Supply:** A power supply is an essential device that provides electrical energy to a load. Its main role is to transform electric current from the source into the specific voltage, current, and frequency needed to power the load effectively.



V. RESULT AND ADVANTAGE

A previous iteration of this system was developed as a semi-automated mechanism featuring a single pump that supplied water to plants when soil moisture levels fell below the required threshold. The system included an LCD display for output visualization and a buzzer to alert the user. Additionally, a GSM module was integrated for communication purposes. To enhance functionality and cost-efficiency, the updated model replaces the LCD display and buzzer with a GSM module and introduces a pair of pumps. Users now receive SMS alerts for every system action. The second pump has been added to automatically refill the storage tank from a reservoir when the water level in the tank reaches its minimum. This eliminates the need for users to manually check the water level and operate the pump at regular intervals

A. MASSAGES – STATE, ALARM, CONDITION

State Monitoring: The system continuously monitors the soil moisture levels using sensors. When the soil is dry, the Arduino triggers the water pump to start irrigation.

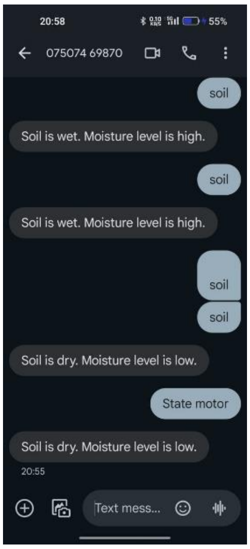


Figure 5.1 Screenshot of massages

B. GSM MODULE TESTING

The GSM module is responsible for enabling remote communication between the user and the irrigation system. GMS testing ensures that the module can send and receive SMS commands, handle missed calls, and provide status updates without errors.

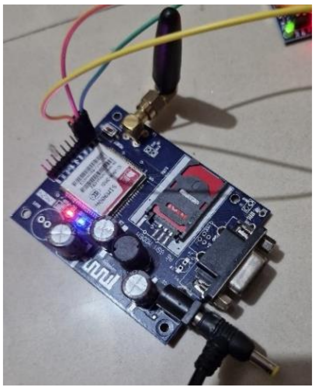


Figure 5.2 GMS Module testing

C. RELAY TESTING

Purpose: The relay module is responsible for turning the water pump on and off based on commands from the Arduino. Testing ensures that the relay responds correctly to signals and operates without faults.

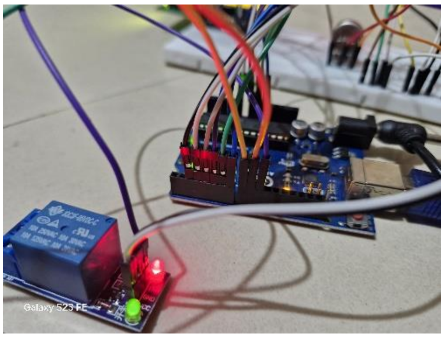


Figure 5.3 Relay Testing

D. SENSOR TESTING

The sensors detect soil moisture levels and send data to the Arduino, which decides whether to activate the water pump. Testing ensures the sensors provide accurate readings under various conditions.

Figure 5.4 Sensor Testing

E. LCD & ARDUINO UNO TESTING

Testing the LCD and Arduino Uno in a GSM-based water pump and irrigation control system is essential to ensure proper functionality and communication between components.

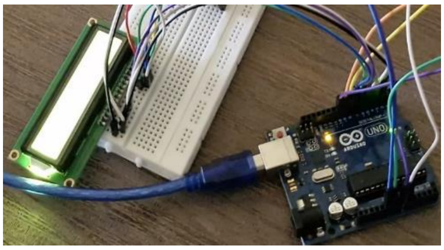


Figure 5.5 LCD & Arduino UNO Testing

F. Limitations

1. Despite efforts to minimize errors, the system has certain limitations that must be considered during operation:
2. The model relies on a power supply rather than a battery, meaning it must remain connected to power whenever available. In the absence of power, sensor data cannot be read.
3. Internet connectivity is required to monitor sensor values through the Thing Speak server. However, even without an internet connection, the system will continue to function.
4. If a sensor malfunctions, an alert message is sent, requiring the user to manually inspect and replace the damaged sensor.
5. The system is not fully automated and, in specific scenarios, still depends on human intervention.

G. Advantages of Drip Irrigation:

1. **Water Efficiency:** Drip irrigation delivers water directly to the root zone of plants, reducing wastage caused by evaporation or runoff. This precise application ensures plants receive adequate water without any excess.
2. **Weed Suppression:** By targeting the root zone only, drip irrigation limits surface moisture, making it harder for nearby weed seeds to germinate. This helps in reducing weed growth.
3. **Disease Prevention:** Supplying water at the roots avoids wetting the plant's leaves and flowers, thereby reducing the risk of leaf diseases and fungal infections such as blight.
4. **Resource Conservation:** Drip irrigation systems are designed to deliver water exactly where it is needed, leading to reduced water consumption compared to traditional methods.
5. **Labor Savings:** With less manual effort required for weeding and disease control, drip irrigation systems make garden or agricultural maintenance more efficient. Timers in these systems further reduce human intervention by automating watering schedules.
6. **Prevention of Disease and Weeds:** Unlike conventional watering methods that saturate the garden, drip irrigation targets individual root zones, preventing the germination of nearby weeds. It also minimizes diseases caused by water droplets on leaves.
7. **Time and Cost Efficiency:** Drip irrigation reduces time spent watering by hand and helps save on water costs. Automated timers ensure that irrigation occurs as scheduled without constant supervision.
8. **Soil and Nutrient Preservation:** Overwatering through traditional hoses can cause soil compaction and nutrient loss due to runoff. Drip irrigation, with its gentle and controlled water delivery, helps maintain soil structure and nutrient content, ensuring healthier plant growth.

V. Conclusion

1. The automatic water pump control system integrates various technologies in its design, development, and implementation.
2. Utilizing a microcontroller, the system automates the water pumping process for overhead tank storage and detects the water level within the tank. It operates the pump, accordingly, sends notifications to the owner via GSM, and displays the status using an LCD screen.
3. Manual operation is also possible, allowing the user to send and receive status updates through messages.
4. This project has improved existing water level controllers by incorporating a calibrated circuit to accurately indicate water levels.
5. Key advantages of this system include reduced power and water wastage, as well as enhanced longevity of the pump due to optimized equipment usage.
6. Looking ahead, the system can incorporate solar panels to supply power to the sensor circuit, ensuring water level monitoring even during power outages.

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