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IRRIGATION SYSTEM ON SENSING SOIL MOISTURE DC MOTOR CONTROL USING GSM

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ABSTRACT

Water scarcity has become a critical issue worldwide, primarily due to the rapid growth of the population and inefficient water usage in agriculture. One of the main causes of water waste in irrigation is waterlogging, which leads to the overuse of water. To address this problem, it is essential to adopt more efficient irrigation methods. This study proposes an autonomous irrigation system powered by an Arduino board and microcontroller, designed to optimize water usage based on soil moisture content. The system continuously monitors the moisture levels in the soil, and when the soil becomes dry, it activates a DC motor pump to supply water to the crop. Once the soil moisture reaches an adequate level, the system automatically shuts off the pump to prevent over-irrigation. By automating this process, the system ensures that crops receive the precise amount of water they need, minimizing waste and contributing to water conservation. This automated solution not only saves water but also enhances the efficiency of agricultural practices. The development and implementation of such automation technologies are transforming traditional methods, making them more efficient and sustainable. In today's fast-paced world, automated systems are increasingly replacing manual processes, offering greater precision and ease in managing essential resources.

Keywords: Autonomous Irrigation System, Arduino Board, Microcontroller, Soil Moisture Content, DC Motor Pump, Water Conservation, Automated Systems, Irrigation Optimization, Agricultural Automation, Water Waste Reduction, Precision Agriculture.

I.INTRODUCTION

Water scarcity is a growing global concern, particularly in agriculture, which accounts for a significant portion of water consumption. Traditional irrigation systems often lead to water wastage due to inefficient water distribution methods, such as waterlogging. This results in both environmental and economic losses, highlighting the need for more sustainable and efficient irrigation practices. With the advent of modern technology, there is a shift towards automating agricultural processes to optimize resource usage, and irrigation is no exception.

This project aims to develop an autonomous irrigation system that uses soil moisture sensors and an Arduino-based microcontroller to monitor the soil's moisture content and determine when irrigation is necessary. By automatically activating a DC motor pump when the soil becomes dry and turning it off when the soil reaches an adequate moisture level, the system ensures that crops receive only the amount of water required, thus preventing

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over-irrigation and water wastage. The system operates with minimal human intervention, offering convenience and accuracy in irrigation.

Incorporating automation technologies into agriculture not only enhances productivity but also contributes to sustainability by reducing the unnecessary use of water, especially in regions facing water scarcity. This project explores the potential of using sensor-based automation to optimize irrigation, improve crop yield, and reduce environmental impact. As water becomes an increasingly valuable resource, adopting efficient irrigation methods is crucial to ensuring sustainable agricultural practices for the future.

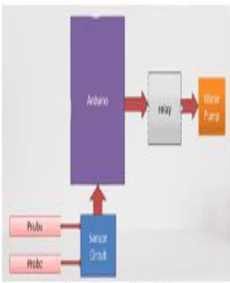

Fig 1:Automatic irrigation system based on soil moisture sensor using arduino uno

II.LITERATURE REVIEW

Irrigation plays a critical role in agriculture, particularly in regions where rainfall is insufficient or inconsistent. Traditional irrigation systems often lead to excessive water consumption and wastage due to improper timing, resulting in over-irrigation or under-irrigation. These inefficiencies have raised significant concerns about water conservation and sustainable farming practices. Consequently, there has been growing interest in developing systems that optimize water usage while ensuring adequate crop growth. A variety of technologies, including automation, sensors, and microcontroller-based systems, have been employed to address these challenges.

One of the most significant advancements in irrigation systems is the use of soil moisture sensors. According to Moghadam et al. (2017), soil moisture content directly correlates with the crop's water requirements. By monitoring the moisture levels in the soil, automated irrigation systems can be programmed to provide water only when necessary, avoiding the wastage associated with traditional systems. Moisture sensors measure the volumetric water content of the soil and trigger irrigation systems based on predefined thresholds. These systems have been shown to reduce water usage while improving crop yield and quality.

In the realm of automated irrigation systems, Arduino-based systems have become increasingly popular due to their affordability, simplicity, and flexibility. Patel et al. (2018) highlighted the effectiveness of using Arduino microcontrollers in precision irrigation systems, where the microcontroller receives inputs from moisture sensors and controls irrigation devices such as pumps. The Arduino platform’s versatility allows for easy integration of additional sensors, such as temperature and humidity sensors, to enhance the accuracy of the system and adapt to varying environmental conditions.

The use of DC motor pumps for water distribution is another common approach in automated irrigation systems. These pumps are controlled by the microcontroller, which activates or deactivates the pump based on the readings from the moisture sensors.

Chaudhary and Patel (2019) developed an automated irrigation system that used a DC motor to pump water when the soil moisture level fell below a set threshold. The motor was deactivated once the desired moisture level was achieved, ensuring that only the necessary amount of water was used.

Wireless communication in irrigation systems has also garnered attention, especially for remote monitoring and control. By incorporating GSM modules, irrigation systems can be monitored and adjusted remotely through mobile devices. Sharma et al. (2020) introduced a GSM-based irrigation system that allowed farmers to control the irrigation process from anywhere by sending SMS commands to the system. This remote control feature improves the system's accessibility, particularly in rural areas, where manual intervention may be limited.

Additionally, various studies have investigated the integration of solar power into irrigation systems to make them more sustainable. Singh et al. (2021) proposed a solar-powered irrigation system, where solar panels provided the energy necessary to run the sensors and pumps, making the system energy-efficient and cost-effective for farmers in remote locations with limited access to electricity.

In summary, the development of automated irrigation systems using microcontrollers, soil moisture sensors, and DC motor pumps is a promising solution for addressing water wastage and ensuring efficient water usage in agriculture. Recent advancements, such as wireless communication for remote control and the integration of solar power for sustainability, offer additional benefits. As water scarcity continues to be a significant concern, the adoption of these technologies could play a crucial role in promoting sustainable and efficient agricultural practices.

III.METHODOLOGY

The Autonomous Irrigation System is designed to optimize water usage for crops by using a combination of hardware and software components. The system uses **soil moisture sensors**, a **microcontroller**, and a **DC motor pump** to automate irrigation based on real-time soil moisture levels. Below is a detailed explanation of the methodology, including system components, design, sensor calibration, and system operation.

System Design and Components

The system is built around several key components that interact to monitor soil moisture and control the irrigation process:

1. **Arduino Microcontroller**: This acts as the central processing unit of the system, receiving data from the sensors and controlling the irrigation process based on predefined logic. The Arduino processes the sensor input and sends signals to control the DC motor pump and relay module.
2. **Soil Moisture Sensor**: The moisture sensor measures the water content in the soil and transmits the data to the Arduino. This sensor is critical for determining whether the soil is dry or wet and whether irrigation is necessary.
3. **DC Motor Pump**: The DC motor pump is used to supply water to the crops. The pump is activated when the soil moisture falls below a certain threshold, and it is

deactivated when the soil reaches the desired moisture level.

4. **Relay Module**: The relay module serves as the switch to control the operation of the DC motor pump. It acts as an intermediary between the Arduino and the motor, turning the pump on or off depending on the moisture sensor readings.

5. **GSM Module**: The GSM module allows for remote monitoring and control of the system via SMS. It sends alerts to the user when the system needs attention or when the soil moisture reaches a critical level, and it can also be used to trigger irrigation manually.

System Architecture

The system operates through a closed-loop architecture where the soil moisture sensor continually monitors the soil's moisture content. When the sensor detects that the soil moisture is below a predefined threshold (indicating that the soil is dry), the Arduino microcontroller triggers the relay to turn on the DC motor pump. Once the soil moisture reaches an optimal level, the Arduino will deactivate the relay, stopping the water flow. The GSM module can send alerts to the user, notifying them of the soil moisture status or allowing remote control of the system.

Sensor Calibration

To ensure the system works accurately, the **soil moisture sensor** must be properly calibrated. Calibration involves determining the appropriate moisture threshold values for the crops being irrigated. By testing the sensor at various moisture levels, a range is established that defines when the soil is considered "dry" or "wet." This calibration ensures that the system provides water only when needed, preventing over-irrigation and optimizing water usage.

System Operation

Once the system is set up and calibrated, it operates autonomously. The soil moisture sensor continuously checks the moisture level of the soil. If the moisture level is too low, the Arduino sends a signal to activate the DC motor pump, ensuring that water is supplied to the crops. When the moisture level reaches the required amount, the pump automatically turns off. Additionally, the GSM module can be configured to send notifications or allow for remote control of the system, providing the user with valuable information and control over the irrigation process.

Through this combination of hardware and software components, the Autonomous Irrigation System effectively automates the irrigation process, saving water, reducing waste, and ensuring that crops receive the proper amount of water for healthy growth.

IV.CONCLUSION

The proposed Autonomous Irrigation System provides a sustainable solution to address water scarcity and inefficient irrigation practices in agriculture. By utilizing an Arduino microcontroller, soil moisture sensors, and a DC motor pump, the system ensures that water is delivered to crops only when necessary, preventing water wastage. The integration of a GSM module for remote monitoring and control adds an extra layer of convenience, allowing users to track and adjust the irrigation system from anywhere. This system offers an efficient, cost-effective, and automated solution to traditional irrigation methods, which are often prone to over-irrigation and water wastage.

Furthermore, the project highlights the growing importance of automation technologies in modern agriculture, where precision in resource management is crucial for both environmental sustainability and improved crop yield. By automating the irrigation process, the system ensures optimal water usage, reduces human intervention, and contributes to more efficient farming practices. The successful implementation of this project demonstrates the potential for such automated systems to revolutionize agriculture, offering solutions that address the challenges of water scarcity and improving overall agricultural productivity.

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