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Irrigation System using GSM

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ABSTRACT:- Water scarcity and inefficient irrigation practices are significant challenges in modern agriculture, necessitating the development of smart, automated solutions to optimize water use. This project introduces an automated irrigation system using the Arduino Uno microcontroller, designed to monitor and manage irrigation efficiently based on real-time environmental and soil conditions. The system incorporates a soil moisture sensor to measure soil water content, a DHT11 sensor to monitor temperature and humidity, and a relay- controlled water pump to automate water distribution. A 16x2 LCD display provides users with real-time feedback on system operations, including soil moisture levels and environmental conditions. The Arduino Uno acts as the core controller, processing data from the sensors and activating the water pump when soil moisture falls below a predefined threshold. This automation reduces water wastage, minimizes manual intervention, and ensures optimal soil conditions for plant growth. The system is cost-effective, energy- efficient, and easy to implement, making it suitable for home gardens, small-scale farms, and urban agriculture. This project demonstrates how accessible technology can address critical agricultural challenges, supporting water conservation, sustainable farming practices, and improved crop yields. Future enhancements could include IoT connectivity for remote monitoring and control, further expanding the system's functionality and scalability.

KEYWORDS:- Smart Irrigation, Arduino Uno, GSM Module, Soil Moisture Sensor, DHT11 Sensor, Automated Farming, Sustainable Agriculture

I. INTRODUCTION

Agriculture plays a pivotal role in the global economy and food production, but it is increasingly threatened by water scarcity, climate change, and inefficient resource utilization. Traditional irrigation systems are often manual and operate on fixed schedules, regardless of soil conditions, leading to overwatering or underwatering. These inefficiencies contribute to water waste, increased labor, and reduced agricultural productivity.

With the advent of embedded systems and the Internet of Things (IoT), agriculture is gradually transitioning towards smarter, automated solutions. Automation not only reduces human involvement but also enhances precision in farming operations. Microcontrollers such as the Arduino Uno offer a low-cost, programmable platform that can integrate with various sensors and actuators to monitor and manage irrigation activities.

This paper introduces a smart irrigation system utilizing Arduino Uno and a GSM module, which automates irrigation based on real-time soil moisture, temperature, and humidity data. The system includes a relay-driven water pump, a 16x2 LCD for status display, and soil/environmental sensors. Although the current implementation doesn't feature GSM functionality, it remains an integral part of future enhancement plans for remote alerting and control. The system is scalable, affordable, and energy-efficient, making it highly suitable for small-scale farms, urban gardens, and sustainable agricultural initiatives.

II. RELATED WORK

Recent research has explored a variety of technological solutions to optimize irrigation practices. Several studies have focused on using microcontroller-based systems for automation in agriculture.



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Rahman et al. (2020) proposed an Arduino-based irrigation model that activates a pump when soil moisture falls below a defined threshold. Their results showed significant water conservation and improved plant growth. Kumar et al. (2018) implemented a similar system but emphasized the importance of integrating environmental parameters such as temperature and humidity using sensors like DHT11.

Other researchers have worked on combining wireless communication with automation. Singh et al. (2021) explored the integration of GSM and Wi-Fi modules to notify farmers about irrigation events and system status via SMS. Although effective, such systems often face challenges related to power availability and network connectivity in rural areas.

Sharma et al. (2017) demonstrated the utility of LCD displays in agricultural automation, which improved the system's interactivity and usability by providing real-time feedback. These studies collectively highlight the feasibility and advantages of smart irrigation systems while also underscoring the importance of sensor accuracy, energy efficiency, and user-friendly interfaces.

III. LITERATURE SURVEY

Arduino-Based Irrigation Control: Patel et al. (2019)

outlined how Arduino microcontrollers can be programmed to receive soil moisture data and activate a water pump. They emphasized the platform's affordability and adaptability to various sensor types.

Soil Moisture Sensors:

Effective soil moisture detection is critical. Sensors used in these systems are capable of providing analog or digital output based on the water content in the soil. This ensures precise watering, which prevents root damage and reduces water waste.

Environmental Monitoring:

Integrating sensors such as the DHT11 allows the system to factor in temperature and humidity, improving irrigation decisions. Research suggests that this enhances the system's adaptability to different weather conditions.

Relay-Controlled Automation:

Relay modules are commonly used to interface low-power controllers with high-power devices like water pumps. Their electrical isolation properties enhance safety and reliability.

User Interface Components:

LCD displays help users monitor system parameters such as soil moisture level, temperature, and pump status in real-time. This improves transparency and manual override capabilities.

Limitations and Improvements:

While many systems achieve automation, they often lack wireless connectivity for remote monitoring. Integrating GSM or IoT platforms is a frequently recommended future direction.

Aim

“To develop a cost-effective, automated irrigation system using Arduino and GSM technology that enhances water management in agriculture”.

Problem Statement

Traditional irrigation systems often waste water and require constant human supervision. There is a need for an automated solution that ensures efficient irrigation based on real-time soil and weather conditions.

Objectives

- 1 To monitor soil moisture, temperature, and humidity using sensors.
- 2 To automate water pumping based on soil moisture data.
- 3 To enable real-time user notifications using GSM.



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4 To reduce water wastage and improve crop health.

IV. PROPOSED METHODOLOGY

1. Sensing Layer

This layer includes the input devices responsible for gathering environmental data:

1.1 Soil Moisture Sensor:

Continuously measures the volumetric water content in the soil. It provides analog or digital signals based on moisture level. When the moisture falls below a pre-set threshold, it triggers the irrigation process.

1.2 DHT11 Sensor:

Captures ambient temperature and humidity. This data, although not used directly in irrigation decisions in the current implementation, is displayed on the LCD and can influence irrigation logic in future upgrades.

These sensors form the foundation for real-time monitoring and ensure that water is only supplied when necessary.

2. Processing Layer

The core of the system is an Arduino Uno microcontroller (ATmega328), which serves as the brain of the entire operation. It performs the following tasks:

2.1 Reads data from soil and temperature/humidity sensors.

2.2 Compares soil moisture level with a defined threshold.

2.3 Makes a decision whether to activate or deactivate the irrigation pump.

2.4 Sends real-time sensor values to the display unit.

2.5 (Future capability) Sends a signal to the GSM module for remote alerts.

The microcontroller is programmed using Arduino IDE, which supports C/C++-like syntax and is ideal for real-time embedded control applications.

3. Actuation Layer

This layer carries out the physical task of watering:

3.1 Relay Module: Acts as a switch controlled by the Arduino. It connects or disconnects power to the water pump based on commands received from the processing unit.

3.2 Water Pump: A standard 12V or 220V AC/DC pump that irrigates the field or plants when activated. The pump is connected to the common (COM) and normally open (NO) contacts of the relay.

The relay ensures safe isolation between the low-voltage microcontroller and high-power irrigation equipment.

4. Display and Feedback Layer

4.1 LCD 16x2 Module: Displays current sensor readings (soil moisture, temperature, humidity) and pump status (ON/OFF). This helps the user monitor the system locally and verify correct operation.

4.2 User Interaction (Optional): A push-button reset or override switch can be added to allow manual control of the system.

5. Communication Layer (Optional / Future Scope)

Although not implemented in the current version, the system is designed for expansion to support a **GSM Module** (e.g., SIM800L or SIM900) for sending SMS alerts or receiving remote commands. This enables the user to monitor and control the system from a remote location via mobile networks. Example use cases include:

5.1 Receiving alerts when soil moisture is critically low or high.

5.2 Sending SMS commands to force-start or stop irrigation remotely.

This layer greatly enhances scalability and aligns with the vision of **IoT-enabled smart farming**.

6. Power Supply and Regulation

6.1 LM2596 Buck Converter: Used to regulate the voltage to 5V DC from a higher-voltage battery or adapter input (e.g., 12V). This ensures that the Arduino and sensors receive a stable and safe power supply.

6.2 In the case of field deployment, the system may be powered by a rechargeable battery or small solar panel system for energy efficiency and autonomy.



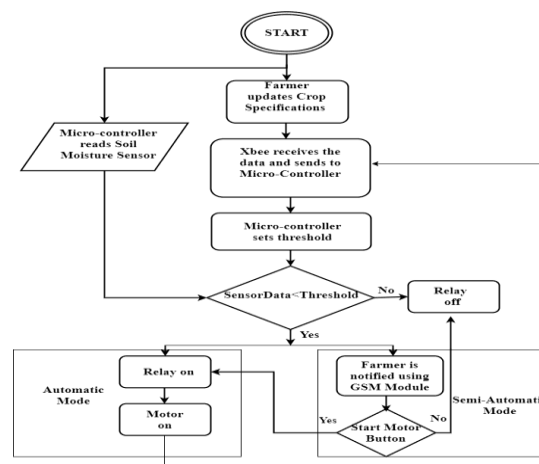
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7. Workflow Overview

- 7.1 Sensors collect real-time soil moisture, temperature, and humidity data.
- 7.2 Arduino processes the data and decides whether to activate the pump.
- 7.3 If moisture < threshold → Relay is activated → Pump irrigates the soil.
- 7.4 LCD displays all live readings and system status.
- 7.5 (Optional) GSM sends SMS to the user with current readings or status updates.

Flow chart



V. RESEARCH WORK

The research focuses on the development of a smart, automated irrigation system using Arduino Uno and basic sensors to optimize water usage in agriculture. It investigates the feasibility of using soil moisture and environmental data for precise irrigation control. The study also explores integration possibilities with GSM technology for remote monitoring, highlighting the benefits of automation in reducing manual labor, conserving water, and improving crop yield. Literature was surveyed from sources like IEEE Xplore, SpringerLink, and agricultural case studies to identify effective sensor-control models and cost-efficient implementation strategies.

Functional Requirement

1. Sensor Monitoring

- 1.1: The system shall monitor soil moisture levels using a soil moisture sensor.
- 1.2: The system shall measure ambient temperature and humidity using a DHT11 sensor.
- 1.3: The sensor readings shall be updated in real-time (within 1-second intervals) to ensure responsive control.

2. Irrigation Control

- 2.1: The system shall activate the water pump automatically when the soil moisture level falls below a predefined threshold.
- 2.2: The water pump shall be controlled using a relay module to ensure safe switching.
- 2.3: The pump shall remain ON until the moisture level reaches the acceptable threshold again.

3. Display and Feedback

- 3.1: The system shall display soil moisture, temperature, and humidity values on a 16x2 LCD screen.
- 3.2: The display shall also indicate pump status (e.g., "PUMP ON" or "PUMP OFF").
- 3.3: All displayed values shall refresh every 1–2 seconds for real-time feedback.

4. Manual and Automatic Operation

- 4.1: The system shall operate autonomously without user intervention under normal conditions.
- 4.2: A manual override switch may be included to reset or disable the system in case of abnormal operation.



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5. Power Management

5.1: The system shall operate on a stable 5V DC supply, regulated using an LM2596 buck converter.

5.2: The system shall consume less than 100 mA during idle states, ensuring energy efficiency.

5.3: A battery backup or solar panel input may be considered in future versions to improve deployment in remote areas.

6. Communication (Planned / Optional)

6.1 (Future Scope): The system shall be capable of sending SMS alerts to the user via a GSM module in future upgrades.

6.2 (Future Scope): The GSM module shall notify users when:

- Soil is too dry.
- Irrigation is initiated or completed.
- Sensor readings cross critical limits.

SYSTEM DESIGN

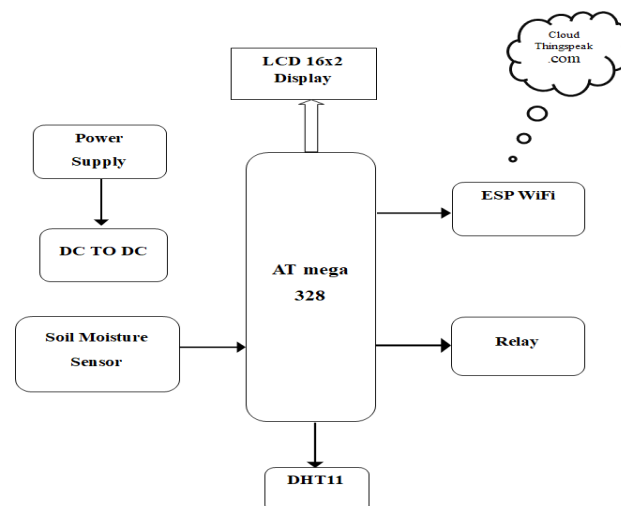


Figure1.2: Block Diagram

Components Description

1.Arduino Uno (ATmega328P Microcontroller):



Fig 1.3 Microcontroller AT Mega 328



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The Arduino Uno acts as the brain of the system. It is an open-source microcontroller board based on the ATmega328P. It reads data from sensors and makes real-time decisions to control irrigation.

- **Operating Voltage:** 5V
- **Digital I/O Pins:** 14 (6 can be used as PWM outputs)
- **Analog Input Pins:** 6
- **Clock Speed:** 16 MHz
- **Programming Interface:** USB
- **Function:** Processes sensor data, executes control logic, controls the relay and pump

The Arduino is ideal for embedded systems projects due to its simplicity and compatibility with a wide range of sensors and modules.

2.LM2596 Buck Converter (Voltage Regulator)

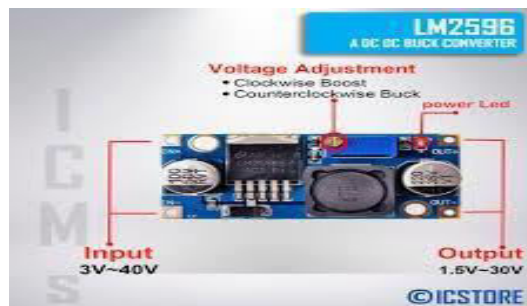


Fig 1.4 Regulator (LM2596)

This component steps down a higher voltage (like 12V from a battery) to a stable 5V for Arduino and other components.

- **Input Voltage:** 4.5V to 40V DC
- **Output Voltage:** Adjustable from 1.25V to 35V
- **Max Output Current:** 2–3A
- **Efficiency:** Up to 92%
- **Function:** Protects sensitive components by providing a constant 5V output

It ensures the system is energy-efficient and protected from voltage fluctuations.

3.LCD Display (16x2)

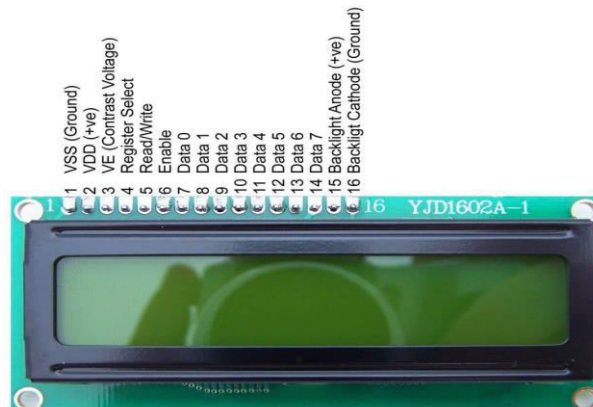


Fig.1.5 LCD 16*2



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The LCD (Liquid Crystal Display) module provides user-friendly interaction by displaying system parameters.

- **Display Capacity:** 2 lines of 16 characters each
- **Interface:** Parallel, using RS, RW, and Enable pins
- **Backlight:** Adjustable brightness
- **Function:** Shows real-time values of soil moisture, temperature, humidity, and pump status

It improves usability and allows local monitoring without needing a PC or mobile app.

4. DHT11 Temperature and Humidity Sensor

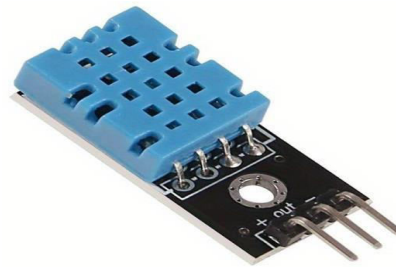


Fig.1.6 DHT11

The DHT11 sensor measures environmental conditions like temperature and humidity to give a broader context to soil readings.

- **Operating Voltage:** 3.3V to 5V
- **Temperature Range:** 0°C to 50°C ($\pm 2^\circ\text{C}$ accuracy)
- **Humidity Range:** 20% to 90% RH ($\pm 5\%$ accuracy)
- **Output:** Digital single-wire data signal
- **Function:** Provides real-time environmental data; useful for future adaptive irrigation logic

The sensor ensures that the system can adapt better to varying climatic conditions.

5. Relay Module



Fig.1.7.Relay

The relay acts as a switch to control the high-voltage water pump based on low-voltage signals from the Arduino.

- **Operating Voltage:** 5V
- **Contacts:** COM (Common), NO (Normally Open), NC (Normally Closed)
- **Load Rating:** 10A at 250V AC / 10A at 30V DC
- **Function:** Turns the water pump ON or OFF based on soil moisture readings

It ensures electrical isolation and safety between the low-power microcontroller and high-power pump.



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VI. CONCLUSION

The system provides an efficient, automated irrigation solution that saves water, reduces manual labor, and supports sustainable farming. Its low-cost and modular design make it ideal for small-scale agriculture. Future developments may include GSM/IoT integration for remote monitoring and cloud-based analytics.

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