IOT Based Smart Irrigation System Using Arduino

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Abstracts: Agriculture is a crucial part of many national economies, but traditional irrigation techniques often fall short in terms of water efficiency and control. To address these limitations, this project presents an IoT-driven smart irrigation system. The system utilizes a network of sensors and actuators to continuously monitor factors like soil moisture, temperature, humidity, and weather conditions. This data is analyzed by a central control unit, which applies algorithms to determine the most efficient irrigation schedules and water usage. Designed to be both energy-efficient and cost-effective, the system operates using a standard power source. This smart irrigation system offers several advantages over conventional methods, including reducing water wastage and conserving resources, which ultimately leads to increased crop yields and cost savings. The system is also user-friendly, simple to install, and easy to maintain, with customization options for various crops and soil types. Furthermore, its scalability allows it to be extended to larger areas or multiple fields. In summary, this IoT-based irrigation solution represents a significant advancement over traditional systems, providing modern agriculture with a sustainable, efficient, and flexible tool. Its energy efficiency, scalability, and adaptability make it an ideal option for farmers seeking to improve their irrigation practices through innovative technology.

Keywords: Internet of Things, Sensor, Irrigation, Agriculture, humidity, Actuators.

1. INTRODUCTION

Plants play a crucial role in our environment, enhancing its beauty and providing the oxygen essential for human life. However, keeping them healthy requires consistent care, including adequate water, sunlight, and nutrients. While many plants are generally low-maintenance, caring for them becomes challenging during extended absences.

Unattended plants can suffer from dryness, wilting, or diseases due to inadequate watering. To address this issue, we propose an automatic irrigation system that autonomously waters plants, ensuring their health even when we’re not around.

As urbanization advances, traditional gardening spaces are becoming more limited, prompting many people to adopt indoor plants. These plants not only add aesthetic appeal but also improve air quality and create a relaxing environment. However, for those with busy schedules or frequent travel, maintaining indoor plants can be difficult. The proposed automatic irrigation system offers a practical solution, facilitating healthy plant growth with minimal oversight.

This paper aims to develop an Arduino-based automatic irrigation system using a moisture sensor to maintain optimal soil moisture levels. Suitable for both indoor and outdoor plants, the system employs an Arduino Uno microcontroller to monitor soil moisture and activate irrigation when levels fall below a set threshold. The design emphasizes cost-effectiveness, energy efficiency, and ease of maintenance.

In essence, this system provides an efficient and convenient solution for plant enthusiasts and water-conscious individuals, ensuring their plants remain healthy in their absence.

Motivation

This project is inspired by agricultural regions facing water scarcity and inconsistent rainfall, where farmers rely heavily on irrigation from borewells. Manual operation of water pumps is often required, leading to inefficiencies.

Objective

The primary aim is to automate irrigation by detecting soil dryness through sensors. The system monitors soil moisture levels and delivers water only when necessary, reducing the need for manual labor and enhancing the irrigation process.

Benefits of the Automated Irrigation System

- **Water Conservation**: The system minimizes water waste by preventing unnecessary usage.

- **Time Efficiency**: Automated irrigation activates only when moisture levels are low, saving time previously spent on manual irrigation.

- **Farmer Welfare**: Reduces manual labor by automating water pump operation, allowing farmers more time for other tasks and rest.

Overall, this automated irrigation system enhances plant care for both home gardeners and farmers, promoting water efficiency and healthier crops.

LITERATURE SURVEY

Automated irrigation systems have increasingly gained prominence due to the growing emphasis on water conservation and the need for more efficient irrigation methods. Numerous studies have explored various approaches to developing such systems for diverse applications.

For instance, Dang et al. (2020) introduced an automatic irrigation system leveraging a wireless sensor network (WSN) and a decision-making algorithm based on fuzzy logic principles. Their system aimed to minimize water consumption while ensuring optimal soil moisture for crop growth. Fuzzy logic was employed to create an algorithm that determined the amount of water required based on soil moisture levels and environmental conditions. The WSN-based architecture enabled real-time monitoring of soil moisture, facilitating precise irrigation control.

In another study, Sandoval-Solis et al. (2018) presented an IoT-based irrigation system that utilized a low-cost microcontroller and a moisture sensor for irrigation control. Their system optimized water usage by collecting real-time data on soil moisture and weather conditions, enabling accurate irrigation management. They also developed a user-friendly web-based interface for monitoring system performance and remote irrigation control.

Additionally, Priyanka and Jain (2017) developed an automatic irrigation system using an Arduino microcontroller and a moisture sensor. This system was intended for small-scale irrigation, offering a cost-effective solution for farmers to reduce labor costs and enhance crop yields. The system utilized a moisture sensor to monitor soil moisture and activate irrigation when levels fell below a set threshold. A mobile application was also created to allow users to monitor and control the system remotely.

Overall, the literature indicates that automated irrigation systems provide an effective solution for efficient water management and crop irrigation. The system proposed in this project, which incorporates an Arduino Uno microcontroller, a moisture sensor, and a rain sensor, aligns with these findings. It offers a cost-effective and practical approach to plant care, with the flexibility to be customized for different plant species and environmental conditions.

EXISTING SYSTEM

Currently, there are several commercially available automated irrigation systems that use various technologies and sensors to control irrigation. Most of these systems use a timer- based approach, which waters the plants at regular intervals, regardless of the soil moisture levels. This approach can lead to over-watering and waste of water resources.

Some existing systems use soil moisture sensorsto determine the soil moisture levels and triggerirrigation when the levels fall below a certainthreshold. However, these systems can beexpensive and complex to install and maintain. Another technology used in automated irrigation systems is the use of weather data to optimize irrigation. This technology uses weather forecasts and historical data to predict the water requirements of plants and adjust irrigation accordingly. However, this technology requires sophisticated sensors and weather forecastingmodels, making it costly and complex toimplement.

In our project, we are proposing an automated irrigation system that uses a rain sensor and a moisture sensor to control irrigation. The rain sensor is used to detect the presence of rain and suspend irrigation to prevent over-watering, while the moisture sensor is used to determine the soil moisture levels and trigger irrigationwhen the levels fall below a certain threshold. Our system offers a low-cost and practical solution that can be easily installed and maintained by homeowners and small-scale farmers.

Existing automated irrigation systems often use soil moisture sensors to activate irrigation when moisture levels drop below a set threshold. Although effective, these systems can be expensive and complex to set up and maintain. Another method involves using weather data to optimize irrigation, relying on forecasts and historical data to estimate water needs and adjust irrigation. This approach, however, can be costly and complex due to the advanced sensors and sophisticated forecasting models required.

In contrast, our project introduces an automated irrigation system that combines both a rain sensor and a moisture sensor. The rain sensor detects precipitation and pauses irrigation to avoid over-watering, while the moisture sensor monitors soil moisture and triggers irrigation when levels fall below a specified threshold. This solution provides a cost-effective and practical option, designed for straightforward installation and maintenance, making it ideal for homeowners and small-scale farmers.

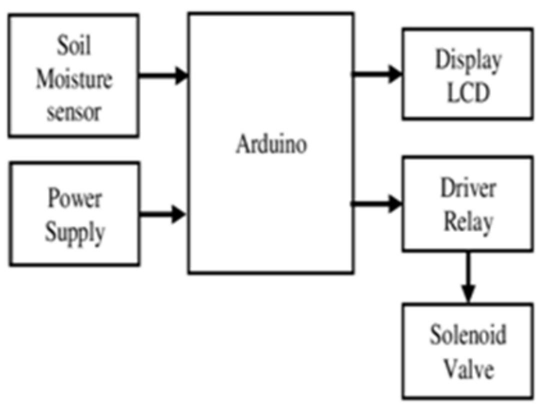

Fig. 1: Block Diagram of Existing System COMPONENTS USED

- **Arduino**
- **Relay**
- **Motor**
- **Soil moisture sensor**
- **Lcd**

PROPOSED SYSTEM

Agriculture is a cornerstone of many economies, but conventional irrigation systems often struggle with water inefficiency and inadequate control. This project addresses these issues by proposing an IoT-based smart irrigation system designed to improve water management and efficiency.

The proposed system leverages a combination of sensors, microcontrollers, and cloud technologies to deliver a sophisticated and efficient irrigation solution. It continuously monitors soil moisture, detects rainfall, and manages the irrigation process.

A standout feature of this system is the rain sensor, which prevents over-watering and minimizes water waste. When rain is detected, the sensor sends a signal to the microcontroller to stop the water pump, ensuring irrigation is only used when needed and promoting more efficient water usage.

The system also supports remote monitoring through the Arduino IoT cloud platform. Sensor data, including soil moisture levels, temperature, humidity, and rainfall, is uploaded to the cloud, allowing farmers to access real-time information via mobile devices. This functionality enables informed decision-making for irrigation and crop management.

In summary, this IoT-based automatic irrigation system overcomes the limitations of traditional methods by offering advanced water management features and remote monitoring capabilities. This innovative solution helps farmers optimize irrigation, reduce water waste, and improve crop yields.

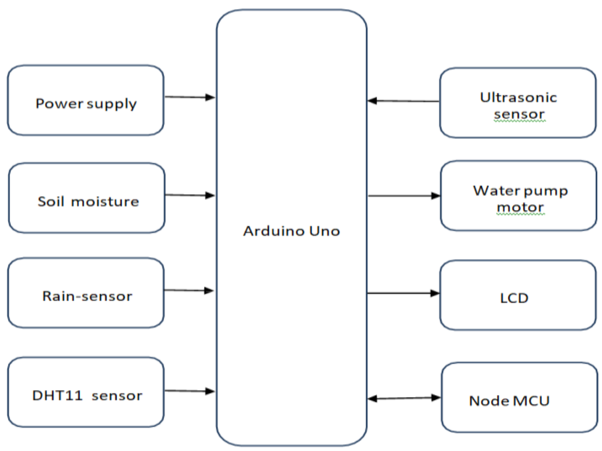

Fig. 2: Block Diagram of Proposed System

The proposed IoT-based automatic irrigation system integrates a range of advanced technologies to offer a sophisticated and efficient solution for managing plant care. Here's a detailed look at how the system operates:

a) Sensor Data Collection

- **Soil Moisture Sensor:** This sensor plays a crucial role in determining the moisture content of the soil. It continuously measures the soil's moisture level and transmits this data to the Arduino Uno board. This information helps to assess whether the soil is adequately hydrated or if it requires additional water.

- **Rain Sensor:** The rain sensor detects the presence of rainfall in real-time. When it detects rain, it sends a signal to the Arduino Uno board, indicating that irrigation may not be necessary at that moment. This feature prevents unnecessary watering and conserves water by taking current weather conditions into account.

- **Ultrasonic Sensor:** This sensor is designed to detect the presence of animals within the garden or field. By emitting ultrasonic waves, it can sense when animals approach and potentially threaten the plants. This helps in taking proactive measures to protect the plants from animal-induced damage.

b) Data Processing and Irrigation Control

- **Arduino Uno Board:** The heart of the system is the Arduino Uno board, which processes the data received from all the sensors. It uses this data to make decisions about irrigation and system operations.

- **Irrigation Decision**

  - If the soil moisture level falls below a predefined threshold and the rain sensor does not detect any rain, the Arduino Uno board will trigger a relay to activate the water pump. This ensures that the plants receive the necessary water to maintain optimal soil moisture.

  - The water pump will continue to operate until the soil moisture reaches the desired level. Once this threshold is achieved, the Arduino Uno board will deactivate the relay, stopping the water pump and preventing overwatering.

- **Rain Detection:** If rain is detected by the rain sensor, the Arduino Uno board will automatically turn off the water pump. This prevents the system from applying unnecessary water, thus avoiding waste and ensuring that the plants are only watered when required.

c) Animal Detection and Protection

- **Animal Detection:** The ultrasonic sensor continuously monitors the vicinity of the garden for animals. When an animal is detected, the system activates a buzzer to scare them away. This deterrent helps protect the plants from potential damage caused by wildlife, ensuring their health and safety.

d) Data Display and Remote Monitoring

- **LCD Screen:** The system includes an LCD screen that displays real-time data including soil moisture levels, temperature, and humidity. This visual display allows farmers and gardeners to monitor the current conditions and assess the performance of the irrigation system at a glance.

- **NodeMCU Module:** The NodeMCU module connects the irrigation system to the internet via Wi-Fi. It facilitates the uploading of sensor data to a cloud database, making it accessible for remote monitoring and management.

- **Cloud Platform:** The cloud platform provides a user-friendly interface that allows farmers to view real-time data on their mobile devices or computers. This feature enables users to make informed decisions about irrigation and plant care based on up-to-date information.

e) Overall System Benefits:

- **Automated Irrigation:** The system automates the irrigation process, reducing the need for manual intervention. By using real-time data from soil moisture and weather conditions, it ensures efficient water usage tailored to the plants' needs.

- **Animal Protection:** By detecting and deterring animals, the system helps safeguard plants from potential harm, enhancing their growth and overall health.

- **Remote Monitoring:** The integration of remote monitoring via the cloud platform allows for comprehensive oversight of the irrigation system. This feature supports better resource management and helps optimize water usage, contributing to healthier plants and reduced water wastage.

Overall, this integrated approach combines automation, real-time monitoring, and advanced technology to create a highly efficient and user-friendly irrigation system. It enhances water management, protects plant health, and supports optimal plant growth through smart and adaptive irrigation practices.

RESULTS

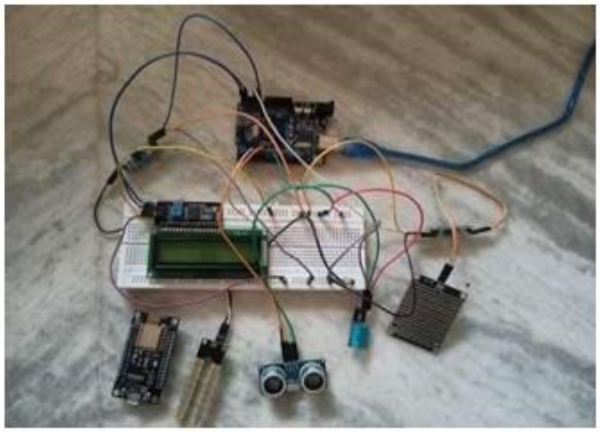

Fig.3: Hardware Implementation with allSensor

Fig.4: Hardware Implementation with soilsensor in sand

Fig.5: Hardware Implementation withcomplete assembly

ARDUINO IOT CLOUD OUTPUT

Fig.6: Temperature and Humidity readings.

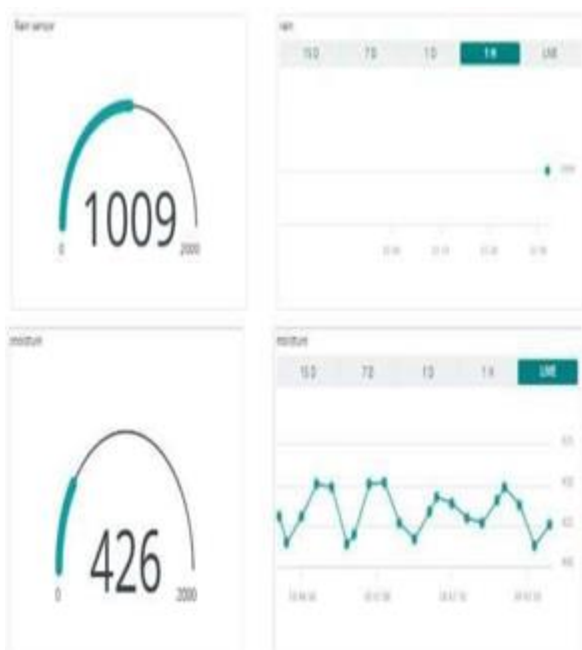

Fig.7: Moisture sensor and rain sensor reading.

ARDUINO IDE OUTPUT

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---------------------------------------------------------
             AUTOMATIC IRRIGATION USING IOT
Distance: 219.06 cm
Humidity: 51.00%
Temperature: 32.80C
Moisture Level : 1016
rain sensor value :: 1015
MOTOR ONN
=========================================================
             AUTOMATIC IRRIGATION USING IOT
Distance: 0.00 cm
Humidity: 51.00%
Temperature: 32.80C
Moisture Level : 1016
rain sensor value :: 1015
MOTOR ONN
=========================================================
             AUTOMATIC IRRIGATION USING IOT
Distance: 46.23 cm
Humidity: 51.00%
Temperature: 32.80C
Moisture Level : 1015
rain sensor value :: 295
MOTOR OFF
=========================================================
             AUTOMATIC IRRIGATION USING IOT
Distance: 222.57 cm
Humidity: 51.00%
Temperature: 32.80C
Moisture Level : 1023
rain sensor value :: 325
MOTOR OFF
=========================================================
             AUTOMATIC IRRIGATION USING IOT
Distance: 29.88 cm
Humidity: 51.00%
Temperature: 32.80C
Moisture Level : 1023
rain sensor value :: 337
MOTOR OFF
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Fig.8: Arduino IDE output

CONCLUSION

The proposed IoT-based smart irrigation system is effectively described as an innovative solution to modernize traditional agricultural practices. The integration of sensors, microcontrollers, and cloud technologies highlights the system’s ability to optimize water usage by monitoring key factors such as soil moisture, temperature, humidity, and rainfall. This empowers farmers to make data-driven decisions, significantly enhancing crop management. The remote accessibility of sensor data through a cloud platform is a standout feature, allowing farmers to adjust settings in real-time. Additionally, the incorporation of rain sensors to prevent over-watering and ultrasonic sensors to protect plants from animals showcases the thoughtfulness of your design in preventing resource waste and enhancing crop protection. This system’s emphasis on efficiency and sustainability demonstrates how technology can be leveraged to solve real-world agricultural challenges, ultimately fostering a more sustainable and productive farming ecosystem.

FUTURE SCOPE

The proposed IoT-based smart irrigation system outline an exciting roadmap for innovation and sustainability. Each point provides valuable insight into potential improvements:

1. **Integration with other IoT systems**: Expanding the system by connecting it with weather stations, crop monitoring systems, and precision farming tools could create a holistic smart farming solution. This integration would allow for a more data-driven and synergistic approach to farming.

2. **Use of AI and Machine Learning**: Incorporating AI and machine learning could revolutionize irrigation by making the system adaptive, learning from environmental data, and making precise decisions

that optimize water usage. This would enhance the system's ability to react dynamically to changing field conditions.

3. **Wireless Sensor Networks**: Implementing wireless sensor networks would simplify installation by removing the need for extensive wiring. This flexibility would make the system more adaptable to different field layouts, improving coverage and scalability.

4. **Use of Solar Power**: Integrating solar energy would not only reduce energy consumption but also promote sustainability by utilizing renewable resources. This makes the system more self-sufficient and eco-friendly.

5. **Use of Drones and Robotics**: Automating irrigation with drones and robots could further enhance efficiency, allowing for more precise water application. Drones could provide aerial monitoring, while robots could automate physical tasks, making farming more efficient and less labor-intensive.

In overall, the proposed system highlights the significant potential for the smart irrigation system to evolve into a cutting-edge solution for modern agriculture. With continued research and development, the system could further address global challenges related to food security and environmental conservation.

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