IoT Based Smart former Agriculture Monitoring and controlling System

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***Abstract*—**The efficient water management has become a major concern in agriculture due to increasing water scarcity and the need for sustainable farming practices. Traditional irrigation methods often depend onmmanual operation or fixed scheduling, which can lead to either overwatering or insufficient watering of crops. To address these limitations, this project proposes an Automated Plant Irrigation and Soil MonistureMonitroing System using IoT technology.The integration of IoT enables real time monitoring and remote access to system data through cloud platforms or mobile applications. Users can track environmental conditions and control irrifation from anywhere, enhancing convenience and decision making capabilities. Similar IoT based systems have demonstrated improved irrigation efficiency and reduced human intervention in agriculture [3][6].

Introduction

Argicultrue plays a crucial role in sustaining human life, and efficient water management is one of its most important challenges. With the growing global population and increasing pressure on water resources, traditional irrigation practices are no longer sufficient. Conventional methods, which rely on manual control or fixed irrigation schedules, often result in overwatering of crops this not only leads to wastage of water but also negatively affects plant growth and crop productivity.

In recent years, advancements in embedded systems and the Internet of Things (IoT) have opened new possibilities for smart agriculture. These technologies enable real-time monitoring of environmental conditions and allow automated decision-making based on sensor data. Among various environmental parameters, soil moisture is considered the most critical factor in determining irrigation requirements, followed by temperature and humidity [2]. By continuously monitoring these parameters, it becomes possible to provide water to plants only when necessary, thereby improving efficiency and sustainability.

Several research studies have explored IoT-based irrigation systems that integrate sensors, microcontrollers, and wireless communication technologies. These systems have demonstrated significant improvements in water conservation and crop yield by reducing human intervention and enabling precise irrigation control [1][3]. Additionally, cloud-based solutions allow users to monitor field conditions remotely and make informed decisions using real-time data analytics [3].

This project presents an Automated Plant Irrigation and Soil Moisture Monitoring System using IoT, designed to address the limitations of traditional irrigation methods. The system uses soil moisture sensors and environmental sensors to collect real-time data, which is processed by a microcontroller to control a water pump automatically. Furthermore, IoT connectivity enables remote monitoring and control, making the system more efficient and user-friendly. Similar approaches have proven effective in enhancing agricultural productivity while minimizing water wastage [5][6].

Doi:10.48047/ijiee.2026.16.2.6

The proposed system is cost effective, scalable, and suitable for a wide range of applications, including home gardening, greenhouses, and large scale farming practices [7].

I. LITERATURE SURVEY

Thedevelopment of smart irrigation systems has gained significant attention in recent years due to the increasing demand for efficient water management in agriculture. Various researchers have proposed IoT based solutions that integrate sensors, microcontrollers, and communication technologies to automate irrigation and improve crop productivity.

Guruprasad Deshpande et al. (2022) [1] proposed a low-cost IoT-based system for monitoring soil moisture and temperature using sensors integrated with a processing unit. The system provides real-time data visualization through a mobile application and demonstrates high accuracy when compared to conventional measurement methods. Their work highlights the importance of affordability and precision in smart agriculture solutions.

L. García et al. (2020) [2] presented a comprehensive review of IoT-based smart irrigation systems by analyzing more than 100 research studies. The study identified soil moisture as the most critical parameter for irrigation decision-making, followed by temperature and humidity. It also emphasized the role of wireless communication and sensor integration in enhancing water-use efficiency and enabling automation.

V. S. Reddy et al. (2024) [3] developed a cloud-based smart irrigation system that integrates IoT technology for real-time monitoring and control. The system allows users to access field data remotely and make informed decisions using cloud platforms. Their research demonstrated improved irrigation efficiency and reduced water wastage through data-driven approaches.

A. K. Mishra (2025) [4] introduced an IoT-enabled irrigation system designed to maintain optimal soil moisture levels automatically. The system reduces human intervention by activating irrigation only when required, thereby improving agricultural productivity and ensuring efficient water usage.

Kanth Lakshmi et al. (2026) [5] proposed a soil monitoring and irrigation system that uses sensors and real-time data processing to automate water supply. Their study focused on improving crop yield while reducing labor costs and resource wastage. The system also supports continuous monitoring, making it suitable for modern smart farming applications.

M. Mohiuddin et al. (2024) [6] presented an intelligent irrigation system that integrates multiple sensors, including soil moisture, temperature, and humidity sensors. The system automates water pump control and eliminates manual intervention, resulting in better water conservation and enhanced crop productivity.

K. Obaideen et al. (2022) [7] provided an overview of smart irrigation technologies and their role in sustainable agriculture. The study discussed how IoT-based systems contribute to efficient water management and support global sustainability goals. It also highlighted future research directions in the field of smart farming.

II. EXISTING METHOD

In traditional agricultural practices, irrigation is primarily carried out using manual methods or fixed scheduling techniques. Farmers typically rely on their experience or visual observation of soil conditions to decide when and how much water should be supplied to crops. While this approach has been user for decades, it lacks precision and often results in inefficient water usage.

One common existing method is manual irrigation, where farmers operate water pumps based on intuition or routine schedules. This method does not consider real-time soil moisture conditions, leading to overwatering or underwatering of plants. Overwatering can cause nutrient loss and root damage, while insufficient

Doi:10.48047/ijiee.2026.16.2.6

watering can hinder plant growth and reduce crop yield.

Another widely used approach is the time-based irrigation system, where water is supplied at fixed intervals using timers. Although this method reduces human effort to some extent, it does not adapt to changing environmental conditions such as rainfall, temperature, or soil moisture variations. As a result, water may be supplied even when it is not required, leading to wastage.

With technological advancements, some systems have incorporated basic sensor-based irrigation, where soil moisture sensors are used to trigger irrigation. However, many of these systems operate in isolation without connectivity or data storage capabilities. They lack remote monitoring features and do not provide real-time updates to users, limiting their effectiveness in large-scale or smart farming applications.

Previous research has shown that traditional and semi-automated irrigation systems are inefficient in terms of water usage and labor requirements. They also fail to utilize advanced technologies like IoT and cloud computing for data analysis and remote control [2][3]. Moreover, these systems often lack scalability and flexibility, making them unsuitable for modern agricultural needs.

There is a clear need for an improved irrigation system that can monitor environmental parameters in real time, make intelligent decisions, and provide remote accessibility. The proposed system addresses these limitations by integrating IoT technology, automation, and smart sensing mechanisms to achieve efficient and sustainable irrigation.

III. PROPOSED METHODOLOGY

The proposed system aims to develop an Automated Plant Irrigation and Soil Moisture Monitroing System using IoT, which ensures efficient water management by continuously monitoring environmental conditions and automating the irrigation process. The methodology is designed to minimize human intervention, reduce water wastage, and improve plant health through intelligent decision making.

The system primarily consist of sensors, a microcontroller unit, a relay module, a water pump, and an IoT communication module. Soil moisture sensors are used to measure the water content present in the soil, while a DHT11 sensor is employed to monitor temperature and humidity. These parameters play a crucial role in determining the irrigation requirements of plants, as highlighted in previous research studies [2].

All sensor data is collected and processed by the microcontroller (Arduino Uno in the prototype stage). The controller continuously compares the soil moisture level with a predefined threshold value. If the moisture level falls below the threshold, the system automatically activates the relay module, which in turn switches on the water pump to supply water to the plants. Once the soil reaches the desired moisture level, the system turns off the pump, thereby preventing over-irrigation and conserving water.

To enhance functionality, the system integrates an IoT modulesuch as ESP8266 that enables wireless communication. This allows real-time data transmission to a cloud platform or mobile application, where users can monitor soil conditions, temperature, humidity, and system status remotely. Similar IoT-based approaches have been proven effective in improving irrigation efficiency and enabling smart decision-making [3][6].

Additionally, an LCD display is incorporated to provide local visualization of sensor readings and system status. This ensures that users can easily monitor system performance even without internet access. The power supply unit ensures a stable and regulated voltage for all components, maintaining reliable system operation.

This methodology provides a smart, automated, and scalable irrigation solution that addresses the limitations of existing systems. By combining real-time monitoring, automation, and IoT connectivity, the proposed system significantly improves water-use efficiency and supports sustainable agricultural practices [5][7].

Doi:10.48047/ijiee.2026.16.2.6

IV. BLOCK DIAGRAM & WORKING SYSTEM

Block Diagram:

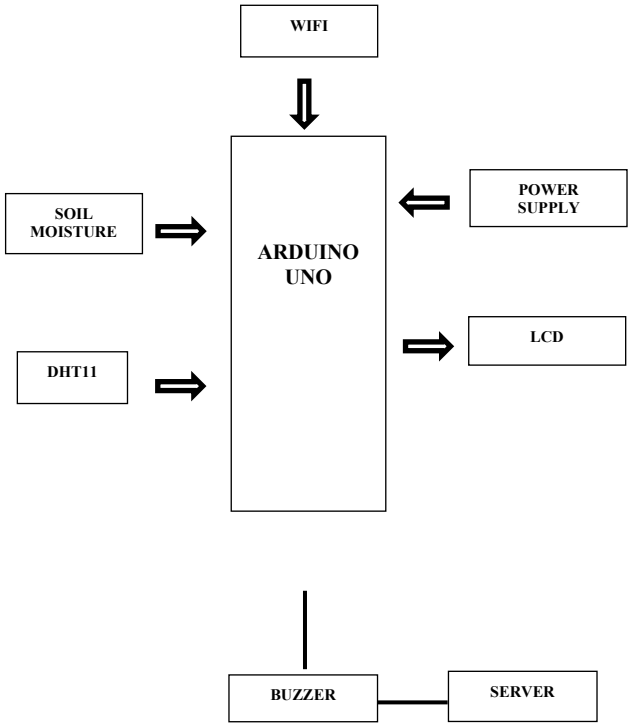

Fig:4.2: BLOCK DIAGRAM

Working System:

The working of the proposed Automated Plant Irrigation and Soil Moisture Monitoring System is based on real time sensing, data processing, and automatic control of irrigation. The system operates continuously to ensure that plants rceive the required amount of water without manual intervention.

Initially, the soil moisture sensor is placed in the soil to measure the water content. At the same time, the DHT11 sensor monitors environmental parameters such as temperature and humidity. These sensors sontinuously collect real time data from the surroundings and send it to the microcontroller

V. RESULTS AND OUTCOMES

The implementation of the Automated Plant Irrigation and Soil Moisture Monitoring System using IoT demonstrated effective and reliable performance in managing irrigation based on real-time environmental conditions. The system was tested under different soil moisture levels and environmental conditions to evaluate its efficiency and accuracy.

The results show that the system successfully monitors soil moisture, temperature, and humidity using sensors and responds appropriately by controlling the water pump. When the soil moisture level drops below the predefined threshold, the system automatically activates the pump, and it turns off once the desired moisture level is achieved. This confirms the proper functioning of the automated control mechanism.

One of the key outcomes observed is significant water conservation. Unlike traditional irrigation methods, the system supplies water only when required, thereby reducing unnecessary water usage. This aligns with findings from previous studies that emphasize the role of sensor-based irrigation in improving water-use efficiency [2][6].

The integration of IoT technology enables real-time monitoring and remote accessibility. Users were able to view sensor data and system status through a connected platform, which enhances convenience and allows better decision-making. The system also provides continuous updates, ensuring transparency in irrigation operations, similar to other smart irrigation solutions [3].

Doi:10.48047/ijiee.2026.16.2.6

Additionally, the system contributes to improved plant health and growth by maintaining optimal soil moisture levels. Consistent and timely irrigation prevents stress conditions in plants, leading to better productivity. The reduction in manual intervention also minimizes human error and labor requirements.

The LCD display provided accurate local readings of system parameters, ensuring easy monitoring even without internet connectivity. The overall system performance was stable, cost-effective, and suitable for small-scale as well as scalable agricultural applications.

These results demonstrate that the proposed system is a practical and effective solution for modern smart agriculture, supporting sustainable farming practices and efficient resource management [5][7].

VI. Conclusion

The proposed Automated Plant Irrigation and Soil Moisture Monitoring System using IoT provides an effective and intelligent solution to address the challenges of traditional irrigation methods. By integrating soil moisture sensors, temperature and humidity sensors, and a microcontroller-based control system, the project ensures that plants receive the right amount of water at the right time without manual intervention.

The system successfully automates the irrigation process by continuously monitoring environmental conditions and making real-time decisions. This not only reduces water wastage but also improves plant health and agricultural productivity. The use of IoT technology further enhances the system by enabling remote monitoring and control, allowing users to access real-time data from anywhere. Similar approaches have been proven to increase efficiency and support smart farming practices [3][6].

One of the major advantages of the system is its cost-effectiveness and scalability, making it suitable for a wide range of applications, from home gardening to large agricultural fields. It minimizes human effort, reduces errors associated with manual irrigation, and promotes efficient use of resources. Additionally, the system contributes to sustainable agriculture by conserving water and supporting environmentally friendly practices, as emphasized in recent studies [5][7].

In conclusion, the project demonstrates how the integration of embedded systems and IoT can revolutionize traditional farming methods. The proposed system serves as a reliable, efficient, and smart irrigation solution that aligns with the goals of modern agriculture and resource management. Future enhancements can further improve the system by incorporating advanced data analytics, machine learning, and weather forecasting for even smarter decision-making.

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Doi:10.48047/ijiee.2026.16.2.6