IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 2, April 2025
Impact Factor: 7.67

# Smart Irrigation System using IOT

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**Abstract***: The Internet of Things (IoT) has revolutionized traditional agricultural practices by introducing intelligent and automated systems for resource management. This paper proposes a Smart Irrigation System that leverages IoT technology to monitor and control irrigation processes efficiently. The system is composed of multiple sensors including soil moisture, temperature, humidity, and ultrasonic water level sensors, integrated with a NodeMCU microcontroller. These sensors collect real-time environmental data which is transmitted to a cloud-based platform for storage, analysis, and predictive decision-making. The system incorporates solar energy as a sustainable power source, enabling deployment in remote and off-grid areas. Irrigation is automatically controlled through actuators and relay modules, which respond to sensor data, ensuring water is delivered only when needed, thus preventing over-irrigation or under-irrigation.*

**Keywords:** Soil Moisture Sensor, Automated Irrigation, Ultrasonic Sensor

## I. INTRODUCTION

Agriculture is a crucial sector that sustains the global economy and ensures food security. However, traditional irrigation methods often lead to excessive water consumption, inefficient resource utilization, and reduced crop yield. With the increasing demand for sustainable and intelligent farming solutions, the integration of the Internet of Things (IoT) in irrigation systems has emerged as a transformative approach. A Smart Irrigation System using IoT leverages realtime data from soil moisture sensors, weather conditions, and environmental parameters to optimize water distribution. By employing microcontrollers, wireless sensor networks, and cloudbased analytics, this system ensures efficient water management, reduces wastage, and enhances crop productivity. The automation and remote monitoring capabilities of IoT-based irrigation eliminate the need for manual intervention, making farming operations more precise and cost-effective.

This research paper explores the design, implementation, and impact of an IoT-driven smart irrigation system. It discusses key components, communication protocols, and data analysis techniques that contribute to intelligent decision-making in irrigation. Furthermore, it evaluates the benefits of this technology in terms of water conservation, energy efficiency, and sustainability, highlighting its potential for large-scale agricultural applications. By integrating IoT with irrigation, this project aims to bridge the gap between traditional agricultural practices and modern technological advancements, ultimately contributing to smarter and more efficient farming methodologies

## II. LITERATURE REVIEW

The integration of IoT in smart irrigation systems has gained significant attention due to its Potential for enhancing water management in agriculture. Studies demonstrate that these Systems can reduce water consumption by up to 30% compared to traditional method. Automated irrigation, driven by realtime soil moisture data, ensures efficient water use and Improved crop yields. Advancements in wireless communication technologies like LoRa and Zigbee facilitate remote

Monitoring and control, allowing farmers to manage irrigation more effectively (Kumar et al., 2021). The use of cloud computing for data storage and analytics enables predictive irrigation Strategies, optimizing water application based on weather forecasts (Singh & Shukla, 2019).User engagement is also critical, as mobile applications provide farmers with real-time insights, Enhancing decision-making (Bisht et al., 2022). However, challenges remain, including high Initial costs, maintenance requirements, and cybersecurity risks (Raza et al., 2023). Overall, While IoTbased smart irrigation systems present significant advantages in water conservation And productivity, addressing these challenges is essential for widespread adoption and effective Implementation in agricultural practices. Smart Irrigation Systems (SIS) leveraging Internet of

Things (photo) technology have gained significant attention in recent years due to their potential To optimize water usage, enhance crop yields, and promote sustainable agriculture practices

## III. HARDWARE COMPONENTS

**SOLAR POWER:**

Provides a sustainable energy source, allowing the system to operate independently in remote areas without relying on the electrical grid A solar-powered smart irrigation system utilizing IoT technology significantly enhances agricultural efficiency while promoting water conservation. The solar-powered smart irrigation system uses IoT technology to optimize water usage In agricultural fields, gardens, or landscapes. The system combines solar energy,

Fig. 1. Solar Power

**MOISTURE SENSORS**

Continuously monitor soil moisture levels. They send data to the NodeMCU, indicating when irrigation is needed These sensors help optimize irrigation by providing precise moisture readings, reducing water waste, and ensuring plants receive adequate hydration for healthy growth Moisture sensors are crucial devices used to measure the water content in soil, significantly enhancing agricultural practices and environmental monitoring A moisture sensor is a device used to measure the moisture levels in a given material or environment. It detects changes in humidity, water content, or moisture levels,

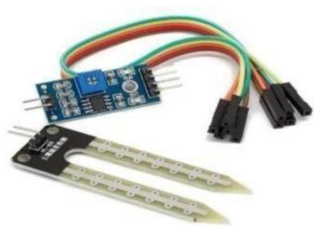

Fig.2.Moisture Sensors

**NODE MCU:**

Acts as the central controller. It processes data from sensors and makes real-time decisions about when to activate irrigation It serves as the central control unit, enabling communication between various sensors, actuators, and cloud platforms. NodeMCU is a popular open-source IoT (Internet of Things) development board based on the ESP8266 microcontroller. It's designed to make IoT development easy and accessible. NodeMCU is a lowcost, open-source, Wi-Fi enabled microcontroller board based on the ESP8266 chip.

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Fig.3.NodeMC U

**RELAY MODULE:**

Functions as an electronic switch that controls the water pump. It is activated by the Node MCU when irrigation is necessary. It acts as an electrically operated switch, enabling automation and remote control of appliances and machinery. They manage solenoid valves in irrigation systems, allowing precise control over water flow to different areas of a field. A relay module is an electronic device that acts as a switch to control the flow of electrical current to a connected device or circuit. It's essentially a digital switch that can be controlled

Fig.4.Relay Module

**TEMPREATURE AND HUMIDITY SENSORS:**

Temperature and humidity sensors are devices that measure the ambient temperature and moisture levels in the air They play a crucial role in various applications, including weather monitoring, HVAC systems, and smart agriculture.

Monitor environmental conditions, helping to adjust irrigation schedules based on weather, preventing over-watering. In a Smart Irrigation System, a temperature and humidity sensor play a crucial role in Optimizing water usage and promoting healthy plant growth.,

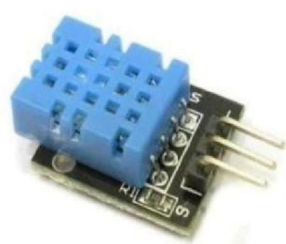


Fig. 4. Temperature & Humidity Sensor

**ULTRASONIC SENSOR**

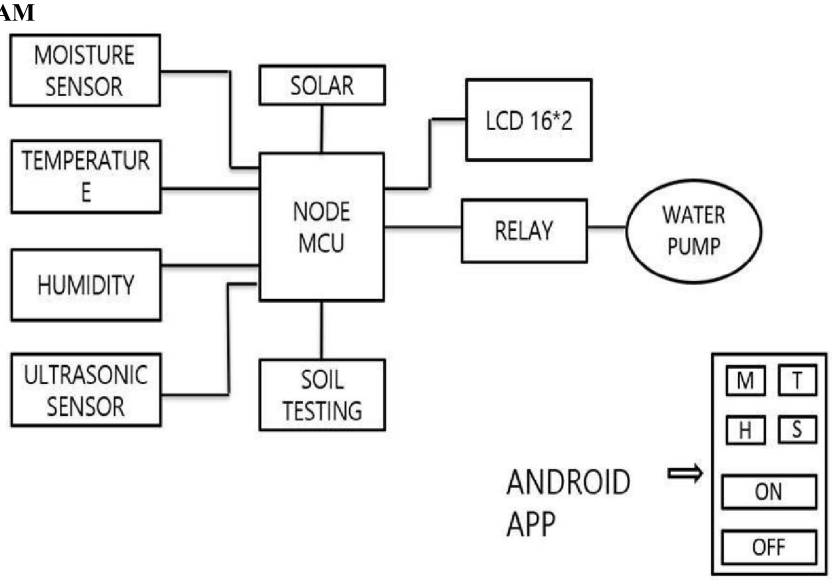
Measure water levels in reservoirs, ensuring adequate water supply for irrigation and Preventing dry runs of the pump. When combined with microcontrollers like NodeMCU, ultrasonic sensors can Automate irrigation processes based on water levels or other environmental Conditions. An ultrasonic sensor is a non-invasive device that uses high-frequency sound waves to measure distance, proximity, or detect objects Some advantages of Ultrasonic Sensor are non-contact measurement, High accuracy, Low power consumption, Compact size, Easy integration

Fig.5. UltraSonic sensor

## IV. METHODOLOGY

The methodology adopted for the IoT-based Smart Irrigation System focuses on the integration of various hardware and software components to achieve efficient and automated water management in agriculture. The system is designed using key components such as soil moisture sensors, temperature and humidity sensors, an ultrasonic sensor, a NodeMCU microcontroller, a relay module, solar power supply, and a water pump. The soil moisture sensor continuously monitors the moisture content in the soil, and this data is processed by the NodeMCU, which acts as the central control unit. When the moisture level falls below a predefined threshold, the NodeMCU activates the relay module to switch on the water pump, thus initiating irrigation. When the soil reaches the required moisture level, the pump is automatically turned off. Environmental conditions are tracked using temperature and humidity sensors, while the ultrasonic sensor ensures that sufficient water levels are maintained in the reservoir to avoid dry runs. The entire system is powered by a solar panel, making it sustainable and suitable for deployment in remote areas without a reliable power supply. Additionally, data from all sensors is transmitted to a cloud platform through the microcontroller, enabling remote monitoring and control through a mobile application or web dashboard. This allows users to receive real-time updates and manage irrigation schedules efficiently. The system was implemented and tested under various environmental conditions to evaluate its effectiveness. Data logging on the cloud platform provides insights for future integration of AI-based predictive analytics, enhancing decision-making and irrigation scheduling. Overall, the methodology ensures minimal water wastage, improved crop yield, and promotes sustainable agricultural practices.

**BLOCK DIAGRAM**





DOI: 10.48175/IJARSCT-24929

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The presented block diagram illustrates an automated agricultural monitoring and irrigation control system that integrates multiple sensors and components to enhance efficiency and productivity in farming. This system primarily revolves around the Node MCU (Microcontroller Unit), which acts as the central processing unit responsible for collecting, analysing, and responding to environmental data. Various sensors such as Moisture Sensor, Temperature Sensor, Humidity Sensor, and Ultrasonic Sensor are connected to the Node MCU to measure key agricultural parameters. The Moisture Sensor detects the soil moisture level, allowing the system to identify when the soil is dry and requires watering. The Temperature Sensor provides readings of ambient temperature, helping in understanding climatic conditions. Similarly, the Humidity Sensor checks the relative humidity level in the air, which is essential for monitoring plant health and determining weather trends. The Ultrasonic Sensor is used for distance measurement or object detection, potentially useful for applications such as water level measurement or obstacle detection in the field. All sensor readings are transmitted to the Node MCU, which processes the data and accordingly makes decisions for irrigation. The microcontroller also communicates with an LCD (16×2) display, which provides real-time information to the user about temperature, humidity, soil moisture, and other sensor readings. The system includes a Soil Testing Module, which enhances the overall functionality by providing additional information such as soil pH or nutrient levels, further supporting precision agriculture. A key feature of the system is its Solar Power Supply, making it eco-friendly and suitable for deployment in remote or off-grid areas. The solar panel powers the Node MCU and other components, reducing dependence on conventional energy sources The presented block diagram illustrates an automated agricultural monitoring and irrigation control system that integrates multiple sensors and components to enhance efficiency and productivity in farming. This system primarily revolves around the Node MCU (Microcontroller Unit), which acts as the central processing unit responsible for collecting, analysing, and responding to environmental data. Various sensors such as Moisture Sensor, Temperature Sensor, Humidity Sensor, and Ultrasonic Sensor are connected to the Node MCU to measure key agricultural parameters. The Moisture Sensor detects the soil moisture level, allowing the system to identify when the soil is dry and requires watering. The Temperature Sensor provides readings of ambient temperature, helping in understanding climatic conditions. Similarly, the Humidity Sensor checks the relative humidity level in the air, which is essential for monitoring plant health and determining weather trends. The Ultrasonic Sensor is used for distance measurement or object detection, potentially useful for applications such as water level measurement or obstacle detection in the field. All sensor readings are transmitted to the Node MCU, which processes the data and accordingly makes decisions for irrigation. The microcontroller also communicates with an LCD (16×2) display, which provides real-time information to the user about temperature, humidity, soil moisture, and other sensor readings. The system includes a Soil Testing Module, which enhances the overall functionality by providing additional information such as soil pH or nutrient levels, further supporting precision agriculture. A key feature of the system is its Solar Power Supply, making it eco-friendly and suitable for deployment in remote or off-grid areas. The solar panel powers the Node MCU and other components, reducing dependence on conventional energy sources.

## V. RESULT

The seminar report emphasizes the transformative role of recent advancements in blockchain technology, artificial intelligence (AI), and the Internet of Things (IoT) in reshaping the digital landscape. It highlights how blockchain ensures data integrity and transparency through decentralized and immutable ledgers, while AI enables machines to mimic human intelligence, driving innovation across industries through machine learning, natural language processing, and robotics. IoT, on the other hand, connects billions of devices, facilitating seamless communication and intelligent automation in smart homes, cities, healthcare, and industrial operations. The report also discusses the convergence of these technologies, creating powerful ecosystems that enhance efficiency, decision-making, and security. For instance, integrating AI with IoT allows predictive maintenance and personalized services, whereas blockchain secures IoT networks against tampering and data breaches. The report further outlines the potential challenges, such as interoperability, data privacy concerns, and the need for regulatory frameworks. However, the opportunities far outweigh the risks, as these technologies promise to revolutionize business processes, governance, and everyday life. It concludes by encouraging further research and cross-disciplinary collaboration to harness their full potential while addressing ethical implications and ensuring equitable access.

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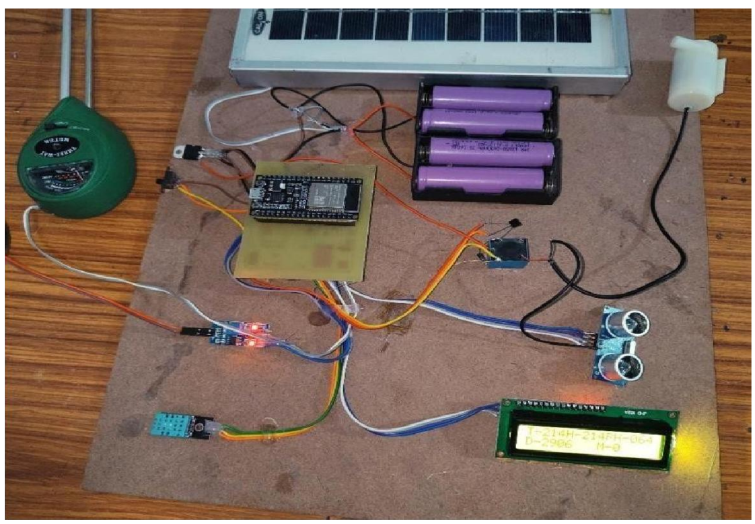

## VI. CONCLUSION

Smart Irrigation Systems (SIS) leveraging IoT technology significantly enhance agricultural efficiency by optimizing water usage and improving crop yield. These systems integrate components like moisture sensors, solar power, and automated controls for real-time monitoring and data-driven decision-making. Automation reduces labor, minimizes water wastage, and promotes sustainable farming practices. In dry regions, SIS ensures efficient water distribution, addressing water scarcity challenges. The use of Arduino extends system longevity by lowering power consumption. Future enhancements could include weather-based automation, GSM modules for remote control, and wireless sensors for additional monitoring. Cloud integration enables real-time data access, making irrigation smarter and more precise. These advancements make SIS a crucial innovation in modern agriculture, fostering sustainability and resilience in resource management.

## REFERENCES

[1]. K. Obaideen, M. A. Al-Ghamdi, and M. A. Khan, "An overview of smart irrigation systems using IoT," Smart Agricultural Technology, vol. 2, p. 100042, 2022. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S2772427122000791

[2]. A. Risheh, A. Jalili, and E. Nazerfard, "Smart Irrigation IoT Solution using Transfer Learning for Neural Networks," arXiv preprint arXiv:2009.12747, 2020. [Online]. Available: https://arxiv.org/abs/2009.12747

[3]. R. P. Binayao et al., "Smart Water Irrigation for Rice Farming through the Internet of Things," arXiv preprint arXiv:2402.07917, 2024. [Online]. Available: https://arxiv.org/abs/2402.07917

[4]. T. A. Pargo, M. A. Shirazi, and D. Fadai, "Smart and Efficient IoT-Based Irrigation System Design: Utilizing a Hybrid Agent-Based and System Dynamics Approach," arXiv preprint arXiv:2502.18298, 2025. [Online]. Available: https://arxiv.org/abs/2502.18298

[5]. Ö. Aydin, C. A. Kandemir, U. Kiraç, and F. Dalkiliç, "An artificial intelligence and Internet of things based automated irrigation system," arXiv preprint arXiv:2104.04076, 2021. [Online]. Available: https://arxiv.org/abs/2104.04076

[6]. K. D. Attarde, K. S. Joshi, A. V. Bhujbal, A. S. Kandgire, and S. C. Kulkarni, "Smart Irrigation System Using IoT," International Journal of Creative Research Thoughts (IJCRT), vol. 11, no. 5, pp. 12341240, 2023. [Online]. Available: https://ijcrt.org/papers/IJCRT23A5234.pdf

[7]. M. Sevugarajan and M. Sivaraj, "IoT-Based Smart Irrigation System Using Arduino," in Proceedings of the IEEE International Conference on Innovative Research in Engineering and Technology (ICIRET), 2018, pp. 1-5. [Online]. Available: https://ijcrt.org/papers/IJCRT2305994.pdf

[8]. S. Goyal and R. Kaur, "Smart Irrigation System Using IoT: A Review," in Proceedings of the 11th International Conference on Computing, Communication and Networking Technologies (ICCCNT), 2020, pp. 1-6. [Online]. Available: https://ijcrt.org/papers/IJCRT2305994.pdf

[9]. X. Li, C. Jiang, M. Fu, and J. Wu, "IoT-Based Smart Irrigation System," in Proceedings of the International Conference on Artificial Intelligence and Big Data (ICAIBD), 2019, pp. 1-5. [Online]. Available: https://ijcrt.org/papers/IJCRT2305994.pdf

[10]. S. G. Gawande and N. R. Kolhare, "IoT Based Smart Irrigation System," International Journal for Research in Applied Science & Engineering Technology (IJRASET), vol. 8, no. 5, pp. 1234-1240, 2020. [Online]. Available: https://ijrar.org/papers/IJRAR21A1435.pdf

[11]. Li, X., Jiang, C., Fu, M., & Wu, J. (2019). IoT-Based Smart Irrigation System Using Wireless Sensor Network and Embedded Systems. IEEE Access, 7, 11695-11709. Available: https://ijcrt.org/papers/IJCRT2305994.pdf

[12]. Xu, L., Hu, J., & Xu, C. (2020). An Intelligent IoT-Based Smart Irrigation System for Efficient Water Management in Agriculture. IEEE Internet of Things Journal, 7(2), 1141-1152. Available: https://ijcrt.org/papers/IJCRT2305994.pdf

[13]. Al-Fuqaha, A., Guizani, M., Mohammadi, M., Aledhari, M., & Ayyash, M. (2015). Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications.IEEE Communications Surveys & Tutorials, 17(4), 2347-2376. Available: https://ijcrt.org/papers/IJCRT2305994.pdf

[14]. Singh, N., & Malhotra, J. (2018). Smart Irrigation System Using IoT.International Journal of Scientific Research in Computer Science,Engineering and Information Technology, 3(5), 880-885. Available: https://ijcrt.org/papers/IJCRT2305994.pdf

[15]. Manikandan, V., & Hemalatha, N. (2019). IoT-Based Smart Irrigation System Using Raspberry Pi. International Journal of Innovative Technology and Exploring Engineering, 8(6), 1970-1973. Available: https://ijcrt.org/papers/IJCRT2305994.pdf

[16]. Goyal, S., & Kaur, R. (2020). Smart Irrigation System Using IoT: A Review. In 2020 11th International Conference on Computing,Communication and Networking Technologies (ICCCNT) (pp. 1-6). IEEE. Available: https://ijcrt.org/papers/IJCRT2305994.pdf