International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 04 | April - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

IOT Irrigation Monitoring & Control System with Smart Sprinkler

Dr.D.A. Shahakar, Abhishek Jaiswal, Mansi Gulhane, Shreyash Kshirsagar, Anjali Mondhe, Dinesh Raut, Krunal Manthapurwar

Department of Electrical Engineering,
PRPCE & M, Amravati 444602, India

Abstract- The integration of IoT (Internet of Things) in agriculture has revolutionized traditional farming practices by enhancing efficiency, productivity, and sustainability. This research paper presents the design and implementation of an IoT-based Irrigation and Monitoring Control System aimed at optimizing water usage and ensuring real-time monitoring of soil and environmental conditions. The system utilizes sensors to measure parameters such as soil moisture, temperature, and humidity, enabling automated irrigation and providing farmers with remote access through a user-friendly interface. The proposed solution reduces water wastage, improves crop health, and offers data-driven insights for informed decision-making. The research highlights the system's efficiency through experimental results, demonstrating its potential for sustainable agriculture and precision farming.
Keywords- IoT, irrigation system, soil moisture sensor, remote monitoring, sustainable agriculture, precision farming, automated control, water conservation, real-time data, smart farming.[1]

I. INTRODUCTION

Agriculture is the backbone of many economies, providing food security and employment to a significant portion of the population. However, traditional farming practices often face challenges related to water management, resource optimization, and crop productivity. With increasing concerns over water scarcity and the need for sustainable agricultural practices, the adoption of technology-driven solutions has become imperative.

The Internet of Things (IoT) has emerged as a transformative technology in modern agriculture, enabling smart farming through real-time data collection, monitoring, and automated control. By integrating sensors, communication networks, and data analytics, IoT-powered systems provide farmers with accurate insights into soil conditions, weather patterns, and irrigation needs. This data-driven approach enhances resource efficiency, reduces wastage, and improves overall crop yield.

The advancement of wireless communication technologies such as Wi-Fi, LoRa, and GSM has further enhanced the reliability and range of IoT-based systems. These technologies enable seamless data transmission and remote access, allowing farmers to monitor and control irrigation processes from distant locations. The combination of IoT and wireless communication ensures real-time decision-making, which is crucial for improving farming efficiency and reducing manual intervention.

In addition to water management, IoT-based agricultural systems also support predictive analytics by collecting and analyzing historical data. This helps farmers anticipate weather changes, soil degradation, and potential crop diseases, enabling them to take preventive measures. The integration of machine learning algorithms with IoT devices further improves accuracy in predicting optimal irrigation schedules, enhancing overall farm productivity.

This research focuses on developing an IoT-based Irrigation and Monitoring Control System that automates the irrigation process based on real-time soil moisture, temperature, and humidity data. The system not only ensures optimal water usage but also empowers farmers with remote access and control, enabling them to make informed decisions regardless of their location.

The implementation of this system aims to address the inefficiencies of manual irrigation practices, promote precision agriculture, and contribute to sustainable farming methods. Through experimental evaluation, the study demonstrates the effectiveness of the proposed solution in reducing water consumption and enhancing crop health, making it a viable and scalable technology for modern agriculture.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 04 | April - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

II. METHODOLOGY

The IoT-based Irrigation and Monitoring Control System was designed and implemented using a combination of hardware components, sensors, and software integration to automate and optimize the irrigation process. The methodology involves the following stages:

System Architecture and Design

The system comprises soil moisture, temperature, and humidity sensors to collect real-time data from the field. The sensors are connected to a microcontroller (Node-MCU or Arduino), which processes the data and triggers the irrigation system when required.

The hardware setup is powered by a regulated power supply and controlled using relay modules to activate or deactivate the water pump based on soil conditions.

Data Acquisition and Processing

The sensors continuously monitor soil moisture levels, temperature, and humidity, transmitting the data to the microcontroller. The collected data is processed using predefined threshold values.

a) If the soil moisture falls below the threshold, the system automatically turns on the water pump.

b) Once the moisture level reaches the desired range, the pump is switched off, preventing water wastage.

Communication and Remote Access

The system utilizes Wi-Fi/GSM modules to transmit real-time data to a cloud-based server or mobile application. Farmers can access the data remotely, monitor soil conditions, and manually control the irrigation system via a user-friendly interface.

Automation and Control

The system features an automated irrigation mechanism controlled by the microcontroller based on the sensor readings. This eliminates the need for manual intervention and ensures precise water usage, enhancing efficiency and reducing waste.

Testing and Validation

The system underwent experimental testing in a controlled agricultural environment. The testing involved monitoring the effectiveness of the automated irrigation system in maintaining optimal soil moisture levels.

Key performance parameters such as water usage efficiency, response time, and system reliability were evaluated to validate the system's effectiveness.

III. ALGORITHM

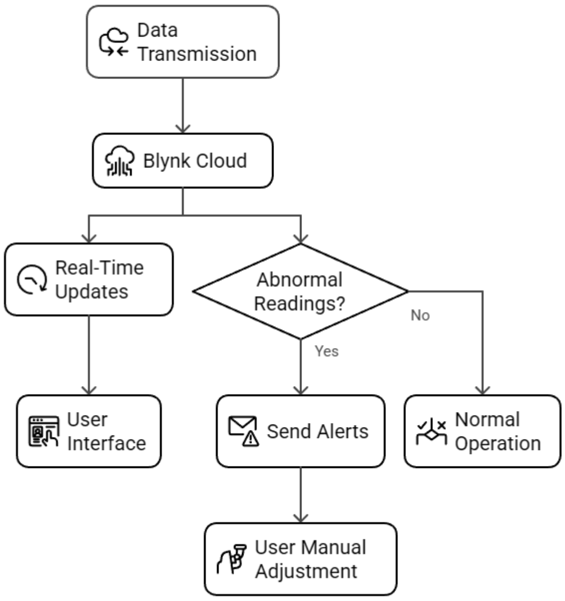

Fig.1: Algorithm of IoT-Based Irrigation System Data Flow

Data Collection: Sensors collect real-time data (e.g., soil moisture, temperature) from the field.

Cloud Integration: The data is transmitted to the Blynk Cloud platform.

Real-Time Updates: The cloud sends real-time updates to the user interface, allowing remote monitoring.

Abnormality Check: The system checks for abnormal readings (e.g., low moisture, high temperature).

Normal Operation (No Abnormality): If no issues are detected, the system continues with normal operation.

Alert Notification (Abnormal Readings): If abnormalities are detected, the system sends alert notifications to the user.

Manual Adjustment: The user can make manual adjustments through the interface for corrective action.
[10]

Volume: 09 Issue: 04 | April - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

IV. BLOCK DIAGRAM

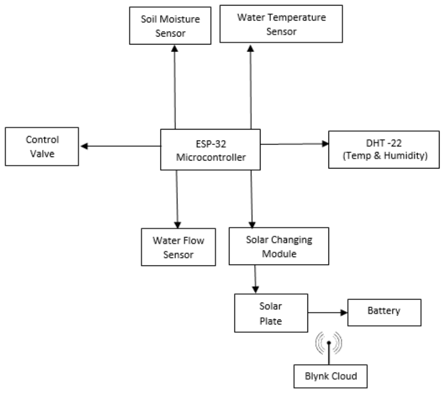

Fig.2: Block Diagram of Smart Sprinkler

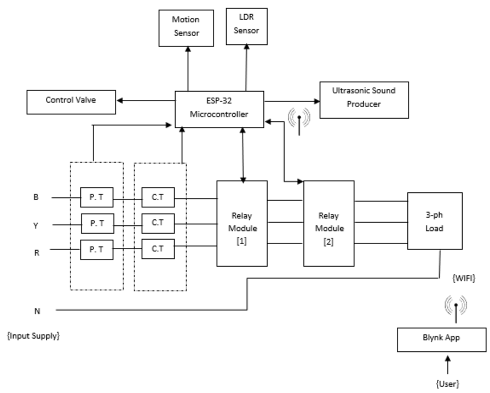

Fig.3: Block Diagram of IOT Irrigation Monitoring & Control System with Smart Sprinkler

Figure 3 represents a smart power monitoring and control system using ESP-32, a microcontroller with Wi-Fi capability. The system includes Current Transformers (C.T) and Potential Transformers (P.T), which measure current and voltage from the three-phase load (R, Y, B phases). The relay modules act as switching devices, controlling the power flow based on real-time data. The ESP-32 communicates with the Blynk App via Wi-Fi, allowing users to monitor and control the electrical parameters remotely.

Figure 2 illustrates an automated irrigation and environmental monitoring system powered by solar energy. It consists of various sensors, including a Soil Moisture Sensor to monitor soil water content, a Water Temperature Sensor for measuring water temperature, and a DHT-22 sensor for temperature and humidity detection. The data collected from these sensors is processed by the ESP-32 microcontroller, which then controls a solenoid valve to regulate water flow based on real-time soil conditions

The power supply for the system in Figure 2 is primarily sourced from a solar plate, connected to a solar charging module and a battery to ensure continuous operation even in the absence of sunlight. Additionally, a water flow sensor is included to measure and regulate the amount of water being distributed. The collected data is transmitted to the Blynk Cloud, enabling remote monitoring and control via the Blynk App.

Both figures demonstrate how IoT-based automation enhances efficiency and control. Figure 3 focuses on smart power management, ensuring stable power distribution and monitoring, while Figure 2 emphasizes precision irrigation and environmental control. In both systems, the ESP-32 microcontroller serves as the central processing unit, interfacing with sensors and actuators while transmitting data to a user-friendly interface for remote access and control.

V. OUTCOME & IMPACT

Outcome:
Improved Water Management:
The system effectively monitors soil moisture levels and automates irrigation, ensuring water is utilized efficiently. This reduces water wastage and promotes sustainable farming practices.

Real-time Monitoring and Control:
Farmers can remotely monitor and control the irrigation system through the IoT interface. The use of sensors and real-time data transmission enhances operational accuracy and reliability.

Energy and Cost Efficiency:
By automating irrigation, the system reduces the dependency on manual labor, thereby lowering operational costs. The optimized water distribution also leads to reduced electricity consumption, making the solution cost-effective.

Enhanced Crop Yield:
The precise water management and timely irrigation contribute to improved soil health and enhanced crop productivity.

Scalability and Adaptability:
The system can be scaled for larger agricultural lands and customized for different crop requirements, making it versatile for varied farming needs.

Impact:
Sustainable Agriculture:
The IoT-based system promotes water conservation and reduces resource wastage, contributing to sustainable agricultural practices. This aligns with global efforts toward efficient resource management.

Environmental Benefits:
Reduced water and energy consumption lowers the overall environmental footprint, supporting eco-friendly farming methods.

Enhanced Farmer Livelihood:
By increasing efficiency and crop yield, the system contributes to better financial outcomes for farmers, improving their overall livelihood.

Technological Advancement in Agriculture:
The project showcases the potential of IoT in transforming traditional farming methods, paving the way for the adoption of smart agriculture practices.

VI. TABLE 1 COMPARATIVE ANALYSIS

Criteria	Traditional System	IoT-Based System
Water Usage Efficiency	20-30% water wastage due to manual control	Reduces water usage by 40-60% through automation
Labor Dependency Reduction	Requires 6-8 hours of daily manual monitoring	Reduces labor time by 80% with remote monitoring
Operational Cost Savings	Higher electricity & water bills (₹5,000-₹7,000/month)	Saves 30-40% on costs (₹2,500-₹4,000/month)
Crop Yield Improvement	Lower yield due to over/under irrigation (10-20% loss)	Increases yield by 15-35% through precise watering
Motor Protection Efficiency	Frequent motor failures, costly repairs (₹10,000-₹20,000)	Reduces motor damage by 90%, preventing major failures

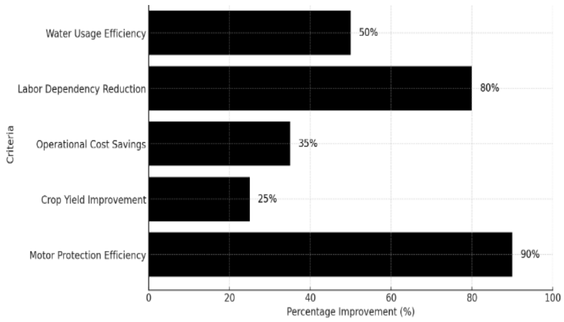

Fig.4: Statistical Representation of above comparative analysis

This representation gives the idea about the uniqueness about the project and, why we need it?

VII. RESULT

The implementation of the IoT-based irrigation system demonstrated significant improvements in water efficiency and resource management. By automating the irrigation process based on real-time soil moisture, temperature, and humidity data, the system effectively minimized water wastage.

This precise and controlled irrigation ensured that crops received the right amount of water, preventing both overwatering and underwatering, which are common issues in traditional systems.

The results showed a notable increase in crop health and yield. By maintaining optimal soil moisture levels, the plants exhibited better growth, uniformity, and resistance to drought stress. The system's ability to provide consistent irrigation based on environmental conditions led to healthier crops and improved agricultural productivity.

Additionally, the reduction in manual labor was a key outcome. The automated system minimized the need for farmers to physically monitor and control the irrigation process. With remote access and real-time monitoring through mobile applications or cloud platforms, farmers could efficiently manage their fields from any location. This not only saved time but also reduced operational costs.

The system also contributed to sustainable farming practices. By optimizing water consumption and preventing unnecessary usage, it promoted water conservation, making it an environmentally friendly solution. The reduction in resource wastage directly impacted cost savings, making farming more economically viable.

Overall, the IoT-based irrigation system proved to be efficient, reliable, and scalable, offering a practical solution for modern agriculture. Its data-driven insights empowered farmers to make informed decisions, leading to improved productivity, lower costs, and sustainable farming outcomes.

VIII. CONCLUSION

The IoT-based irrigation system presented in this research offers a smart and efficient solution for modern agriculture. By integrating real-time data collection and automated control, the system significantly improves water management and resource efficiency. The use of sensors and cloud-based monitoring ensures precise irrigation, reducing water wastage and preventing issues caused by overwatering or underwatering. This data-driven approach enhances crop health and overall productivity.

The results clearly demonstrate that IoT-based irrigation leads to higher crop yields and better farming outcomes. By maintaining optimal soil moisture levels, the system promotes uniform plant growth and drought resistance. The improved water efficiency directly contributes to sustainable farming practices, making agriculture more resilient to changing climatic conditions.

Furthermore, the system reduces the dependency on manual labor, allowing farmers to remotely monitor and control the irrigation process. This not only saves time but also reduces operational costs, making farming more cost-effective. The automation of repetitive tasks increases accuracy and consistency, leading to better agricultural practices and higher profitability.

Overall, the IoT-based irrigation system offers a scalable and eco-friendly solution for the agricultural sector. Its technological efficiency, water conservation benefits, and labor-saving capabilities make it a promising tool for sustainable and precision farming, paving the way for more efficient and profitable agricultural operations.

REFERENCES

[1]. Kavitha and Kumar Smart irrigation system using IoT technology", Vol. 19, No. 14. 2020

[2]. Li et al "Smart irrigation system using IoT and Machine Learning Algorithms" Li et al. 2021.

[3]. Zaman et al "Smart irrigation system" Vol. 11, No. 10. (2020).

[4]. S. S. Saini, N. Narender, and V. Kumar, "Design and implementation of a smart irrigation system using IoT technology", International Journal of Computer Science and Information Security, Vol. 16, No. 4. 2018

[5]. R. K. Gupta, A. Sharma, and M. R. Sharma," Smart irrigation system using IoT technology", Proceedings of the 2018 3rd International Conference on Computing Sciences (ICCS), 2018.

[6]. S. Patil and S. S.Suryawanshi. "A review of smart irrigation systems using IoT technologies", Journal of Ambient Intelligence and Humanized Comp, vol.20, No.13,2020.

[7]. Li, D., Huang, G. B., Zhang, Y., & Zhu, Q. (2018). IoT-Based Smart Agriculture: Toward Making the Fields Talk. IEEE Access, 6, 4, 2019.

[8]. Al-Saedi, H. A., Mirjalili, S., & Sadiq, A. S. (2019). Smart Irrigation Systems: A Review on Recent Literature. Sensors, 19(3), 487.

[9]. Khan, I. A., Islam, N., & Hassan, S. U. (2019). IoT-based Smart Agriculture: A Review. Journal of Sensor and Actuator Networks, 8(1),12.

[10]. Jha, S. K., Ansari, M. I., & Malhotra, J. (2020). IoT-Enabled Smart Irrigation System Using Machine Learning Algorithms. In Proceedings of 2020 International Conference on Smart Electronics and Communication (pp. 1-6). IEEE.

[11]. Kavitha, G., & Thangavel, P. (2021). Design and Implementation of Smart Irrigation System Using IoT. In 2021 International Conference on Computing, Communication, and Signal Processing (ICCSP) (pp. 601-604). IEEE.

[12]. Hussain, M., Javaid, N., & Wadud, Z. (2021). Smart Irrigation Systems for Sustainable Agriculture: A Comprehensive Survey. Computers and Electronics in Agriculture, 192, 106437. Patel, S., & Shah, N. (2022).

[13]. IoT-Based Smart Irrigation System: A Comprehensive Survey. In Proceedings of the 3rd International Conference on Smart Systems and Inventive Technology (pp. 10371042). Springer.

[14]. Zhang, Y., Zhang, C., Wang, J., & Dong, X. (2020). A Smart Irrigation System Based on IoT and Edge Computing. In 2020 International Conference on Electronics and Communication Engineering (ICECE) (pp. 316-321). IEEE.

[15]. Mubeen, S., Liaqat, M., Javaid, N., & Akram, A. (2020). IoT-Based Smart Irrigation System Using Machine Learning Techniques. In 2020 International Conference on Advances in Emerging Computing Technologies (AECT) (pp. 1-5). IEEE.

[16]. Gupta, R., Tripathi, A. K., & Mishra, S. (2021). Smart Irrigation System for Precision Agriculture Using IoT. In 2021 International Conference on Automation, Computational and Technology Management (pp. 423-428). IEEE. 11 E3S Web of Conferences 472, 01026 (2024) https://doi.org/10.1051/e3sconf/202447201026 ICREGCSD 2023

[17]. Taha, A. M., Othman, S. A., & Hassan, W. H. (2021). Smart Irrigation System Based on IoT and Machine Learning for Water Conservation. In Proceedings of the International Conference on Smart Systems and Technologies (pp. 107-119). Springer.

[18]. Qazi, T. U., Hanif, U., Khan, M. A., & Waheed, S. (2022). Smart IoT-based Irrigation System Using Machine Learning for Efficient Crop Growth. In Proceedings of the 3rd International Conference on Smart Systems and Inventive Technology (pp. 1324- 1328). Springer.