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REVIEW PAPER ON AUTOMATED IRRIGATION SYSTEM USING ARDUINO

Prof. Sagar R. Raut[1], Ankita G. Ughade[2], Srushti D. Upadhye[2], Anuradha D. Rathod[2], Nandini G. Bhagat[2], Bhushan K. Raut[2], Abhilash A. Matekar[2], Akash M. Chokhat[2]

[1]Assistant Professor, Department of Civil Engineering, Jagadambha College of Engineering & Technology, Yavatmal, Maharashtra, India

[2]Students of Second Year, Department of Civil Engineering, Jagadambha College of Engineering & Technology, Yavatmal, Maharashtra, India

ABSTRACT

Water is an essential requirement for agricultural production. Traditional irrigation generally depends on manual operation, which can lead to over-irrigation, under-irrigation, water wastage, and increased labour. Automated irrigation systems can overcome these problems by supplying water according to the moisture condition of the soil. This review combines the supplied research papers, project presentations, and previous review material on automated irrigation systems. The focus is on Arduino-based irrigation using a soil moisture sensor, DHT11 temperature-humidity sensor, relay, and water pump. The soil moisture sensor detects whether the soil is dry or sufficiently wet. Arduino processes the sensor value and operates the pump through a relay. DHT11 can additionally provide temperature and humidity information. The reviewed studies show that moisture-based automatic control can reduce unnecessary watering, human effort, and water wastage.

Keywords: Automated irrigation, Arduino, Soil moisture sensor, DHT11, Relay, Water pump, Water conservation

I. INTRODUCTION

Agriculture requires an adequate and timely supply of water for healthy plant growth. In conventional irrigation, farmers generally inspect the field and manually operate the pump. This requires regular attention and may result in supplying either too much or too little water. The supplied project material identifies manual operation, continuous monitoring, water wastage, and improper irrigation as important problems. An automated system can monitor soil moisture and operate the pump according to the actual soil condition

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Fig. 1: Traditional irrigation system

II. OBJECTIVES

1. To review the existing smart irrigation systems and their working methods.
2. To review the use of sensors and Arduino for automatic irrigation.
3. To review different methods of soil moisture monitoring for efficient water management.
4. To review the advantages and limitations of smart irrigation systems.
5. To review the potential of smart irrigation technology in saving water and improving irrigation efficiency.

III. LITERATURE REVIEW

3.1 Moustafa et al. (2026): conducted a systematic review of IoT-enabled smart irrigation systems for precision water management. The study examined the integration of IoT, wireless sensor networks, and decision-support systems for real-time irrigation management. The reviewed studies showed that smart irrigation can substantially reduce water consumption while maintaining or improving crop productivity. The authors also identified challenges such as sensor calibration, system scalability, farmer training, and economic feasibility.

3.2 Mohammadi et al. (2026): reviewed the integration of IoT and machine learning in smart irrigation, particularly for water-scarce agricultural regions. The study explained how soil-moisture sensors, weather information, and crop-related data can be combined to determine appropriate irrigation schedules. Machine-learning methods can support predictive decision-making and reduce unnecessary irrigation. The authors emphasized the importance of developing affordable and adaptable systems for water secure agriculture.

3.3 Dutta et al. (2026): investigated the integration of IoT and communication technologies for smart and precision irrigation. Their review considered sensors, wireless communication, cloud computing, and real-time control technologies. The study showed that combining these technologies can improve monitoring and automation of irrigation operations. It also identified

communication reliability, scalability and interoperability as important challenges for future system.

3.4 Khazraji, Hussein, and Almawla (2026): The authors reviewed IoT and soil-sensor technologies for sustainable smart irrigation. Their work compared different approaches for measuring soil conditions and discussed technologies such as time-domain reflectometry and wireless communication. The review highlighted that accurate soil information is essential for determining irrigation requirements. The study also emphasized the need for reliable sensors and standardized systems for large-scale agricultural applications.

3.5 Jaiswal, Kumar, and Shukla (2025): reviewed IoT-enabled smart drip irrigation systems, focusing on system architectures, machine-learning models and emerging technologies. The review examined 56 peer-reviewed studies and discussed the use of AI, IoT and real-time monitoring for irrigation optimization. The authors reported that machine-learning models can improve irrigation scheduling and resource management. They also identified the lack of standardized datasets and scalable frameworks as major research gaps.

3.6 Sharma et al. (2025): presented an overview of smart irrigation systems and examined IoT, wireless sensor networks, cloud computing, artificial intelligence, and machine learning. The study explained how these technologies enable real-time monitoring and data-based irrigation decisions. The authors highlighted their potential to improve crop productivity and water-use efficiency. They also discussed limitations associated with system complexity, data management, and implementation costs.

3.7 Taufik et al. (2025): Developed a low-cost, solar-powered smart irrigation system using Arduino, GSM, and a capacitive soil-moisture sensor. The system enables automatic monitoring, SMS-based pump control, and reduced manual intervention and water wastage.

3.8 Hammouch et al. (2024): conducted a systematic review and meta-analysis of intelligent irrigation systems. The study classified research into three major areas: IoT-based field measurements, remote sensing, and artificial intelligence. It reviewed a large number of publications and demonstrated the increasing importance of data-driven irrigation management. The authors concluded that combining sensing, remote sensing and AI can provide more accurate and sustainable irrigation decisions.

3.9 Abiadi et al. (2024): reviewed recent developments in smart irrigation and precision agriculture technologies. The study discussed the use of sensors, communication systems, and intelligent control methods to monitor agricultural fields. It highlighted the importance of realtime information for improving irrigation scheduling. The authors also pointed out That practical implementation requires reliable technology, suitable infrastructure and consideration of local agricultural conditions.

3.10 Bounajra et al. (2024): examined smart irrigation approaches for improving agricultural water management. Their study emphasized the use of environmental information and crop water requirements to determine irrigation timing and quantity. The authors showed that precision irrigation can reduce unnecessary water application. The work supports the integration of monitoring and automated control for sustainable agriculture.

3.11 Sadiq, Wanke, and Azad (2024): investigated research trends in IoT-enabled smart irrigation using bibliometric analysis. Their study identified the increasing use of IoT, sensors, artificial intelligence, and data analytics in irrigation research. The authors observed a strong movement toward automated and predictive irrigation systems. Their findings help identify important research directions for future smart irrigation development.

3.12 Togneri et al. (2023): studied data-driven approaches for estimating crop water requirements in IoT-based smart irrigation. The research emphasized the importance of determining how much water should be applied and when it should be applied. Machine learning and data-analysis techniques were considered useful for improving irrigation decisions. The study concluded that accurate water-need estimation is an important component of precision irrigation.

3.13 Kodati et al. (2023/2024): conducted a systematic literature review of smart irrigation systems using IoT and advanced machine-learning models. The study analyzed research on predictive analytics, anomaly detection, and adaptive irrigation control. The authors identified improvements in real-time data processing and system responsiveness. However, they also reported challenges involving data integration, network reliability, scalability, and lack of standardization.

3.14 Anoop and Bala (2023): Investigated an IoT- and machine-learning based automatic irrigation system. Their approach used sensor information and intelligent algorithms to support irrigation decisions. The study demonstrated how automated systems can reduce dependence on manual irrigation. The authors emphasized that combining IoT monitoring with machine learning can improve irrigation precision.

3.15 Alagarsamy et al. (2023): developed an Arduino-based automated irrigation system using soil-moisture and temperature sensors. The system determines irrigation requirements using sensor data and threshold values. It reduces manual effort, improves water management, and supports smart agriculture through IoT and precision farming. The study concluded that automated irrigation could provide real-time field information, reduce unnecessary water use, and improve agricultural productivity.

3.16 Obaideen et al. (2022): reviewed smart irrigation technologies for sustainable water management. The study explained how sensors and IoT technologies can monitor soil and environmental conditions in real time. Automated irrigation can then respond to actual crop

water requirements instead of using fixed schedules. The authors concluded that smart irrigation could contribute significantly to water conservation and sustainable agriculture.

3.17 Sangeetha et al. (2022) proposed an IoT-based smart irrigation management approach for sustainable agriculture. The system uses real-time monitoring and automated decision-making to manage irrigation. The study emphasized that intelligent irrigation could reduce water wastage while supporting agricultural productivity. The authors also discussed the role of IoT technology in improving remote monitoring and management.

3.18 Phasinam et al. (2022): Investigated the application of IoT and cloud computing in smart agriculture. Their research explained how field sensors can collect agricultural data and transmit it to cloud platforms for analysis. Such systems allow farmers to monitor field conditions remotely. The study highlighted cloud-based data management as an important component of modern automated irrigation.

3.19 Raghuvanshi et al. (2022): Examined security issues associated with IoT-enabled smart irrigation systems. Because irrigation systems increasingly depend on connected sensors and communication networks, protecting agricultural data and devices is important. The authors explored machine-learning-based approaches for detecting abnormal or malicious network behavior. The study demonstrated that cybersecurity should be considered alongside irrigation efficiency.

3.20 Abioye et al. (2022): reviewed monitoring and advanced control strategies for precision irrigation. The study considered sensor-based monitoring, automated control, and data-driven irrigation decisions. It showed that accurate monitoring of soil and environmental parameters can improve irrigation management. The authors also discussed the importance of advanced control strategies for achieving efficient water application.

3.21 Munir et al. (2021): Developed an intelligent irrigation-management approach using IoT and edge-computing technologies. Edge computing allows agricultural information to be processed closer to the field rather than depending entirely on remote cloud systems. This can improve response time for irrigation decisions. The study demonstrated the potential of combining IoT sensing with intelligent local decision making.

3.22 Hassan et al. (2021): Developed a wirelessly controlled, Arduino-based smart irrigation system using soil-moisture, humidity, pH, and nutrient sensors. The system uses threshold values to automatically control irrigation and allows remote monitoring through GSM and a mobile application. The study showed that automation can reduce water wastage and improve irrigation efficiency, although cost, maintenance, and installation complexity remain challenges.

3.23 Kanade and Prasad (2021): Developed an Arduino-based Machine Learning and IoT Smart Irrigation System. The system uses soil-moisture, temperature, humidity, and pH sensors

to monitor field conditions and automate irrigation. IoT and machine learning are used to improve irrigation decisions and conserve water. The study concluded that smart irrigation could reduce water wastage, manual effort, and improve crop management.

3.24 Jamroen et al. (2020): Investigated an intelligent irrigation scheduling system using a low-cost wireless sensor network. The system was designed to collect field information and support irrigation decisions. The study demonstrated that wireless sensors could reduce the need for continuous manual field inspection. The research also highlighted the potential of low-cost technology for precision agriculture.

3.25 Jimenez et al. (2020): Developed a cyber-physical intelligent agent for irrigation scheduling in horticultural crops. The system combines perception, actuation, reasoning, and control components. Crop modelling was used to determine irrigation prescriptions based on field conditions. The study showed that intelligent scheduling can improve water-use efficiency compared with simple fixed irrigation methods.

3.26 Abioye et al. (2020): Presented a detailed review of monitoring and advanced control strategies for precision irrigation. The authors examined technologies for sensing field conditions and automatically controlling irrigation. Their work showed that precision irrigation depends on reliable monitoring and appropriate control algorithms. The review also discussed future opportunities for integrating IoT and intelligent technologies.

3.27 Krishnan et al. (2020): Investigated intelligent irrigation approaches using sensor information and automated decision-making. The research focused on improving irrigation efficiency by responding to actual field conditions. Intelligent control can help prevent both over-irrigation and under-irrigation. The study supports the use of automated sensing and decision systems for sustainable water management.

3.28 Hamoodi, S. A., Hamoodi, A. N., & Haydar, G. M. (2020): Developed an automated irrigation system based on soil moisture using an Arduino board. The system uses a soil moisture sensor to monitor the moisture level and automatically controls a DC water pump. When soil moisture falls below the set level, the pump turns ON, and when sufficient moisture is present, the pump turns OFF. The system also uses solar energy, making it suitable for reducing water and electricity wastage. The practical results were like simulation results, showing that the system can reduce manual work and improve irrigation efficiency.

3.29 Prasojo et al. (2020): Developed an automatic plant-watering system using Arduino and a soil-moisture sensor. The system automatically opens a solenoid valve when soil is dry and stops watering when sufficient moisture is detected.

3.30 Ayaz et al. (2019/2020): Reviewed IoT-based smart agriculture and discussed the use of sensors, communication technologies and cloud platforms. The study explained how connected agricultural devices can collect information about soil and environmental conditions. These

data can support irrigation decisions and remote monitoring. The authors identified IoT as an important technology for developing more efficient and sustainable agricultural systems.

3.31 Nawandar and Satpute (2019): Developed a low-cost intelligent module for smart irrigation. The system incorporated IoT communication, neural network-based decision-making, and remote monitoring. MQTT and HTTP protocols were used to communicate irrigation information. Their experimental work demonstrated that a portable and relatively low-cost intelligent system can support efficient irrigation management.

3.32 Kamaruddin et al. (2019): Developed an IoT-based intelligent irrigation management and monitoring system using Arduino, soil-moisture sensors, wireless communication, and an Android application. The system can automatically irrigate when soil moisture falls below a set threshold and allows remote monitoring and manual control. The study showed that the system can reduce water wastage and prevent over-irrigation.

3.33 Goap et al. (2018): Developed an IoT-based smart irrigation management system using machine learning and open-source technologies. Field sensors and weather information were used to support soil-moisture prediction and irrigation scheduling. The system aimed to apply water according to predicted crop requirements rather than a fixed schedule. This work demonstrated the value of combining IoT sensing, machine learning, and weather forecasting for precision irrigation.

3.34 Jawad et al. (2017): Studied energy-efficient wireless sensor networks for precision agriculture. Since agricultural monitoring systems may operate over large fields, reducing sensor-network energy consumption is important. The research discussed communication and networking strategies that can improve the lifetime of sensor nodes. Such energy-efficient networks can support long-term agricultural monitoring and automated irrigation

3.35 Devika, Bose & Vijayalekshmy (2017): Developed an automatic plant irrigation system using Arduino, demonstrating the application of Arduino-based automation in irrigation

3.36 Ojha, Misra, and Raghuwanshi (2015): Reviewed wireless sensor networks used in agriculture. Their study discussed sensor deployment, communication, energy consumption, and agricultural monitoring applications. Wireless sensor networks were identified as useful for collecting spatially distributed field information. The review provides an important technological foundation for sensor-based smart irrigation systems.

3.37 Gutiérrez et al. (2014): Developed an automated irrigation system using a wireless sensor network and GPRS communication. The system monitored agricultural conditions and enabled irrigation to be controlled automatically. Their research demonstrated that wireless communication could reduce manual intervention in irrigation. It also provided an early example of remote agricultural monitoring and automated water management.

3.38 Evans et al. (2013): Investigated wireless sensing technologies for irrigation management. Their work demonstrated how sensors could provide information about field conditions to support irrigation decisions. The research contributed to the development of more precise irrigation practices. It also showed the importance of real-time field data in reducing unnecessary water application.

3.39 Vellidis et al. (2013): Investigated real-time wireless sensor technology for irrigation management. Their research focused on using sensor data to support timely irrigation decisions. Real-time monitoring can help identify changes in soil and crop conditions and adjust irrigation accordingly. The study demonstrated the potential of wireless sensing for improving water management.

3.40 Kim, Evans, and Iversen (2008): Developed a remote sensing and control system for irrigation using a distributed wireless sensor network. Soil and environmental information were collected using wireless sensors and used for irrigation control. The study demonstrated the feasibility of remotely monitoring and controlling irrigation operations. This research is an important early foundation for modern IoT-based irrigation systems.

IV. CONCLUSION

The combined review shows that an Arduino-based automated irrigation system is a simple, economical, and practical approach for improving irrigation management. The system uses a soil-moisture sensor to determine when water is required. Arduino processes the sensor signal and controls a relay-connected pump or solenoid valve. When the soil becomes dry, irrigation starts, and when sufficient moisture is reached, irrigation stops. DHT11 can additionally measure temperature and humidity. The reviewed studies demonstrate that this approach can reduce unnecessary watering, save labour and improve irrigation efficiency. For a student-level project, Arduino + soil-moisture sensor + DHT11 + relay + water pump provides a suitable basic system without requiring IoT or GSM.

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