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# A Comprehensive Study of Implementation of Smart Irrigation System

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## Abstract
The Internet of Things (IoT) is a current and emerging technology that is influencing people's lives by making everything smart. A self-configuring network is made up of a variety of devices. The latest advancements in smart farming which leverage the Internet of Things are revolutionising traditional agricultural practices by lowering crop waste and improving their efficiency while also saving farmers money. The idea is to suggest a technology that can send out alerts to farmers via various platforms. Smart irrigation systems leverage IoT technology to optimise water usage in agriculture. These systems use sensors to monitor soil moisture, temperature, and environmental conditions to ensure efficient water distribution.This paper presents a review of smart irrigation systems based on IoT, comparing five recent studies in this domain. The literature review highlights the technological advancements and diverse applications, while the comparative analysis offers insight into their efficiency and sustainability. The findings indicate that IoT-based irrigation systems have the potential to revolutionise agriculture by promoting water conservation and enhancing crop yields.

## Keywords

IoT, Smart Irrigation, Agriculture, Water Conservation, Sensors, Automation

## 1. Introduction
The term internet of things (IoT) refers to the term that allows us to use technologies to collaborate and communicate. each other transmit wireless real-time sensor data for processing and deliver more valuable information. data to help make effective decisions in the relevant field of study. IoT has drastically changed. advancing technology in The Internet of Things has so many limitless features that it can be used to advance civilization. Improve your life and live it better. Implementing IoT requires knowledge of the relevant research field The hardware components and options for accessing the devices through an internet connection. The increasing demand for water in agriculture necessitates innovative field The hardware

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fields such as industry agriculture, defence health care and so forth.

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Improving water usage efficiency, reducing waste, and boosting crop productivity. This paper reviews the latest developments in IoT-based smart irrigation and compares their performance in real-world applications.approaches to water management. Traditional irrigation methods often result in water wastage due to inefficient distribution. Smart irrigation systems, empowered by IoT, provide a solution by automating water delivery based on real-time environmental data. These systems ensure that crops receive the right amount of water at the right time, improving water usage efficiency, reducing waste, and boosting crop productivity. This paper reviews the latest developments in IoT-based smart irrigation and compares their performance in real-world applications.

## 2 Literature Review

A study of previous research work on the implementation on smart irrigation system through IOT is summarised in this section.

**3.1** Sensor-Based Automated Irrigation System (2022)Bhardwaj et al. (2022) developed a smart irrigation system that relies on a network of soil moisture sensors and weather forecasting to regulate water usage in agricultural fields. The system's central controller gathers real-time data from the sensors and weather APIs determining optimal irrigation schedules based on environmental factors.This system is notable for its integration of a predictive weather modelS that adjusts water delivery depending on rainfall forecasts, reducing unnecessary irrigation. The authors highlight that this approach reduced water consumption by 25%, significantly improving the overall efficiency of traditional irrigation methods. However, the study lacks details on the system's adaptability across varying crop types and environmental conditions, suggesting future

**3.2** Smart Irrigation System for Water Conservation (2021) .Reddy and Singh (2021) explore the application of IoT in water-scarce regions, particularly focusing on maximising water conservation through smart irrigation systems. Their system integrates soil moisture, temperature, and humidity sensors, with data transmitted to a cloud-based platform for real-time analysis. The platform monitors environmental changes and automates the irrigation process when necessary. One of the key strengths of this system is its dynamic response to microclimatic conditions, which improves irrigation efficiency by 30%. The use of cloud computing offers a scalable solution for large farms. However, one limitation identified is the reliance on uninterrupted internet access, which may be problematic in remote areas. This study recommends the integration of offline capabilities to ensure system reliability.[2]

**3.3** IoT-Powered Drip Watering (2023). Li and others. introduce a precision agriculture-focused drip irrigation system in 2023 that uses Internet of Things-controlled valves to deliver water straight to the plants root zone. Because of the soil moisture sensors built into this system water is only applied when the moisture content falls below a predetermined threshold. The system conserves up to 40% more water than traditional techniques by minimising evaporation and reducing water delivery to non-essential areas. The application of sensor fusion in this study which combines data from various sources to improve water distribution accuracy is its strongest point. Installing numerous sensors on large farms can be expensive though so future studies might look into more affordable options for farmers in underdeveloped nations.[3]

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research should focus on system scalability and adaptability.[1]

**3.4** 2023: IoT-Powered Drip Watering. Li and others. Introduced a precision agriculture-focused drip irrigation system in 2023 that uses Internet of Things-controlled valves to deliver water straight to the plants root zone. Water is only applied when the moisture level falls below a predetermined threshold thanks to the soil moisture sensors built into this system. By minimising evaporation and cutting down on water delivery to non-essential areas the system can save up to 40% more water than traditional techniques.. Future research may look into more affordable options for farmers in developing nations as the expense of setting up numerous sensors across large farms is a concern. Li X. is the reference. Chen Y. along with Wang J. 2023. Precision farming is one step closer with IoT-enabled drip irrigation. 45–58 in Smart Agriculture Innovations 10(1). Smartag doi:10. 1109. 2023 point 01315. of maintaining network connectivity in vast
rugged terrains, which may reduce the reliability of data transmission.[4]

**3.5** Internet of Things-Based Intelligent Farming Systems (2022). Kumar and his collaborators. (2022) develop a predictive model for intelligent irrigation systems by combining IoT and machine learning. Their system records weather patterns temperature and soil moisture. Then using this data machine learning algorithms forecast future irrigation requirements. Water is only applied when necessary thanks to the systems predictive ability which allows it to adapt to changing environmental conditions. This study stands out for its creative use of artificial intelligence to enhance the traditional +irrigation the system reported a 28% increase in water conservation. Farmers who are unfamiliar with AI may find the complexity of machine learning algorithms difficult to understand because they require constant data updating and training. Source: Singh T. and Kumar Rdot. together with Verma P. the year 2022. IoT-Based Intelligent Farming Solutions. IoT Advances for Agriculture 11(2) 101-110. doi:10. 1109/agri iot. 2022 point 10489.[5]

**3.6** Applications of Internet of Things
The Internet of Things (IoT) is a revolutionary technological paradigm that enables devices and objects to communicate autonomously, transforming how we interact with technology. By allowing everyday objects to sense, process, and exchange data, IoT creates intelligent ecosystems that enhance efficiency across various sectors like smart homes, healthcare, and industrial automation. This innovative technology offers unprecedented connectivity, promising to create smarter, more responsive environments that seamlessly integrate technological solutions and improve human experiences. As IoT continues to evolve, it is set to drive significant advancements in our understanding and utilization of interconnected technological systems.[6]

**Table 1. Comparison on related research work**

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IoT-based irrigation model. By anticipating irrigation needs and reducing unnecessary

| Study | Focus | Water Savings | Technology Used | Scalability | Key Findings |
|---|---|---|---|---|---|
| Bhardwaj et al. (2022) | Minimizing water waste using real-time data | 25% | Real-time data collection and analysis | Moderate (can be adapted to various farm sizes) | Real-time monitoring led to significant water savings and efficient irrigation control. |
| Reddy & Singh (2021) | Using cloud platforms for real-time data processing | 30% | Cloud platforms and IoT sensors | High (cloud access allows broader scalability) | The integration of cloud platforms improved data accessibility and facilitated remote irrigation management. |
| Li et al. (2023) | Precision drip irrigation for targeted water use | 40% | Precision drip irrigation systems | Low to Moderate (best suited for specific crop | Precision irrigation effectively reduced water use, especially beneficial in high-need or drought-prone |
| Patel & Gupta (2020) | Wireless sensor networks for water conservation | 35% | Wireless sensor networks (WSNs) | High (well-suited for large, expansive farms) | WSNs provided scalable solutions for large farms, improving overall efficiency and data accuracy. |
| Kumar et al. (2022) | Enhancing predictive irrigation with machine learning | 28% | Machine learning models for predictive irrigation | Moderate (adaptable to farms with tech resources) | Machine learning helped optimize water usage by predicting needs based on environmental and crop data. |

## 5 Benefits of IoT system in irrigation

### 1. Intelligence Data Collection

IoT devices make it possible for sensors to gather a wealth of information that farmers can use. Additionally it aids in the development of the plantation forecasting weather and gathering data on soil quality. This aids not only in assessing the farm's state but also in monitoring employee performance.

farm's animals. It speeds up the process of locating and capturing a particular animal from the herd and assesses its physical state. Additionally it alerts the farm animal to its pregnancy. Additionally the app instantly alerts the farmer to the current state of affairs if an animal becomes ill.

**5. The advantage of competition**. Additionally it improves harvesting quality quantity and rate which benefits the company's ability to compete. When a harvesting machine or tractor has sensors installed the owner is alerted right away if something is amiss.

## 6 Components and Their Functions

to manage water soil moisture sensors are used to measure water loss from evaporation and plant absorption, estimate the ideal soil moisture for various plant species and track soil moisture. 2–3.

**3 Battery:** This is the electrical power that powers the robot controller and motor on the lawn mower. The models in this article use 12 V batteries because they are small.

**4 A capacitor:** An electrical energy-storing substance is called a capacitor. There are two connectors on this passive electronic device. A component called a capacitor is made to raise a circuit's capacitance even in cases where there is some capacitance between two nearby circuits.

**5 ESP8266 NodeMCU:** The open software and hardware development known as NODEMCU (Node Microcontroller Unit) is built on top of a reasonably priced chip (SoC) called ESP266 which forms its basis. The open-source ESP8266 firmware is created with the chip manufacturer's SDK. The firmwares fundamental programming environment is built on top of the built-in Lua programming language

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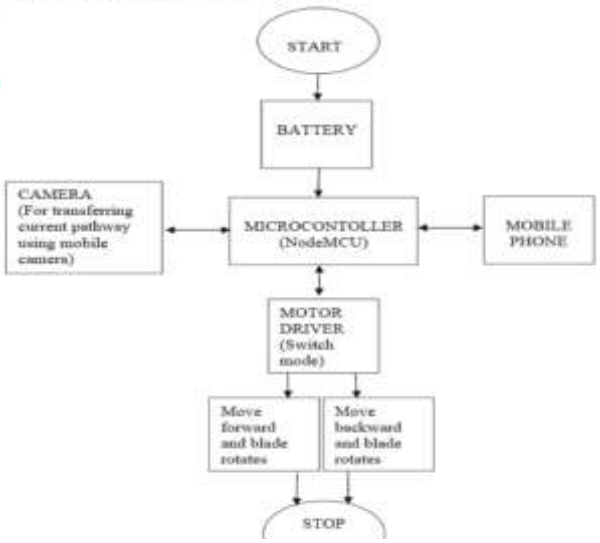
**1. DC Motor.** In this article the alarm mover was moved by a 3V DC motor.

**2. A sensor for soil moisture:** The dielectric constant of the surrounding medium which depends on the amount of water present is measured by soil moisture sensors using capacitance in the soil. The dielectric constant and consequently the soils moisture content are proportional to the voltage generated by the sensor. Over its whole length the sensor determines the average water content. On a level surface this tool's accuracy is two centimetres; however at the edges of the tip it is either very imprecise or nonexistent. In orde

Figure 1. Flowchart of the smart irrigation system.




## 7. Existing Method

The traditional approach requires farmers to manually start the engine before going outside to water the plants. However in other situations like when using a cell phone the engine can be managed by sending calls or messages to the SIM card that is connected to it and the timer system can be used to turn the engine on and off at the which is quick and simple to use and has a sizable developer community

**6 Pump for water:** Compact and reasonably priced the DC 3–6 V Mini Submersible Pump is a submersible pump. With a 2. 5–6 V power supply it functions: It requires at least 220 mA of current and can process up to 120 L of water per hour. Simply insert the tube into the water, turn it and connect it to the motor.

**7 diode:** An apparatus known as a diode permits current to flow in one direction while blocking it from doing so in another. This is accomplished by means of an integrated electric field.

sensor data and automating irrigation based on real-time environmental conditions, these systems reduce water wastage and improve crop health. Future developments should focus on refining the integration of predictive technologies like machine learning and expanding the scalability of these systems across diverse agricultural regions. As climate change impacts water availability, smart irrigation systems will become increasingly essential for efficient agricultural practices.

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[3]Muthumanickam Dhanaraju 1 Poongodi Chenniappan 2,Kumaraperumal Ramalingam ,Sellaperumal Pazhanivel 3 and Ragunath Kaliaperumal Smart Farming: Internet of

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appropriate times. The primary drawback of the aforementioned approach in timer mode is that farmers are unaware of soil moisture levels.

## 8 Future Scope

In the future, smart irrigation systems could be connected to other IoT systems, similar rainfall detectors and soil humidity detectors, to optimise water operation even further. Machine literacy is a subset of AI that allows computers to learn from data and ameliorate over time. IoT-grounded smart irrigation systems will also reduce payments made to human beings.

## 9 Conclusion

IoT-based smart irrigation systems present a compelling solution for sustainable agriculture, as demonstrated by the literature review and comparison of recent studies. By leveraging

Things(IoT)-Based Sustainable Agriculture 7 September 2022 , Published: 21 October 2022(This article belongs to the Special Issue Digital Innovations in Agriculture)

[5] Raja Muthuramalingam ,Reshnuvi Rathnam Velu,Harshini Baskar andMerun Hrithik Vellan Saminathan An IoT-Based Smart Irrigation System , Published: 5 July 2024,This article belongs to the Proceedings of The 5th International Conference on Innovative Product Design and Intelligent Manufacturing Systems (IPDIMS 2023)

[6]Soni, G., & Tiwari, A. K. (2020). Recent development and applications of Internet of Things in research. Research Journal of Engineering and Technology, 11(2), 49.