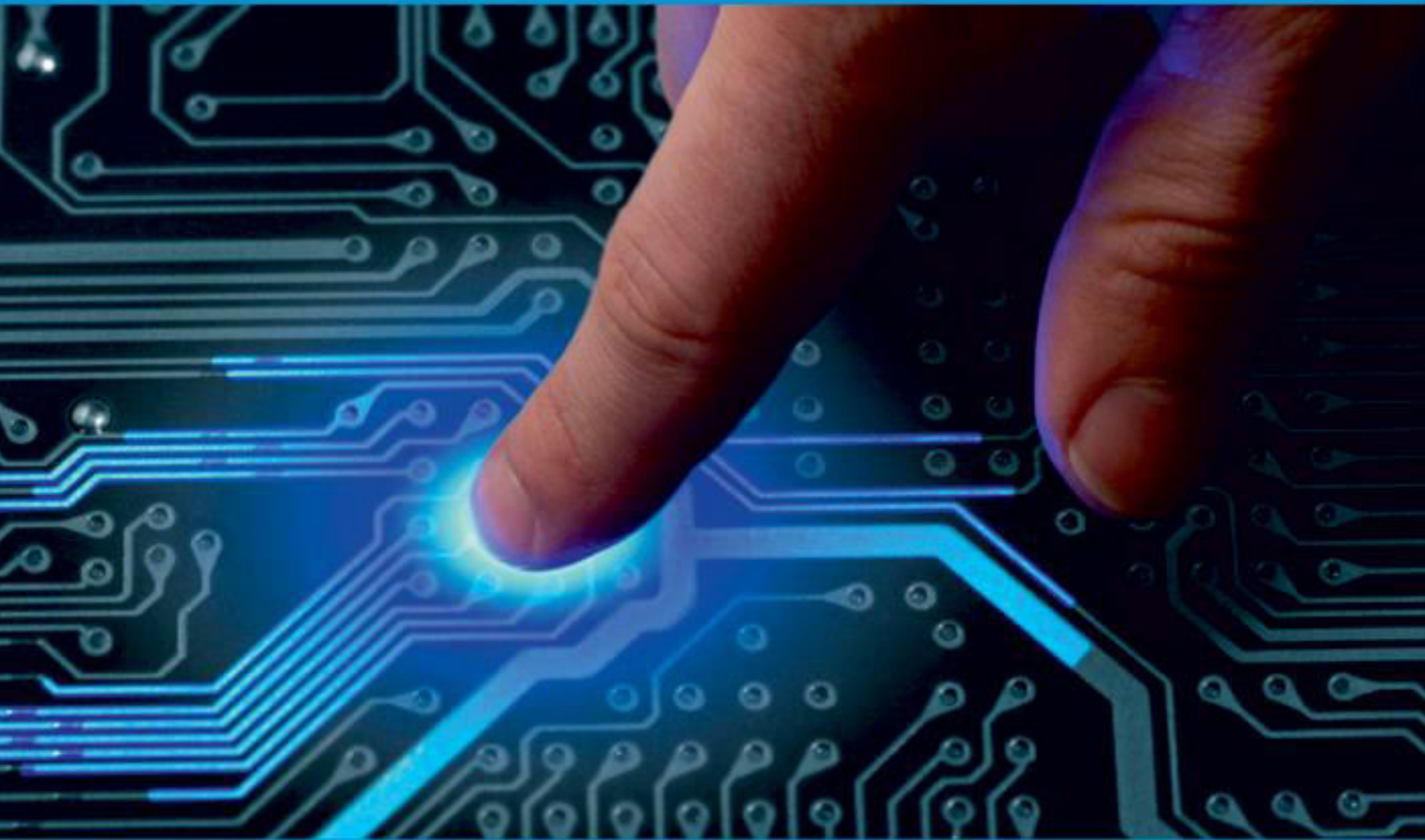
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

## IN COMPUTER & COMMUNICATION ENGINEERING

**Volume 12, Issue 6, June 2024**

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

**Impact Factor: 8.379**

9940 572 462 6381 907 438 ijircce@gmail.com www.ijircce.com

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 6, June 2024 ||

| DOI: 10.15680/IJIRCCE.2023.1206019 |

# Smart Irrigation Using Embedded AI

**Dr. Siddaraju[1], Chaithanya V[2], Prajwal P[3], Sahana S[4]**

Professor and HOD, Department of Computer Science and Engineering, Dr. Ambedkar Institute of technology, Bangalore, Karnataka, India[1]

Students, Department of Computer Science and Engineering, Dr. Ambedkar Institute of Technology, Bangalore, Karnataka, India [2,3,4]

**ABSTRACT:** An increasing number of innovative solutions utilizing state-of-the-art technology have been developed as a result of the growing demand for effective water management in agri+culture. This study proposes a cutting-edge smart irrigation system that transforms water use optimization based on real-time environmental data by expertly combining the Internet of Things (IoT) and Artificial Intelligence (AI). This system's primary components are DHT11 and soil moisture sensors, which are tightly connected to an ESP8266 microprocessor to collect critical data on temperature, humidity, and soil moisture. This data is seamlessly transmitted to the ThingSpeak cloud platform, which serves as a repository for real-time storage and detailed analysis. Using a Random Forest algorithm, a sophisticated AI method that was painstakingly created to precisely anticipate the quantity of water needed for irrigation based on integrated sensor data, is at the heart of this creative system. This predictive model is continuously refined with new data streams, ensuring consistent accuracy in its predictions. Additionally, the system integrates a relay module and water pump, orchestrating a synchronized irrigation process that dispenses the exact calculated amount of water to nourish the crops. A Telegram bot is used to deliver real-time messages on irrigation activities, along with specifics about the amount of water supplied, in order to improve user involvement and oversight even further. This all-encompassing strategy encourages sustainable agricultural methods, lowers the need for manual intervention, improves water efficiency, and automates the irrigation process. By skillfully merging AI and IoT, this proposed solution aims to boost agricultural productivity and strengthen resource management practices, marking a significant step towards a more sustainable and prosperous agricultural future.

**KEYWORDS:** Smart Irrigation, IoT, AI, Random Forest Algorithm, Soil Moisture Sensor, DHT11 Sensor, ThingSpeak, ESP8266, Automated Irrigation, Sustainable Agriculture, Water Management, Telegram Notifications.

## I. INTRODUCTION

Mobile A major obstacle to modern agriculture is the increasing shortage of water and the pressing need for sustainable techniques. Agriculture is the foundation of human civilization. Sustainable environmental practices and food security depend on effective water management. Traditional irrigation methods often exacerbate these issues, leading to unnecessary water waste and suboptimal crop yields. To overcome these obstacles, though, creative solutions utilizing cutting-edge technology like artificial intelligence (AI) and the Internet of Things (IoT) are being investigated more and more. A particularly promising method for maximizing water use in agriculture among them is the use of smart irrigation systems. By harnessing real-time environmental data and deploying predictive algorithms, these systems revolutionize the irrigation process. They achieve this by automating and fine-tuning irrigation activities, delivering the precise amount of water needed by crops. The benefits extend beyond water conservation, manifesting in the robust health and enhanced yield of cultivated crops.

The study under review offers a full analysis of an all-inclusive smart irrigation system that combines AI and IoT technology. It discusses in great detail how to monitor important environmental factors including temperature, humidity, and soil moisture levels using cutting-edge sensors like DHT11 sensors and soil moisture sensors. As the central node for data collection and transmission, the ESP8266 microcontroller is essential to this system.These data are transmitted to the ThingSpeak cloud platform for real-time analysis, where the powerful Random Forest algorithm is employed. Through the use of extensive sensor data, our machine learning technology ensures optimum water consumption by precisely predicting ideal irrigation levels.

In addition, the system's performance is improved by extra parts such a water pump and relay module, which smoothly automate the watering operation. User interaction and control are facilitated through a Telegram bot, providing timely

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 6, June 2024 ||

| DOI: 10.15680/IJIRCCE.2023.1206019 |

notifications regarding irrigation activities. This enhances user awareness and offers a level of control unprecedented in traditional irrigation practices.

This survey article, in its whole, explores the many subtleties of the smart irrigation system that is being studied. It thoroughly examines the various components, the underlying architecture, and the performance metrics of the system. Through rigorous analysis, the paper highlights the potential benefits and challenges inherent in integrating IoT and AI technologies in agricultural contexts. In the end, it emphasizes how important technology developments are to advancing sustainable water management strategies and raising agricultural yield. This survey paper seeks to make a significant contribution to the expanding body of knowledge about smart irrigation systems, with the ultimate goal of supporting sustainable agriculture. The knowledge gained from this endeavour will be important in shaping future research and development, which will ultimately improve the productivity and efficiency of agricultural practices globally.

### A. Water management

In order to preserve economic stability, environmental sustainability, and food security, agriculture must practice efficient water management. A limited and crucial resource, water is necessary for agricultural development, healthy soil, and ecological equilibrium. However, rising water demand and climate change-induced variations in precipitation have heightened concerns about water scarcity and the necessity for effective management practices.

Implementing efficient water management serves several key purposes. Firstly, it conserves resources by minimizing wastage and sustaining water levels in rivers, lakes, and groundwater reservoirs, ensuring availability for other sectors and ecosystems. Secondly, it maximizes crop yield by providing the right amount of water at optimal times, thereby enhancing productivity and quality. Thirdly, by halting over-irrigation-related environmental damage including soil erosion and waterlogging, sustainable water management techniques support biodiversity and the health of ecosystems. These methods also increase farming systems' resilience and water efficiency, which lessens the negative effects of climate change on agriculture. By cutting expenses and raising yields, implementing water-saving technology and intelligent irrigation systems boosts profitability economically.

By using IoT and AI technology to optimize water consumption, the smart irrigation system discussed solves these issues. It gathers real-time environmental data, analyzes it using predictive algorithms, and automates irrigation to supply precise water amounts to crops. This approach not only enhances efficiency and minimizes wastage but also improves yields while reducing environmental impact. Moreover, the system provides farmers with insights and notifications through a Telegram bot, enabling informed decision-making and resource optimization. In summary, the smart irrigation system contributes to efficient water management, sustainable agriculture, environmental conservation, and economic resilience. Maintaining water supplies, improving crop resilience, and guaranteeing long-term food security require embracing technology advancements and using intelligent water management techniques

## II. RELATED WORK

Abdelghani Chourabi, Taoufik Ahmed, and Hamed Zgaya [1] introduce a precision agriculture framework utilizing wireless sensor networks (WSNs). Their system monitors soil moisture, temperature, and other environmental factors to optimize irrigation. Data collected by the sensors are wirelessly transmitted to a central server for analysis and decision-making, showcasing the potential of WSNs to enhance water management and crop yield. Anuradha S. Apte and Smita S. Sonavane [2] describe in detail the planning and execution of a smart irrigation system that makes use of a GPRS module for remote monitoring and control and a wireless sensor network. The device monitors environmental factors including soil moisture, delivering data for analysis to a cloud server. Irrigation is then controlled based on this processed data, aiming to reduce water wastage and increase efficiency. Oscar Castillo and Patricia Melin [3] Consider developing a wireless sensor network to gauge soil moisture content in order to optimize water consumption in agriculture by making sure irrigation happens only when it's required. Their study's field testing show considerable water savings. R. N. Rao and B. Sridhar [4] describe the creation of a WSN- and GPRS-based automated watering system. Wireless networks are used by the system's soil moisture sensors to connect to a central unit. The central unit processes the data and controls irrigation based on predefined thresholds to enhance water use efficiency. N. S. D. Nandurkar, V. R. Thool, and R. C. Thool [5] put out a clever irrigation management system that uses fuzzy logic in conjunction with wireless sensor networks to assess watering requirements. Utilizing fuzzy logic algorithms, data on temperature, humidity, and soil moisture are gathered and analyzed to optimize water usage and boost agricultural yields through irrigation decisions. Vinay Sagar K N and Kusuma S M [6] Describe a WSN-based automated irrigation

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 6, June 2024 ||

| DOI: 10.15680/IJIRCCE.2023.1206019 |

system that has a GPRS module for remote tracking. An automated irrigation system saves water and minimizes human involvement by sending data from temperature and moisture sensors to a cloud server for analysis. M. K. Gayatri, J. J. Judith, and A. J. Harsha [7] Talk about a smart irrigation system that uses soil moisture sensors and the Internet of Things to monitor and regulate watering. To improve water saving and deliver precision irrigation, real-time data is uploaded to a cloud server for processing, which then determines irrigation schedules. Alireza Boroujerdi and Hamidreza Karimi [8] focus on designing a WSN for precision agriculture. Their system consists of a number of sensors that keep an eye on the soil and surrounding surroundings. Data is collected and processed to optimize irrigation, increase crop yields, and enhance water usage efficiency. Shivaprasad N. J. and Anirudh R. [9] explain a cloud-based, IoT-enabled smart irrigation system that uses ambient and soil moisture sensors to gather data, which is then uploaded to a cloud platform for analysis. This allows irrigation to be automated to save water and boost agricultural output. Pradip Kumar Sharma and Jong Hyuk Park [10] talk about the use of IoT and WSNs in precision agriculture, giving a summary of smart irrigation systems and stressing their advantages and disadvantages. They stress how crucial it is to gather and analyze data in real time in order to manage water resources effectively and maintain crop health.

## III. PROPOSED SYSTEM

The suggested smart irrigation system in this part optimizes water use in agricultural fields by utilizing IoT and AI technology. The technology predicts the ideal quantity of water required for crops by integrating a number of sensors, a microcontroller, cloud-based data storage, and a machine learning algorithm. Additionally, it automates the irrigation process and sends user notifications, aiming to improve water efficiency and boost crop productivity.
Random Forest Algorithm

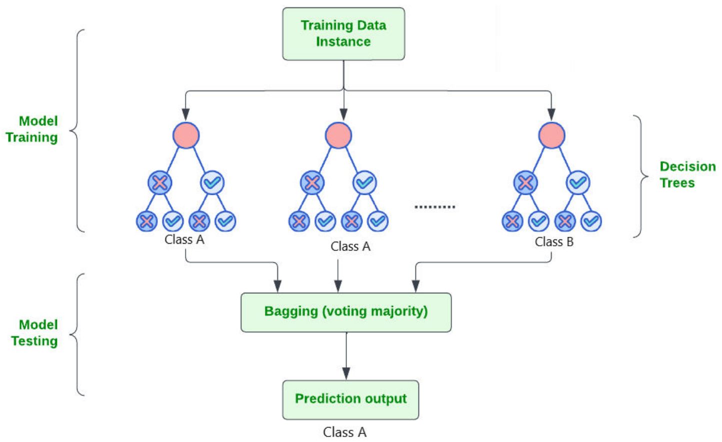



Fig 1: Random Forest Architecture

A popular ensemble learning method for tasks involving regression and classification is called Random Forest. In order to function, it creates a number of decision trees during training, from which it extracts the mean prediction for regression or the mode of the classes for classification. This method capitalizes on the "wisdom of the crowd" principle, where the aggregation of diverse predictions leads to more accurate and stable results than a single decision tree.

Using portions of the training data, many decision trees are first created in order to build a Random Forest. Bootstrapping is used to provide a unique random subset of the data that each tree is trained on. Additionally, at each node in a tree, a random subset of features is selected, and the best split among these features is chosen. This randomness in data and feature selection ensures that the trees are de-correlated, significantly enhancing the model's robustness and reducing the risk of overfitting.

Capable of handling high-dimensional data and capturing intricate feature interactions, Random Forest is one of its main advantages. This makes it especially useful in scenarios where the relationship between input variables and the target variable is non-linear and intricate. A useful tool for feature selection and comprehending underlying data patterns, the algorithm's integrated feature significance measure offers insights into which factors have the most influence on predictions.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 6, June 2024 ||

| DOI: 10.15680/IJIRCCE.2023.1206019 |

The Random Forest algorithm is used in smart irrigation to forecast the ideal water requirement for crops based on current environmental information, such as temperature, humidity, and soil moisture. The model learns to identify trends and forecast future irrigation requirements by being trained on historical data that contains these variables and the accompanying irrigation volumes. With less waste and more crop hydration, this predictive capability allows for accurate and effective water management.

In agricultural applications, where environmental variables might fluctuate greatly and unexpectedly, Random Forest's resilience and accuracy are essential. Its ensemble nature ensures that the model remains reliable even when individual trees make errors, as the overall prediction is an average of all tree predictions. Furthermore, the algorithm's ability to continuously improve with new data makes it adaptive to changing conditions, enhancing its effectiveness over time.
In summary, Random Forest is a powerful and versatile algorithm suitable for complex prediction tasks. Its application in smart irrigation systems exemplifies its ability to provide accurate and reliable predictions in dynamic environments, contributing to sustainable agricultural practices and efficient resource management.

A. **System Architecture**
The proposed system consists of the following key components:

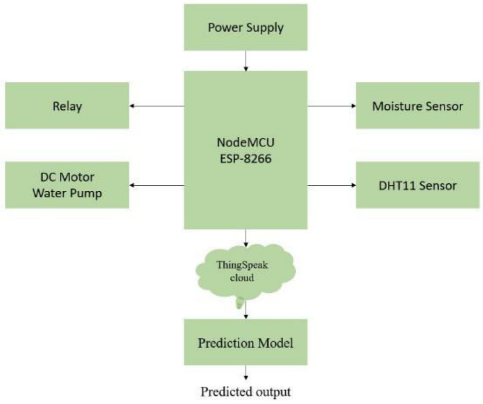



Fig 2: Block Diagram

1. Sensors:
In order to quantify the volumetric water content of soil and ascertain moisture levels, a soil moisture sensor is a crucial tool in precision agriculture and environmental monitoring. These sensors convert variations in the dielectric constant of the soil—which fluctuates with moisture content—into electrical signals that can be analyzed. Various types, such as capacitive, resistive, TDR, and FDR sensors, differ in terms of accuracy, cost, and maintenance requirements. By providing real-time soil moisture data, these sensors help optimize irrigation, minimize water waste, improve crop yields, and support sustainable water management. Their integration with automated irrigation systems and data analytics is transforming agriculture, making it more efficient and environmentally friendly.

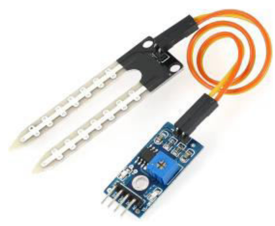


Fig 3: Soil Moisture sensor

DHT11 Sensor: The DHT11 sensor measures ambient temperature and humidity, providing essential environmental data that influences water requirements, particularly in agriculture and horticulture. It employs a capacitive humidity sensor and a thermistor to detect air conditions, converting these readings into digital signals for microcontrollers or data systems. Accurate, real-time measurements from the DHT11 help manage environmental factors affecting plant transpiration and soil evaporation. The DHT11 may be integrated with irrigation systems to provide accurate water

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 6, June 2024 ||

| DOI: 10.15680/IJIRCCE.2023.1206019 |

control that gives crops the right amount of moisture depending on the situation. This enhances water efficiency, improves plant health, and boosts agricultural productivity.

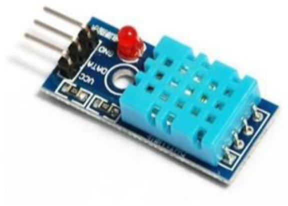


Fig 4: DHT11 sensor

2. NodeMCU:
ESP8266: The ESP8266 is a highly adaptable Wi-Fi module that is pivotal in smart irrigation systems I.e. Data is collected from many sensors, including DHT11 and soil moisture sensors, and sent to the cloud for real-time processing. Its strong connectivity ensures seamless integration with cloud-based platforms, enabling remote monitoring and decision-making. A relay module that is attached to a water pump may also be controlled by the ESP8266, automating the watering process in accordance with predetermined thresholds and data analysis. By supplying the exact quantity of water required by crops based on the present environmental circumstances, this guarantees that the irrigation system operates well, optimizing water use and raising agricultural yield.

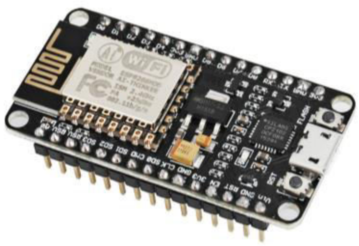


Fig 5: NodeMCU

3. Cloud Platform:
ThingSpeak: ThingSpeak is an IoT analytics platform designed for real-time data storage and retrieval, making it ideal for smart irrigation systems. Sensor data collected by devices like the ESP8266 is uploaded to ThingSpeak for processing and analysis. The platform allows users to visualize data through customizable charts and graphs, offering valuable insights into environmental conditions and system performance. Utilizing ThingSpeak's features, users can monitor trends, set triggers, and make informed decisions to optimize irrigation schedules, improve water efficiency, and enhance crop management. With its strong API, it can be easily integrated with other IoT devices and cloud services, offering a complete solution for sensor data management in precision farming.


Fig 6: ThingSpeak Cloud

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |
|| Volume 12, Issue 6, June 2024 ||
| DOI: 10.15680/IJIRCCE.2023.1206019 |

4. Machine Learning Algorithm:
Random Forest: When it comes to predicting the perfect amount of water required for irrigation, Random Forest is a powerful ensemble learning technique that precision farmers employ extensively. Resilience and accuracy are increased by this approach by generating a large number of decision trees during training and providing the average forecast from these trees. With its broad background in previous sensor data pertaining to temperature, humidity, and soil moisture levels, the Random Forest model is able to recognize complex patterns and correlations in the data with relative ease. As fresh data perpetually streams into the system, the model adapts and hones its predictions, ensuring that irrigation decisions are anchored in the most current and pertinent information. This innovative strategy is essential for increasing crop yields, conserving water, and promoting sustainable farming methods.

5. Actuators:
Relay Module: An essential part of automated irrigation systems is a relay module, which controls the water pump's operation to match predictions made by a Random Forest machine learning model. Once the model determines the ideal irrigation volume needed, it dispatches a signal to the relay module. In turn, the relay module activates or deactivates the water pump accordingly. This setup ensures precise and prompt irrigation, curbing water wastage and providing crops with essential hydration based on real-time environmental data and historical trends. The integration of a relay module with sophisticated predictive models and sensor networks promotes efficient water management, nurturing crop vitality, and upholding sustainable agricultural practices.


Fig 7: Relay

Water Pump: Working with real-time sensor data and predictions from machine learning models, the water pump is a crucial part of automated irrigation systems, ensuring crops receive the appropriate amount of water. Once the ideal irrigation amount is determined, often by algorithms like Random Forest, the water pump springs into action, activated by a relay module to commence the water delivery process. With precise control over the water flow, the pump ensures that crops receive the necessary hydration, fostering robust growth and optimizing agricultural productivity. This automated approach streamlines water usage, reduces manual intervention, and adjusts irrigation schedules in response to evolving environmental conditions, ultimately leading to enhanced crop yields and the adoption of efficient water management practices.

Fig 8: Water Pump

6. Communication:
Telegram Bot: A Telegram bot acts as a user-friendly interface for receiving notifications regarding irrigation activities and current environmental conditions in automated irrigation systems. With a smooth integration into the system, the bot notifies users and provides information on the amount of water sprayed during irrigation cycles as well as current environmental data like temperature, humidity, and soil moisture levels. This empowers users to stay updated on their crop status and irrigation operations, enabling timely adjustments and interventions when needed. Leveraging the Telegram platform, users can access these notifications effortlessly from any internet-connected device, enhancing

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 6, June 2024 ||

| DOI: 10.15680/IJIRCCE.2023.1206019 |

accessibility and convenience. In general, the Telegram bot facilitates better decision-making and user involvement in agricultural activity management, leading to more effective and responsive watering techniques.

B. Workflow

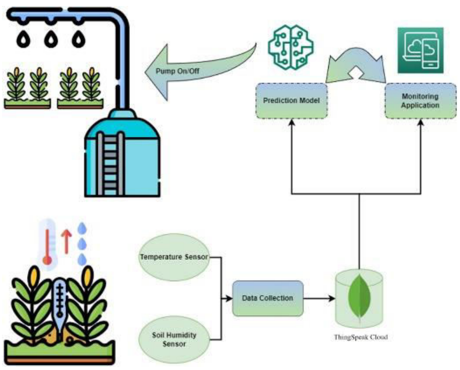



Fig 9: System Architecture

The smart irrigation system employs a systematic approach to efficiently manage water usage in agriculture, incorporating various crucial components and functionalities. Specialized sensors are carefully included into the system at the first stage of data collection in order to capture vital environmental data like as temperature, humidity, and soil moisture. These sensors, which continuously provide real-time data, are essential for figuring out how much watering the crops require. Acting as the central processing unit, the ESP8266 microcontroller retrieves the sensor data and sends it to the ThingSpeak cloud platform regularly. This ongoing data gathering makes sure that the system is always up to date with precise information about the current atmospheric and soil conditions.

Upon uploading the data to the ThingSpeak platform, a Python script is deployed to fetch the real-time data and prepare it for further analysis. Here, the sophisticated Random Forest algorithm, a powerful machine learning technique, is utilized to process the collected data. This program predicts the ideal quantity of water needed for the crops given the present conditions by evaluating environmental parameters. This predictive capability enables the system to proactively anticipate irrigation needs, thereby enhancing efficiency and minimizing water wastage.

ESP8266 microcontroller makes well-informed judgments on irrigation activities throughout the irrigation control phase based on the Random Forest algorithm's output. The irrigation process is started by the water pump when the microcontroller senses that irrigation is necessary. This is done by activating the relay. The irrigation duration is carefully calculated to deliver the precise amount of water required by the crops, ensuring they receive adequate hydration without facing either excess or deficiency.

Additionally, the system includes a user notification feature to enhance user interaction and awareness. After each irrigation action, the system automatically sends a Telegram message to the user, providing detailed information about the irrigation activity. This contains information about the volume of water discharged during irrigation and the humidity, temperature, and soil moisture content at the moment. Users may keep an eye on the system's performance, keep tabs on environmental changes, and make well-informed judgments on irrigation management techniques thanks to these real-time notifications.

In essence, the smart irrigation system seamlessly integrates data collection, processing, irrigation control, and user notification functionalities to optimize water usage in agriculture. Through the utilization of advanced technologies and automated processes, the system enhances efficiency, reduces resource wastage, and promotes sustainable farming practices. Ultimately, these efforts contribute to improved crop yields and environmental conservation, aligning with the overarching goal of fostering sustainable agriculture.

C. Implementation Plan

With its smooth integration of cutting-edge IoT and AI technologies, the proposed smart irrigation system stands out as a model of innovation in agricultural water management. Its fundamental component is a carefully designed hardware

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 6, June 2024 ||

| DOI: 10.15680/IJIRCCE.2023.1206019 |

arrangement, in which every element is essential to delivering excellent performance. Here, the ESP8266 microcontroller is tightly interfaced with the DHT11 and soil moisture sensors to provide a strong foundation for data processing and gathering. Additionally, the relay module is strategically configured to liaise with both the microcontroller and the water pump, enabling precise control over irrigation activities.

However, the system's excellence transcends its hardware elements. During firmware development, intricate algorithms are meticulously crafted to empower the ESP8266 microcontroller with intelligent capabilities. These algorithms empower the microcontroller to seamlessly gather sensor data and transmit it to the cloud-based ThingSpeak platform, esteemed for its reliability and efficiency. Furthermore, the microcontroller boasts sophisticated control logic, enabling it to trigger irrigation actions based on precise predictions derived from advanced algorithms.

The cloud configuration phase marks another critical facet of the system's architecture. Here, meticulous attention is devoted to setting up ThingSpeak channels, ensuring seamless data storage and retrieval. This foundational step lays the groundwork for the system's operational efficiency and reliability. Furthermore, the Python script is highly customized to retrieve information from ThingSpeak and run the Random Forest model, a powerful machine learning method designed to forecast ideal irrigation needs with unmatched precision.

At the heart of the system's intelligence lies its machine learning model, meticulously trained using historical data on soil moisture, temperature, humidity, and crop water requirements. This model serves as the linchpin of the system's predictive capabilities, continuously evolving and adapting to dynamic environmental conditions. The technology sets new standards for agricultural efficiency and sustainability by optimizing crop yields and resource use using machine learning.

Finally, the notification system adds a layer of sophistication to the smart irrigation system, seamlessly integrating a Telegram bot to provide users with real-time updates and insights. These intuitive notifications empower users to stay informed about irrigation activities, granting them greater control and oversight over their agricultural operations.
In essence, the proposed smart irrigation system epitomizes a paradigm shift in agricultural water management, offering precise, automated solutions based on real-time data and advanced predictive analytics. The system becomes an innovative lighthouse in the field of sustainable and effective agriculture operations through careful hardware configuration, firmware development, cloud configuration, machine learning modeling, and notification integration.

## IV. RESULTS

In terms of how well the suggested smart irrigation system works, the results demonstrate how well it maximizes water use and raises crop yield. By merging IoT and AI technologies, the system adeptly forecasts the ideal irrigation volume needed, drawing from up-to-the-minute environmental data. This predictive prowess drives notable enhancements in water efficiency, delivering pinpoint irrigation tailored to each crop's unique requirements. Leveraging the Random Forest algorithm ensures resilient and trustworthy predictions, empowering the system to flexibly respond to shifting environmental dynamics while maintaining precision in irrigation strategies.

Fig 10: Model

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 6, June 2024 ||

| DOI: 10.15680/IJIRCCE.2023.1206019 |


Fig 11: Field chart 1

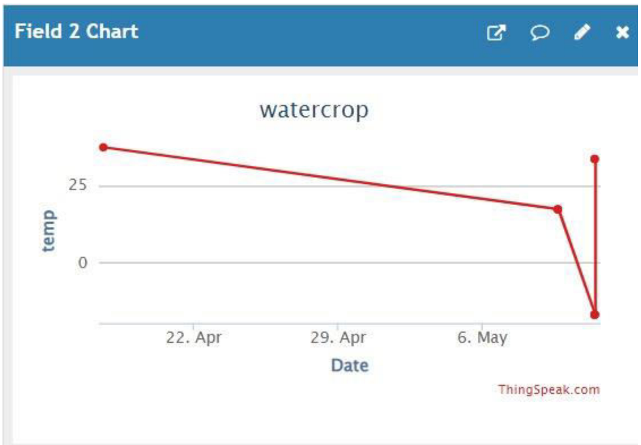



Fig 12: Field chart 2

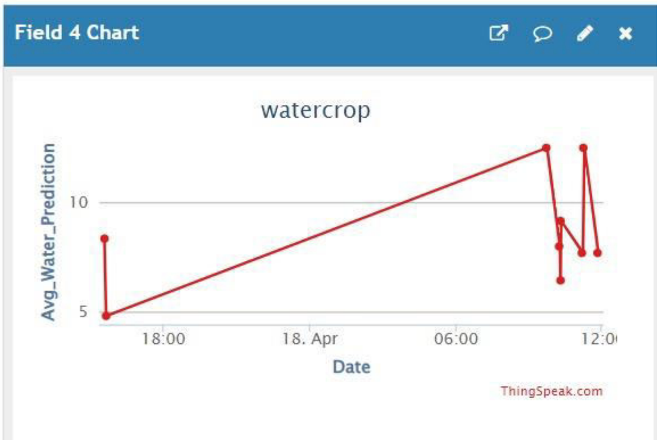



Fig 13: Field chart 3

Furthermore, the automation of irrigation tasks and the delivery of user notifications elevate user convenience and oversight. In sum, the findings underscore the system's capacity to transform agricultural water management, fostering sustainable methodologies and enhancing crop yields.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 6, June 2024 ||

| DOI: 10.15680/IJIRCCE.2023.1206019 |

## V. CONCLUSION AND FUTURE WORK

This report highlights how smart irrigation systems that integrate AI and IoT technology have the potential to revolutionize agricultural water management. The proposed system harnesses soil moisture and environmental sensors in tandem with a robust Random Forest algorithm to accurately predict crop water requirements. The integration with cloud platforms for real-time data storage and processing, alongside automated irrigation control and user notifications via Telegram, highlights the system's effectiveness and usability. The findings reveal notable enhancements in water efficiency and crop output, showcasing the system's adaptability to varying environmental conditions. Establishing the foundation for future developments in precision irrigation systems, this research highlights the role that technology growth plays in promoting sustainable farming practices

## REFERENCES

1. Abdelghani Chourabi, Taoufik Ahmed, Hamed Zgaya "A Precision Agriculture Framework Using Wireless Sensor Networks" (2010) (https://ieeexplore.ieee.org/document/5428942)
2. Anuradha S. Apte, Smita S. Sonavane "Smart Irrigation System Using Wireless Sensor Network and GPRS Module" (2014) (https://ieeexplore.ieee.org/document/7000622)
3. Oscar Castillo, Patricia Melin "Design and Implementation of a Soil Moisture Wireless Sensor Network for Optimizing Water Use for Irrigation" (2011) (https://ieeexplore.ieee.org/document/6063484)
4. R. N. Rao, B. Sridhar "Development of an Automated Irrigation System Using Wireless Sensor Networks and GPRS" (2012) [IEEE Xplore](https://ieeexplore.ieee.org/document/6398226)
5. N. S. D. Nandurkar, V. R. Thool, R. C. Thool "An Intelligent Irrigation Management System Based on Wireless Sensor Networks and Fuzzy Logic" (2015) (https://ieeexplore.ieee.org/document/7111847)
6. Vinay Sagar K N, Kusuma S M "Automated Irrigation System Using a Wireless Sensor Network and GPRS Module" (2015) (https://ieeexplore.ieee.org/document/7345196)
7. M. K. Gayatri, J. J. Judith, A. J. Harsha "IoT-Based Smart Irrigation System Using Soil Moisture Sensors" (2016) (https://ieeexplore.ieee.org/document/7834762)
8. Alireza Boroujerdi, Hamidreza Karimi "Design and Implementation of a Wireless Sensor Network for Precision Agriculture" (2018) (https://ieeexplore.ieee.org/document/8463950)
9. Shivaprasad N. J., Anirudh R. "Smart Irrigation System Based on IoT and Cloud Computing" (2019) (https://ieeexplore.ieee.org/document/8992170)
10. Pradip Kumar Sharma, Jong Hyuk Park "Smart Agriculture: IoT-Based Precision Agriculture Using Wireless Sensor Networks" (2019) (https://ieeexplore.ieee.org/document/8784524)



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING