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Smart Irrigation Systems using (IoT) – A Survey

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ABSTRACT

In India a very vast population is dependent on farming activities and most of them still uses traditional methods of irrigation. Water availability plays main role in this sector. As the world is advancing and population of India is on the rise scarcity of water is becoming a common problem in most part of the country. This survey paper provides a comprehensive overview of smart irrigation systems, focusing on their integration with IoT, deep learning, sensors, and AI to optimize agricultural practices. The paper conducts an extensive literature review, exploring challenges and opportunities in the domain, including IoT applications in agriculture, deep learning techniques, sensor technologies, and AI-driven decision-making. The methodology involves developing and integrating key components like sensor deployment, data collection, deep learning model training, and AI-based decision-making algorithms. Performance evaluation compares the system's effectiveness with traditional methods, analyzing irrigation decisions, water consumption, crop yield, and water conservation. The results demonstrate how the smart irrigation system optimizes water usage, maintains optimal soil moisture levels, and improves crop health, leading to increased agricultural productivity and reduced water waste. Overall, this survey paper contributes valuable insights for researchers, practitioners, and policymakers, emphasizing the potential of IoT, deep learning, sensors, and AI in revolutionizing agriculture and promoting sustainable and efficient irrigation practices to address water scarcity challenges.

Keyword:- IoT(internet of things), ML (Machine Learning), LDR(light dependent register), DHT (Dihydrotestosterone)

INTRODUCTION

In the domain of irrigation farmers are mostly dependent on rainwater, ground water and irrigation canal systems. Of total 500 million acres of arable land in India, about 100 million acre is irrigated through ground water, nearly 80% of that is wasted due to inefficient methods. Over and Under irrigation are a major cause of lower yield. We aim to develop irrigation systems utilizing the Internet of Things (IoT) that have the potential to revolutionize the way in which crops are watered, leading to significant improvements in crop production, quality and sustainability. By integrating sensors and actuators into an IoT network, farmers in India can automate their irrigation processes and make smart-driven decisions to optimize water usage and save electricity and machine life. This paper offers a comprehensive overview of IoT-based smart irrigation systems in India, encompassing essential components, and the latest technological advancements in the field. Furthermore, we delve into the advantages associated with smart irrigation systems, such as enhanced water management practices, amplified crop yields, and diminished water wastage. Considering the escalating global demand for sustenance and freshwater resources, coupled with India's substantial agricultural potential, the development and implementation of IoT-driven smart irrigation systems emerge as a critical imperative for achieving sustainable agriculture and ensuring food security within the country.

This study aims to present a smart irrigation system that utilizes Raspberry Pi Pico as its central control unit and ML techniques to make decisions. The proposed system integrates various sensors including a soil moisture sensor, a temperature sensor (LM35), a light sensor (LDR), and a humidity sensor (DHT11). The data gathered from the aforementioned sensors is transmitted to the central control unit, where it undergoes thorough processing and analysis to facilitate informed decisions pertaining to water pump control. Moreover, the integration of ML technology further augments the system, enabling real-time data logging and monitoring through a web API. The proposed smart irrigation system presents various advantages, encompassing enhanced water utilization efficiency, diminished water wastage, and elevated crop productivity. Notably, the system exhibits remarkable adaptability and scalability, rendering it suitable for diverse agricultural applications.

The aim to address the limitations of previous smart irrigation systems that were proposed using various devices such as ESP8266, Arduino, ZigBee, GSM, GPRS, and smartphones. We believe that their proposed system offers a low-cost and efficient solution for smart irrigation, which can help optimize water usage by switching the irrigation motor ON/OFF automatically. The system can be easily replicated and adapted to various agricultural settings, making it a valuable contribution to the field of smart agriculture and sustainable agriculture practices.

RELATED WORK

Some scholars have researched various technologies to modernize irrigation system. Their findings have stimulated studies in modernizing the irrigation system. Each technique uses different processors, platform, architecture and communication modules having its own advantages and applications.

The project aims to create an autonomous irrigation system for large- and small-scale plantations, replacing the manual approach that poses liability concerns and relies on field workers' judgment. The system monitors various environmental factors, such as temperature, humidity, soil moisture, and air pollutants like PM2.5, PM10, CO, and NOx. By comparing these factors with historical data, the system predicts the necessity of irrigation. A microcontroller system then regulates the water release from pumps based on this information. Additionally, the system provides the capability to monitor plant growth both longitudinally and horizontally. This technology aims to improve irrigation efficiency and yield prediction, reducing manual errors and optimizing water usage in plantation estates. [1]

In this paper the author studied that the agricultural water consumption accounts for 69% of all freshwater used worldwide, and food production must increase by 50% by 2050. To monitor and sense the agricultural environment, the use of Internet of Things (IoT) platforms is increasing. However, a challenge faced by such platforms is the validation of their operation in different irrigation systems. In this study, a discrete-event simulation of an IoT-integrated irrigation system was developed using digital manufacturing software Plant Simulation. An OPC UA server enables real-time communication between the IoT platform and the simulation software, allowing farmers to observe how an irrigation prescription is executed in the irrigation system in real-time. [2]

The author's aims to monitor and control the irrigation and fertilization system in agriculture to ensure sufficient nutrients and moisture are supplied to the plants at all times. Soil moisture and pH level are two important parameters that need to be monitored systematically to uphold sustainable farming solutions. The main objective of this project is to design a smart irrigation and fertilization system for chili plants using Fuzzy Logic, and the implementation of IoT is also included. Fuzzy Logic is used as a controller in this system to administer the flow rate of water, alkali, and acid solutions into the soil to maintain its moisture and pH level. Two input fuzzy memberships, moisture and pH value, and three output fuzzy memberships, alkali, neutral, and acid solution flowrate, are assigned. The fuzzy rules are programmed into an Arduino to control the water pump and valve opening, and the system is able to store the data and display it on a mobile phone through the Blynk mobile application. This system has been tested on a chili plant, and the growth of the plant under controlled environment has shown better performance compared to the traditional method. [3]

The article highlights the challenges faced by small-scale farmers in developing and under-developed countries due to traditional farming methods, such as low profits, water wastage, and the need for continuous monitoring. It notes that agriculture is the primary income source for 58% of India's population, but many farmers have extremely low incomes and cannot afford costly machinery. cost-effective processors and IoT devices can provide a solution, and proposes a smart irrigation system design using NodeMCU to wirelessly operate a network of irrigation modules. The system measures the water content of the soil and checks the plant's condition using a camera, irrigating the field when necessary. discusses the importance of data security and proposes ciphering methods to ensure the integrity of data traveling from NodeMCU to user smartphones. [4]

This paper discusses that the agricultural irrigation mechanisms are advancing through the use of Internet of Things (IoT) technology, and prediction mechanisms that examine fields in real-time. IoT systems use sensors and microcontrollers to save farmers time and minimize the usage of resources such as water and electricity. Machine Learning (ML) is also used for automation in the farming industry. IoT in agriculture starts with automating irrigation methods to conserve resources and provide the best care for crops. The proposed system uses a Real Time Clock (RTC) module and ML algorithms like Multiple Linear Regression (MLR), Random Forest (RF), and K-Nearest Neighbor (KNN) to measure rainfall conditions. The RF algorithm has the highest accuracy of about 75% and the system operates according to the time and predicted rainfall data obtained by the RF algorithm, turning on the pump automatically. Overall, this system promotes water conservation and efficient resource utilization in agriculture. [5]

A new type of automatic irrigation technology is proposed to improve the utilization rate of irrigation water in farmland and reduce the cost of irrigation water. The technology is realized by using Internet of Things (IoT) technology and wireless sensors to create an intelligent sensor network. The system focuses on the analysis of the sensor network node routing protocol, system hardware and software design to comprehensively improve the automation and monitoring level of the system. The farmland precision irrigation control strategy based on the network is analyzed to achieve water-saving goals. The system completes intelligent irrigation through embedded control technology, which helps to improve the utilization rate of agricultural irrigation water. The water-saving efficiency of the system reaches 96.3%. [6]

This Paper depicts that the precision farming is gaining popularity due to the increased demand for food and water globally. To meet this demand, farmers need a strategy to modify their behavior and make better use of limited

resources. Machine learning-based irrigation methods have been suggested to efficiently utilize water. However, these algorithms have limited learning abilities under unusual weather conditions. DLiSA, an innovative solution that integrates intelligence, predicts overall soil moisture levels for the next day, duration of irrigation, and geographic extent of water required using a lengthy short attention span network. The simulation results show that DLiSA is more efficient than cutting-edge technology, making it a promising prototype for research agriculture. [7]

The paper discusses the development of a smart irrigation system using the Internet of Things (IoT) and artificial neural networks (ANN). The system utilizes sensors such as the FC-28 soil sensor and DHT11 sensor to measure environmental parameters like soil moisture, temperature, and humidity. Two microcontrollers, Arduino and Node MCU ESP 8266, are used to control the water pump state and flow based on the sensor inputs. The ANN technique is crucial for automatic control of the irrigation system, which can help save water and regulate water usage effectively. [8]

This paper discusses the need for automation in agriculture and the advantages of using Internet of Things (IoT) technology for automated irrigation systems. Outdated irrigation techniques have led to water crisis in many countries, and automation is necessary for the development of the field. The paper focuses on the use of Arduino microcontroller, sensors, and LoRa module to construct a smart system for irrigation. Sensors collect soil data and send it through the LoRa gateway to a microcontroller based on which irrigation is performed precisely, reducing the need for large manpower. LoRa is a long-range transceiver with low power consumption and better data transfer rate, making it suitable for achieving precise automation. [9]
The article discusses the importance of agriculture in India's economy and the need for efficient water management. Smart irrigation, which combines IoT and machine learning, is proposed as a solution to improve crop productivity. The article describes the design and implementation of a Smart Irrigation System (SIS) that collects data on soil moisture, temperature, and humidity using sensors, and transmits it to a base station through Zigbee technology. The base station uses a Raspberry Pi for computation and machine learning to predict the crop water requirement. The sensor module is solar-powered, which enhances the system's robustness and reduces power consumption. [10]

This work proposes a Smart Irrigation Monitoring System for IoT based on artificial intelligence. The system comprises of soil moisture measurements, a photovoltaic panel power supply, and machine learning algorithms to predict water requirements and soil moisture. The system is controlled by a Raspberry Pi3 card, and communication between the Raspberry Pi3 card and several ESP32 clients is established using MQTT and HTTP protocols. The system is monitored in real-time using Node-RED platform and stored as a database in the SQLite programming language. The machine learning algorithm used is the decision tree model, which enables accurate projections about water requirements and soil moisture, allowing for more efficient and intelligent management of the irrigation system. [11]

CONCLUSION

The developed System can be used in a variety of areas to optimizes the proper use of underground water and regulate the water supply based upon crop, nature of soil and weather conditions. This feature makes it very efficient. It is a technically advanced irrigation system which can use real-time data and forecast too. The Raspberry PI along with sensor and associated ML algorithm is capable of correlating real-time soil information with the OpenWeatherAPI to irrigate the fields. The system is very advantageous as for small as well big farms, and for all types of crops.

References

[1] Dasgupta, A., Daruka, A., Pandey, A., Bose, A., Mukherjee, S., & Saha, S. (2018). Smart Irrigation: IOT-Based Irrigation Monitoring System. Proceedings of International Ethical Hacking Conference 2018, 395–403.

[2] R. Gomes Alves, R. Filev Maia and F. Lima, "Discrete-event simulation of an irrigation system using Internet of Things," in IEEE Latin America Transactions, vol. 20, no. 6, pp. 941-947, June 2022

[3] N. S. Pezol, R. Adnan and M. Tajjudin, "Design of an Internet of Things (Iot) Based Smart Irrigation and Fertilization System Using Fuzzy Logic for Chili Plant," 2020 IEEE International Conference on Automatic Control and Intelligent Systems (I2CACIS), Shah Alam, Malaysia, 2020, pp. 69-73

[4] S. Badotra et al., "Smart Irrigation System using Internet of Things (IoT) and Machine Learning," 2021 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO), Noida, India, 2021, pp. 1-4

[5] R. Madhumathi, T. Arumuganathan, R. Shruthi and R. Sneha Iyer, "Intelligent Time-based Irrigation System using Predictive Algorithms and Internet of Things," 2022 International Conference on Data Science, Agents & Artificial Intelligence (ICDSAAI), Chennai, India, 2022, pp. 1-6

[6] L. Qi, "Agricultural Water-Saving Precision Irrigation Control Strategy based on Internet of Things and Rainy Season Prediction," 2022 6th International

Conference on Trends in Electronics and Informatics (ICOEI), Tirunelveli, India, 2022, pp. 527-530

[7] T. V. Aravinda and K. R. Krishnareddy, "Internet of Things and Machine Learning Based Intelligent Irrigation System for Agriculture," 2022 2nd International Conference on Technological Advancements in Computational Sciences (ICTACS), Tashkent, Uzbekistan, 2022, pp. 481-484

[8] S. N. M. Al-Faydi and H. N. Y. Al-Talb, "IoT and Artificial Neural Network-Based Water Control for Farming Irrigation System," 2022 2nd International Conference on Computing and Machine Intelligence (ICMI), Istanbul, Turkey, 2022, pp. 1-5

[9] M. R, A. T, V. T and V. S, "A LoRa based Wireless Smart Irrigation System," 2022 6th International Conference on Electronics, Communication and Aerospace Technology, Coimbatore, India, 2022, pp. 514-517

[10] R. N. Kirtana, B. Bharathi, S. K. Priya, S. Kavitha, B. Keerthana and K. Kripa, "Smart Irrigation System using Zigbee Technology and Machine Learning Techniques," 2018 International Conference on Intelligent Computing and Communication for Smart World (I2C2SW), Erode, India, 2018, pp. 78-82

[11] H. Youness, G. Ahmed and B. E. Haddadi, "Machine Learning-based Smart Irrigation Monitoring System for Agriculture Applications Using Free and Low-Cost IoT Platform," 2022 International Conference on Microelectronics (ICM), Casablanca, Morocco, 2022, pp. 189-192