A Review on Implementation Of Smart Irrigation System

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Abstract—Agriculture is an essential part of our modern life, as it supplies us with food and raw materials. However, various factors, such as labor intensity, resource management, and technological limitations, often hamper the efficiency and sustainability of agricultural practices. Irrigation is one of the key aspects of modern agriculture, as it affects crop growth and health. By using the Internet of Things (IoT), smart farming can offer innovative solutions to existing agricultural problems, especially to improve the efficiency and control of irrigation systems.

The paper offers a comprehensive review of the latest progressions in irrigation systems. It covers diverse methodologies utilized, the incorporation of state-of-the-art technologies, and delineates potential future advancements within this domain.

Keywords— Arduino, Cloud Server, Soil Moisture Sensor, ESP8266, DTH11, LDR, ZigBee, Blynk app.

I. INTRODUCTION

Within modern agriculture and the realm of smart technology, the fusion of IoT systems with farming practices has sparked a revolution in traditional irrigation methods. An exemplary breakthrough in this domain is the Smart Irrigation System, marrying efficient water management with the convenience of app-controlled functionality. Improving irrigation techniques becomes pivotal in effectively managing water resources, especially in water-scarce regions and drought-prone areas. These advancements play a critical role in mitigating environmental impacts linked to agriculture, such as waterlogging, salinization, and chemical leaching, fostering ecological equilibrium and supporting ecosystem health.

Economically, enhanced irrigation systems bolster farmers' profitability by yielding higher crop outputs and optimizing resources, thereby stimulating economic growth. At its essence, this system optimizes water usage by harnessing real-time data and intelligent algorithms to administer precise and targeted irrigation. Through the user- friendly app interface, individuals can tailor watering schedules, specify zones, and integrate weather forecasts. This innovative setup not only provides convenience but also significantly enhances resource efficiency. By eradicating guesswork and offering precise irrigation control, it effectively curtails water wastage and reduces operational costs.

Below are the primary challenges encountered by farmers concerning water resources and electricity availability:

- **Challenges from Inadequate Electricity and Irregular Water Supply**:- Insufficient electricity and unpredictable water availability present significant hurdles for farmers, directly impacting their agricultural practices and overall livelihoods.
- **Dependency on Electricity for Modern Irrigation Systems**:-Contemporary irrigation methods heavily hinge on stable electricity to power motorized pumps and sprinkler setups, creating barriers in areas lacking dependable power sources.
- **Manual Irrigation Methods:-** Absence of technology prompts farmers to employ manual irrigation techniques, which increase labor requirements and time expenditure.
- **Impact of Unpredictable Water Supply**:- Unstable water sources caused by fluctuating weather patterns or limited access create uncertainties in water availability for irrigation, posing challenges in effectively distributing water across fields.

The main objectives of the development IoT enabled smart irrigation systems are as follows:

1. **Remote Control and Accessibility:** The application allows users to remotely access and control irrigation valves from anywhere with internet connectivity. Users can easily toggle valves on or off through the app, providing them with convenient control over their irrigation system regardless of their physical location.

2. **Customized Scheduling:** Users can create customized watering schedules tailored to their specific plant needs. They can set watering times and durations, through the app's scheduling feature. By integrating moisture sensors into the system, water scheduling can be done based on real-time data gathered by these sensors. This ensures that plants receive adequate moisture without excessive water usage, promoting healthier growth and conserving resources.

3. **Notifications and Alerts:** The application sends real-time alerts and notifications to users to keep them informed about the status of their irrigation system.. Additionally, the app can alert users to any obstacles detected within the field, such as unauthorized entry .

4. **Efficiency and Resource Optimization:** By providing remote valve control and customized scheduling options, the app ensures efficient water distribution and optimal resource utilization. Users can adjust watering schedules based on plant requirements and weather forecasts, preventing overwatering or under-watering scenarios. This not only conserves water resources but also promotes the efficient use of energy and reduces operational costs associated with irrigation.

5. **User-Friendly Interface:** The application features an intuitive and visually appealing interface designed to cater to users with minimal technical expertise. Clear and concise navigation menus, along with user-friendly controls, make it easy for users to access and utilize the app's features effectively. The interface prioritizes simplicity and ease of use, ensuring a positive user experience for all users, regardless of their familiarity with technology.

II. SMART IRRIGATION SYSTEM

The block diagram(Fig 1) illustrates the functioning of the smart irrigation system, encompassing water sources, the main valve, moisture sensor, motion detector sensors, and an ESP32 that transmits collected data to the user interface app. This depiction outlines the basic operational flow, with the ESP32 serving as the system's core. Incorporating advanced sensors and implementing machine learning techniques stands as a potential enhancement to elevate the system's performance.

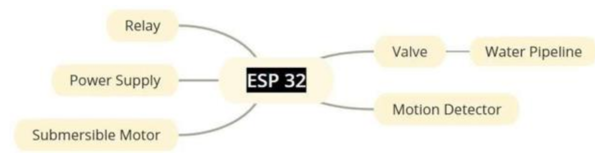

Fig 1: Block diagram of smart irrigation system

The smart agriculture system, powered by ESP32 technology, is designed to enhance efficiency and reliability in rural farming environments through a suite of advanced features. It establishes robust Wi-Fi connectivity for seamless communication and data synchronization among multiple users, ensuring consistent operational updates. The system incorporates a voltage sensor to monitor electricity status, alerting users to power supply issues that could affect system performance. It utilizes moisture sensors to provide real-time soil moisture data, enabling precise irrigation control and water conservation. Additionally, the system supports customizable irrigation schedules, allowing for automated and optimized water usage. To enhance security, PIR sensors are deployed for intrusion detection, offering remote monitoring capabilities and protecting the agricultural site from unauthorized access. Overall, this comprehensive system addresses critical challenges in rural agriculture, such as connectivity, power reliability, and resource management, promoting sustainable and efficient farming practices.

The proposed smart agriculture system harnesses the capabilities of ESP32 technology, alongside various sensors and connectivity solutions, to address the multifaceted challenges of rural farming. By integrating real-time monitoring, automated control, and security features, the system promises to enhance operational efficiency, resource management, and crop productivity in the agricultural sector.

III. LITERATURE REVIEW

Dankan Gowda .V et.al[1] emphasize the potential benefits of IoT in agriculture, including improvedefficiency, reduced production risks, and enhanced resource management. Crop docking and air temperature sensors connect to a network gateway via a Wireless Sensor Network (WSN), typically employing ZigBee for its versatility across applications. Using 4G LTE mobile communications, this system ensures cost-effective data transmission with minimal capacity requirements. Through cloud- based web services, subscribed mobile network data integrates weather services and satellite imagery to derive irrigation index values using Crop Water Stress Index (CWSI) models. The network gateway then transmits this data to an irrigation management controller, allowing analysis, setting adjustments, and access to results via specialized web applications for farmers and professionals, encouraging collaborative data sharing within the agricultural community.

G. Sasi Kumar et.al [2] aims to streamline irrigation by reducing manual work, benefiting farmers with Using sensors and IoT, the system monitors soil moisture, automating irrigation even in less developed areas, making it cost-effective. Operating at its core is the Node MCU, functioning as the system's central processor. Soil moisturedata is collected by sensors and transmitted to the Node MCU, which is pre-programmed to control a relay switch based on specified moisture thresholds. This information is then relayed to the user's mobile device, allowing them to remotely activate or deactivate the irrigation motor accordingly. This method ensures that field irrigation is carried out autonomously, eliminating the need for human involvement and enabling farmers to reduce labor costs significantly.

Abdelhamid Benbatouche and Boufeldja Kadri [3] this paper details an innovative approach to modernize and streamline irrigation practices by introducing a comprehensive remote-controlled system. Unlike traditional methods, this system addresses their limitations and offers an time and cost savings, affordable solution for farmers. It allows remote manipulation of solenoid valve functions in real-time, accessible through a website or SMS messages. Crucially, it delivers immediate notifications about crucial factors such as temperature, humidity, tank water levels, and soil moisture, ensuring that farmers stay constantly updated. Its primary goal is to promptly inform farmers through SMS alerts and website updates whenever any operation occurs. This system consists of two main components: a remote-control mechanism tailored for managing solenoid valves and the development of a cost-effective 63mm diameter valve. Importantly, this system is purposefully designed to cater specifically to the needs of agricultural applications, aiming to revolutionize irrigation methods for farmers. Offering an affordable solution for farmers, this innovative remote- controlled irrigation system addresses limitations in traditional methods. With capabilities for real-time valve control and environmental updates, it stands poised to revolutionize agricultural efficiency and productivity.

Muhammad Ibrar et.al [4] developed a model to tackle water management challenges encountered by farmers. Traditional manual irrigation lacks real-time detection of blockages or leaks. This system utilizes IoT and sensors to monitor irrigation channel water levels, transmitting data to a cloud server in real time. Upon data capture by the sensor from the irrigation channel, transmission to the cloud server occurs through the internet. Stored and processed within the cloud server, the farmer can visualize water levels for each sensor location via a web-based visualization screen. Notably, if the water level diminishes, the system autonomously notifies the farmer via mobile alerts to address open irrigation channels requiring closure. The process initiates with a distance-measuring sensor gauging the distance to the water surface in the channel, determining its water level. Data collected from the channel is relayed to the microcontroller board, which subsequently transmits it to the cloud server using a network interface module for storage and processing.

Accessible through a graphical interface on a screen,the cloud-stored sensor data illustrates the water levels in the specific channel where the sensor is placed. Alerts are triggered when the water level dips below or reaches a pre- set threshold (e.g., 60%), signaling the farmer through smartphone notifications to handle the identified issue promptly.

Srishti Rawal [5] developed an IoT-based smart irrigation system aiming to automate farm irrigation for enhanced agricultural productivity while reducing water wastage. Using a microcontroller (ATMEGA328P on Arduino Uno), the systemmanages irrigation based on soil moisture levelsmeasured by sensors, ensuring precise water delivery to prevent both over and under-irrigation. Employing IoT technology, sensor data updates the status of water sprinklers on a webpage through a GSM-GPRS SIM900A modem. Furthermore, it transmits readings to a ThingSpeak channel for graphical analysis.

Key hardware components encompass soil moisture sensors, Arduino Uno, and GSM-GPRS SIM900A modem. The control unit regulates water sprinkler operations based on sensor data. The IoT aspect features a webpage displaying sprinkler status and a ThingSpeak page presenting sensor value graphs.

The methodology involves setting moisture level thresholds for irrigation initiation, and activating sprinklers when moisture drops below the threshold. Operational details, including AT commands for data transmission, are elucidated. Results showcase readings from soil moisture sensors, illustrating varied moisture reduction rates in over-irrigated versus initially moist soil. Graphs from the ThingSpeak channel visualize sensor data.

Highlighting its potential to automate irrigation and optimize water usage in agriculture, the document suggests future enhancements such as remote water pump control and extending IoT applications to other farming activities.

R. Tharwin Kumar1 et.al [6] the document introduces an investigation into an IoT-based smart irrigation monitoring and control system utilizing the Arduino Uno microcontroller. It targets challenges arising from climate change and reduced rainfall in agriculture. The system integrates Node- Microcontroller ESP8266, a DHT11 sensor (comprising Humidity and NTC Temperature sensors), and a soil moisture sensor to oversee irrigation management.

The soil moisture sensor measures soil water content, aiming to curtail water wastage and furnish real-time data to farmers. Data encompassing temperature, humidity, and soil moisture is transmitted to a cloud-based Blynk app, enabling remote access and control of the irrigation system by farmers. The microcontroller's Wi-Fi module uploads all data to the Blynk app's cloud server. This system's development aligns with the burgeoning demand for sophisticated agricultural practices and technology. Its successfulimplementation demonstrates temperature, humidity, and soil moisture monitoring and control through the Blynk app, catering to middle-class farmers by offering affordable and user-friendly IoT technology for agricultural management.

V. Elizabeth Jesi et.al [7] describes the development of an advanced irrigation system designed to predict the best times for watering chili plants using the ANFIS method. The system, named "ACRIS: Agriculture Cultivation Recommender and Smart Irrigation System," aims to improve water management in precision farming by integrating IoT and machine learning. It is comprised of three main modules: precise farming recommendations, advanced irrigation planning, and multi-parameter optimization systems. The primary focus is on leveraging IoT technologies to predict soil moisture, control irrigation, and ensureoptimal crop growth and water conservation. The system has been shown to enable smart irrigation, leading to increased crop yields while using less water. By incorporating a variety of sensors, machine learning algorithms, and weather forecasting data, the system accurately predicts and adjusts irrigation needs. Its high accuracy and efficiency in forecasting soil moisture levels and optimizing irrigation demonstrate its practicality and reliability for large-scale agricultural operations. This work presents a comprehensive approach to developing an advanced irrigation system that utilizes IoT and machine learning to improve water management and enhance crop productivity in precision agriculture.

Haritha J et.al [8] The system proposed here regulates water flow in the fields based on the intensity of sunlight and soil moisture levels. It utilizes a microcontroller (Arduino UNO) along with an LDR (Light Dependent Resistor), a capacitive moisture sensor, and a DHT11 (temperature and humidity sensor). The Arduino UNO is programmed to control a solenoid valve connected to the water pipeline, adjusting water flow according to sunlight intensity and soil moisture. The solenoid valve, an electromechanical device, is employed to control the water flow, while the Arduino UNO serves as the central microcontroller.

The system effectively regulates water flow based on moisture, temperature, humidity, and sunlight intensity, offering both automatic and manual control options. This automation allows the system to supply water to the fields as needed, without requiring human intervention. Additionally, a Wi-Fi module (ESP8266) is integrated, enabling manual operation of the solenoid valve via mobile phones or laptops based on the measured parameters, if necessary.

The system offers an innovative and practical solution to mitigate water wastage in agricultural fields while ensuring efficient water management. The integration of IoT technology and mobile applications further enhances its usability and potential for widespread adoption.

Ahmad Faisol Suhaimi et.al [9] the system is designed to address the limitations of conventional irrigation methods and the essential need for real-time monitoring and intrusion detection in agricultural settings. Utilizing sensors linked to a NodeMCU ESP32 microcontroller, it collects environmental data—humidity, temperature, and soil moisture levels—to automate irrigation based on specific soil moisture conditions. Additionally, it integrates a passive infrared sensor for detecting intruders near crop fields. Upon detection, an ESP32 camera captures the area and alerts farmers, while also issuing warnings for extreme temperature conditions to prevent potential open burning incidents.

Its primary objectives include enhancing water consumption efficiency, minimizing human errors, and bolstering security within agricultural environments. Simultaneously, it involves developing a mobile application that empowers farmers to oversee and regulate irrigation, receive timely alerts, and access real-time environmental data.

Functionally, the system encompasses phases for data acquisition, intrusion detection, smart irrigation, and monitoring, as well as data storage and notification. Furthermore, it's adept at storing and presenting information and images related to crop field conditions and intruder detection.

This IoT-based Smart Agriculture Monitoring, Automation, and Intrusion Detection System offers a comprehensive solution to optimize agricultural practices. Future advancements might encompass integrating machine learning for refined intruder detection and expanding capabilities for animal detection and differentiation.

Aakash Bhandari et,al[10] The NodeMCU ESP8266 microcontroller is integrated into a system designed for automated plant watering, using soil moisture levels as a trigger. This system, accessible via a smartphone app, enables remote monitoring and control of plant growth—a boon for farmers unable to make regular field inspections. It incorporates soil moisture and temperature sensors, a Wi-Fi module, and a relay module to streamline irrigation. Moreover, it offers email notifications on plant status. By leveraging these components—NodeMCU ESP8266, relay module, DHT11 (Temperature and Humidity Sensor), and Soil Moisture Sensor—the system optimizes irrigation, conserving farmers' time and resources while ensuring crops receive precise water quantities. This email notification feature proves invaluable, keeping farmers updated on crop conditions even from a distance. The relay module manages the water pump, while soil moisture and temperature sensors monitor soil conditions, with the DHT11 sensor gauging surrounding temperature and humidity—crucial factors influencing plant growth.

IV. Conclusion

Irrigation plays a crucial role in agriculture, providing a dependable water source for crop cultivation in areas with limited rainfall or unpredictable weather. By employing water-saving techniques and precision methods, efficient irrigation practices maximize yield while minimizing water wastage. This review delves into recent strides and research in IoT-enabled smart irrigation systems, highlighting the pressing need for an efficient and dependable model to optimize resource utilization. Through the utilization of soil moisture detection sensors and LDRs for data collection, this work underscores the accessibility of data for farmers through platforms like the Blynk app, cloud services, or websites using the Zigbee protocol.

Future advancements, such as integrating machine learning for intrusion detection and image processing, hold promise in refining and further enhancing irrigation systems for enhanced practicality and effectiveness.

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