IOT BASED IRRIGATION SYSTEM WITH LORA TECHNOLOGY

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ABSTRACT

The Internet of Things (IoT) and Long-Range Low Power (LoRa) communication are transforming agriculture. IoT provides real-time data and automated control over irrigation processes, reducing waste and promoting sustainable water management. LoRa technology facilitates seamless communication between IoT devices and gateways, allowing farmers to monitor and control irrigation systems remotely. The project aims to develop an innovative and efficient solution that empowers farmers with the tools needed to make informed irrigation decisions. The system includes a network of soil moisture sensors, weather sensors, LoRa-enabled controllers, and a user-friendly mobile application. The development of the IoT-based irrigation system follows a systematic approach, including sensor deployment, data collection, and remote monitoring and control. The significance of the project lies in its potential to revolutionize agriculture by making it more data-driven, efficient, and sustainable. The project aims to develop an IoT-based irrigation system that integrates sensors, communication technology, and control mechanisms. It aims to optimize water resource usage, enhance crop yield, minimize energy consumption, enable remote monitoring, and ensure data security. The methodology for developing the system involves project planning, requirements analysis, sensor selection and integration, hardware development, software development, data transmission and central server setup, sensor deployment, irrigation automation, real-time data display and analysis, testing and calibration, and user training and documentation. The system is designed to provide precise and timely irrigation tailored to the specific needs of different crops. The project also includes robust data security measures to protect sensitive agricultural data and regular data backups to prevent data loss. Regular monitoring and maintenance of the system is necessary to monitor its performance and cover any issues. The aim is to ensure that the system can adapt to changing weather conditions and crop growth stages. The approach is systematic and iterative, with a focus on expanding the system's capabilities and implementing smart loop improvements.

Keyword: - *Internet Of Things, Irrigation system, LoRa technology, agriculture, water efficiency, Sustainable development goals, Sensors, arduino.*

1. INTRODUCTION

Agriculture, the cornerstone of human civilization, has always been a dynamic and evolving field. As the global population continues to grow, the demand for food production surges in tandem. This necessitates more efficient and sustainable agricultural practices to optimize resource utilization and maximize yields. In this context, the integration of cutting-edge technology into agriculture emerges as a pivotal solution. One such technological advancement is the Internet of Things (IoT), which, when coupled with Long-Range Low Power (LoRa) communication, brings about transformative changes in the form of an IoT-based irrigation system. Traditional agricultural practices often rely on manual labor, periodic inspections, and standard irrigation schedules, leading to inefficient resource allocation and sometimes over-irrigation. This not only leads to wastage of water but can also degrade soil quality over time. Additionally, climate change brings increased uncertainty regarding rainfall patterns, making it challenging for farmers to make precise irrigation decisions. The adoption of IoT in agriculture addresses these challenges by providing real-time data and automated control over irrigation processes.

The primary objective of our project is to develop an innovative and efficient solution that empowers farmers with the tools needed to make informed irrigation decisions. Specifically, our project aims to Enhance Water Management by continuously monitoring soil moisture levels and weather conditions, ensuring that water is used optimally, reducing waste, and promoting sustainable water management; Increase Crop Yields through precise and timely irrigation by providing crops with the right amount of water at the right time; Reduce Labor and Energy Costs through Automation of irrigation processes reducing the need for manual labor and minimizes energy consumption; Remote Monitoring and Control by incorporating LoRa technology which allows farmers to monitor and control irrigation systems remotely through a user-friendly mobile application.

Nazma Tara and Shelina Sharma [1] address that The Internet of Things (IoT) is a popular technology for smart home, smart vehicle, and smart agriculture. Traditional agriculture relies on human skills and experiences for production, but this does not ensure higher productivity and efficiency. IoT assists farmers to determine the appropriate necessity by analyzing the dynamic condition of the soil, weather, and plant. In Bangladesh, agriculture is one of the most dominant sectors, and IoT-based smart irrigation plays a pivotal role in making the agricultural sector more productive and sustainable. Abhilash Lad and Krishna Raichurkar's [2] research proposes that The Indian agriculture sector is losing ground, and there is a growing need to resolve the issue. The IoT is a network of interconnected devices that can transmit and receive data over the internet. This project aims to create an embedded-based soil monitoring and irrigation system that will reduce manual field monitoring and provide information via a mobile app. The system includes IoT-based agricultural monitoring, and the data will be available on both a smartphone and a computer. The project achieves irrigation automation with the aid of a Raspberry Pi, which controls the moisture and temperature sensors based on the input provided. The Internet of Things (IoT) is transforming the agriculture business and addressing the enormous difficulties and huge obstacles that farmers confront today in the field.

Izzatdin Abdul Aziz and MohdHilmiHasan [3] have provided a user-centric approach to the development of a mobile application for IoT-based LoRa irrigation systems. Her research emphasizes the importance of a user-friendly interface that empowers farmers to monitor and control irrigation processes effortlessly. Izzatdin Abdul Aziz discusses the design principles, features, and usability testing of the mobile app, which allows users to access real-time data, receive alerts, and adjust irrigation settings remotely. Through field surveys and feedback from farmers, she validates the effectiveness of the app in improving user engagement and overall system usability. Her work highlights the significance of human-computer interaction in ensuring the successful adoption of IoT-based technologies in agriculture. Sankha Subhra Debnath and Abhinaba Dutta Choudhury's [4] research states that In the 21st century one of the most important issues that remains is the water resource, especially fresh water and water used for irrigation. India as a third world country, agriculture remains the largest sector that contributes to the GDP of the country. Most of the freshwater goes for the irrigation sector. Even with all the development in technologies we have seen that comparatively the agricultural industry still is unable to make the most out of it and the outreach is still poor. Still today a large sector is being operated manually and the traditional techniques like drip irrigation, sprinkler irrigation are still widely used. With the help of large-scale automation along with IoT implementation it is possible to make a paradigm shift in the Agriculture Industry of the country to yield the best result. All these works laid the foundation and provided valuable insights which helped in successful implementation of this project.

2.1 METHODOLOGY PROPOSED

The methodology proposed is planned to minimize the need for human intervention to the minimum. By doing so, It could help the user to have minimal focus on the system. The system can be mostly taken care of by the microcontroller which handles all the sensor data and functions accordingly to maintain the agricultural field in which it is set. The entire system is backed up by an external server that will store all the information required for its functioning such as storing the received sensor data, fetching the data at times of requirement, and the water requirement level depending on the crop to be vegetated. It also has the logic for processing the data received from the microcontroller and based on the crop chosen. The proposed system has several features to support usability and scalability through a mobile application designed entirely to monitor the system remotely, LoRa compatible modules for easier access and communication between the system modules and separate sensors for detecting any possible variations in the environment where the system is set. The block diagram representing the project is shown below.

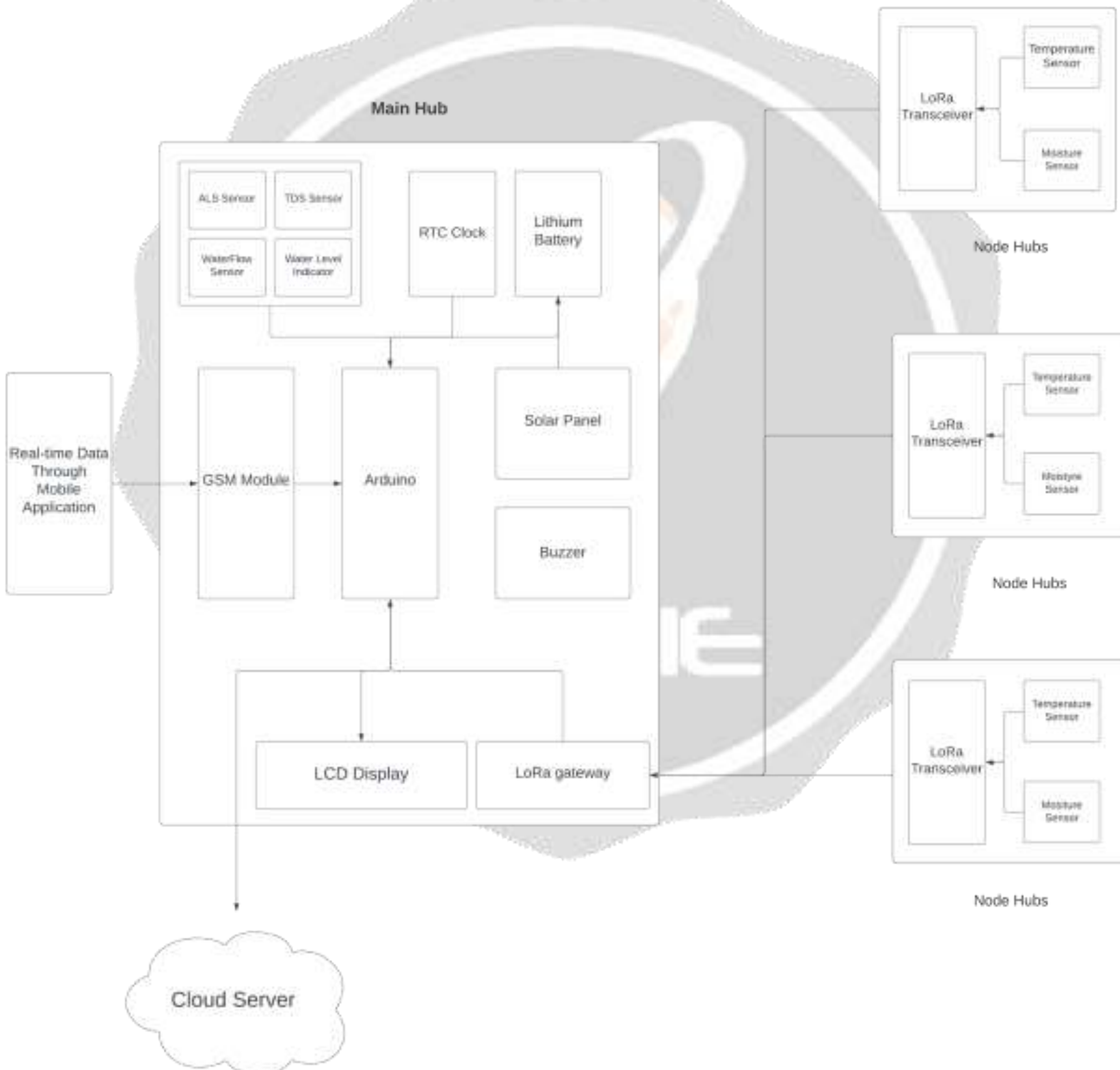

Fig.1: Block diagram

2.2 Components

2.2.1 GSM module

A GSM (Global System for Mobile Communications) module is a critical component in the IoT-based irrigation system project. It provides cellular connectivity, allowing the system to communicate remotely through standard mobile networks. The GSM module enables real-time alerts, notifications, and data exchange between the irrigation system and users via SMS or mobile apps. It plays a pivotal role in ensuring that users can monitor the system's status, receive alerts, and make adjustments, even when they are not physically present at the field. This connectivity is vital for timely responses to system events and efficient remote management, enhancing the project's usability, accessibility, and user-friendliness.

2.2.2 ALS Sensor

An Ambient Light Sensor (ALS) measures the intensity of light in the environment. In the IoT-based irrigation project, an ALS sensor can provide essential data on the ambient light levels, helping optimize the irrigation system. By monitoring light conditions, the system can adjust irrigation schedules based on natural light variations, ensuring water is not wasted during daylight hours. It can also trigger actions like reducing or increasing light levels in indoor crop environments. This data helps in energy-efficient farming and ensuring that irrigation schedules are aligned with the specific lighting conditions required for plant growth, resulting in resource conservation and improved crop health.

2.2.3 Solenoid Valve

A solenoid valve is an electromechanical device that controls the flow of fluids, such as water, by using an electromagnetic coil to actuate a valve mechanism. In the IoT-based irrigation system project, a solenoid valve is essential for regulating the flow of water to the fields. It enables precise control of irrigation, allowing the system to deliver the right amount of water to crops based on real-time sensor data. This results in efficient water usage, reduced wastage, and optimal crop growth. Solenoid valves can be remotely controlled, making them a crucial component for automating irrigation processes and conserving resources.

2.2.4 Arduino Microcontroller

Arduino is an open-source microcontroller platform that plays a pivotal role in the IoT-based irrigation system project. It serves as the brain of the system, receiving data from various sensors, processing this data, and controlling critical components like the solenoid valve, LCD display, and GSM module. With its versatility and ease of use, Arduino enables real-time data analysis, precise irrigation scheduling, and remote monitoring via a mobile app. Its ability to interface with various sensors and communicate with LoRa and GSM technology makes it an ideal choice for orchestrating the complex interactions in the project, ultimately enhancing water efficiency, crop yield, and sustainability.

Fig.2: Arduino Microcontroller

2.2.5 Submersible pump

A submersible pump is a specialized water pump designed to be submerged in a liquid, such as a water source or reservoir. In the IoT-based irrigation project, a submersible pump plays a crucial role in delivering water to the irrigation system. It is submerged in a water source, such as a well or a reservoir, and is controlled by the system's microcontroller. The pump is activated based on data from moisture sensors, temperature sensors, and the irrigation schedule. This automated control ensures that the right amount of water is delivered to crops, enhancing water efficiency and crop health. Submersible pumps are highly efficient and can be easily integrated into modern irrigation systems, making them an essential component for reliable water delivery.

2.2.6 Temperature and Moisture Sensors

In the IoT-based irrigation system, a temperature sensor measures the ambient temperature. This data helps in understanding the environmental conditions, particularly in regions with varying climates. The temperature information is crucial for determining the most suitable times for irrigation. The system uses this data to adjust irrigation schedules, promoting efficient water usage and ensuring the well-being of crops. The moisture sensor measures soil moisture levels, a critical parameter for effective irrigation. These sensors help prevent overwatering or underwatering by providing real-time data on the soil's moisture content. The system uses this information to trigger irrigation events only when the soil moisture falls below a specified threshold, ensuring that crops receive the right amount of water at the right time

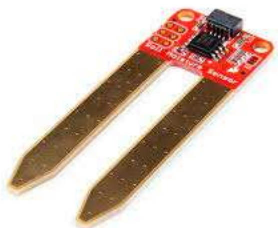

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Fig.3: Moisture Sensor

3. SYSTEM WORKFLOW

Moisture sensors, temperature sensors, ALS sensor, TDS sensor, water flow sensor, and water level indicator provide real-time data on soil conditions, ambient light, water quality, and water levels. These sensors are connected to the Arduino board for data acquisition. An RTC clock module is connected to the Arduino to provide accurate time and date information for scheduling irrigation events. The Arduino board processes the sensor data and controls the system's components. It utilizes an integrated GSM module for communication. LoRa communication is established between the Arduino and a LoRa gateway. This communication is used to transmit data over long distances with low power consumption. An LCD display is connected to the Arduino to provide real-time information to users about system status and sensor data. A buzzer is connected to provide audible alerts and notifications to users in case of critical system events or alarms. The Arduino is programmed to send sensor data to the ThingSpeak server for storage and processing. It uses the ThingSpeak API to make HTTP POST requests.

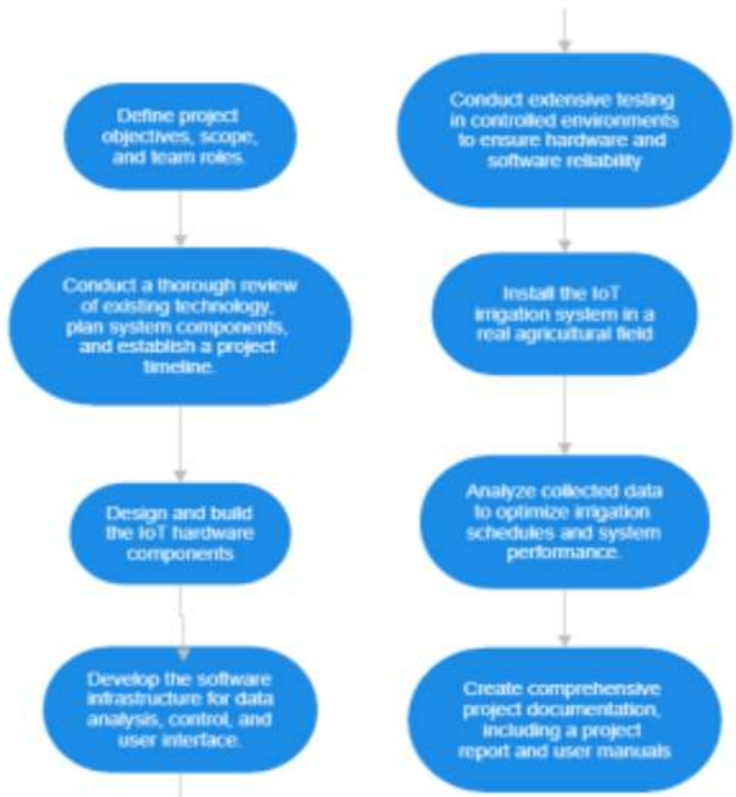

Fig.4: Workflow of the Irrigation System

Users can access the system remotely via a mobile app connected to the GSM module. The mobile app communicates with the system to view data, change settings, and trigger manual irrigation events. The Arduino processes sensor data and triggers the solenoid valve to control the flow of water to the submersible pump. The submersible pump draws water from a water source and delivers it to the irrigation system. The Arduino board uses the RTC clock for precise scheduling of irrigation events.It considers data from moisture sensors, temperature sensors, and water level indicators to make informed irrigation decisions. Data from the TDS sensor is used to monitor water quality. The system, through the GSM module, sends users notifications about critical events, irrigation schedules, and system status. Users can also receive data reports and historical information via the mobile app. The system is powered by a lithium-ion battery and uses power management techniques to optimize battery life. The system remains in sleep mode during idle periods to conserve power. In case of low battery levels or system failures, the system sends alerts and notifications to users for timely maintenance.

This technical workflow illustrates how the various components in the IoT-based irrigation system work together, collect data, process information, and enable remote monitoring and control while ensuring efficient water usage and crop health. The integration of LoRa technology, GSM communication, and ThingSpeak server storage provides a robust and scalable solution for modern precision agriculture.

4. RESULTS AND DISCUSSION

The proposed smart irrigation project addresses water scarcity, environmental sustainability, precision agriculture, data-driven decision-making, food security, and technological innovation. It automates irrigation, reduces water wastage, and provides real-time data on soil and water quality. Precision agriculture enhances crop health and yield while minimizing inputs. Real-time information empowers farmers to make informed decisions about irrigation and crop management. The project's emphasis on efficient water use and precision agriculture has economic implications, reducing production costs and increasing farm profitability. It paves the way for a more resilient, sustainable, and prosperous agricultural sector. Through all this, it can help the society in overcoming water scarcity challenges, improving environmental sustainability, practicing data-driven and precision agriculture and enhancing food security.

5. CONCLUSIONS

A smart irrigation system has been developed to simplify and revolutionize agriculture through the integration of sensor technology and data-driven decision-making. It offers an unprecedented level of control and efficiency in farming by automating irrigation based on unique requirements of each crop and real-time conditions in the field. The system optimizes water usage and contributes significantly to conserving this invaluable resource. It also aids in the preservation of limited freshwater resources, aligning perfectly with global efforts to combat climate change and ensure food security. The project is a holistic approach to modernizing agriculture and fostering responsible stewardship of our environment. It promises to reshape the future of farming by optimizing irrigation practices, enhancing crop yields, and conserving precious water resources.

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