LoRa and IoT Based Smart Irrigation System

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Abstract - The use of Internet of Things (IoT) and LoRa technologies to the implementation of smart farming practices with the purpose of improving agriculture. The goal is to enhance yield by reducing human participation in agricultural operations while keeping high accuracy and using minimum electricity. To do this, we developed a method to manage the flow of water into the fields depending on soil moisture levels, which are critical for crops. Temperature and humidity sensors are utilized to decide what the farmer needs to do. Using LoRa technology, which can reach up to 20 km in rural regions and up to 8 km in urban areas, the detected data is transferred over vast distances.

Key Words: Internet of Things (IoT), LoRa technology.

1. INTRODUCTION

Overall, the proposed LoRa-based irrigation system has several advantages for smart agriculture. For starters, it enables remote monitoring and control of the irrigation system, eliminating the need for manual intervention and increasing overall efficiency. Second, it provides accurate and real-time data on soil moisture levels, which can assist farmers in making informed irrigation and water usage decisions. Third, it has a low power consumption, making it a long-term cost-effective and sustainable solution.

Aside from the advantages listed above, the use of LoRa WAN technology allows the system to operate over long distances, making it suitable for large agricultural fields. Because the system can transmit data over a large area, farmers can gain a comprehensive understanding of soil moisture levels and irrigation requirements across their entire field. Furthermore, the irrigation system's integration with cloud-based applications and APIs allows it to be integrated with other smart agriculture solutions, such as weather forecasting and crop monitoring systems.

2. LITERATURE SURVEY

Davcev *et al.* [1] The purpose of this idea that is highly scalable, power-efficient, and inventive. To enable long-range and low-power consumption, the system uses a LoRa WAN network to transport sensor data from the nodes to cloud services. The system uses a highly scalable data streaming approach to perform analytics. This study illustrates the useful methods that can be applied in a LoRa-based smart agriculture system. The LoRa modules in the system connect to the sensor nodes, sending the sensor data to the processing system for uploading onto a cloud platform. Using this approach, farmers will be able to make data-driven decisions that maximize crop yields, which has the potential to transform agriculture. The system is a desirable option for large-scale agricultural operations due to its power efficiency and scalability.

Kumar et al. [2 In their investigation, the researchers assessed several sensors and precision agriculture application methodologies. Temperature and humidity sensors were included, as well as an Arduino microcontroller board with a wireless sensor network system. The wireless sensor network's primary purpose was to gather data from far locations and wirelessly transmit it to the receiver. Early monitoring systems had a number of shortcomings, including reliability and range difficulties. RF technology was employed in the early wireless networks, which was subsequently supplanted by Bluetooth and then ZIGBEE technology. The researchers concentrated on creating a precision agricultural wireless sensor network (WSN) system that would leverage the ZIGBEE wireless sensor network protocol. ZIGBEE is meant for wireless personal area networks and operates at frequencies of 868 MHz, 902-928 MHz, and 2.4 GHz (WPANs). A wireless personal area network, or WPAN, is a network that allows devices to connect with one another. ZIGBEE is utilized as an LR-WPAN, or low-rate wireless personal area network, allowing devices to communicate at up to 250 Kbps while physically separated by up to 50 meter's in ordinary situations, and even further in optimal conditions.

Lavric *et al.* [3] Proposed a discussion of the difficulties and limitations involved in integrating LoRa technology into IoT systems. New solutions have been studied, and the study concentrates on high-density sensor networks employed in the IoT idea. According to the needs of IoT systems, the LoRa modules' low transmission rate allows for long-distance information transfer. The key issues experienced during IoT development are also covered in the study, along with information on the difficulties met during WSN research. Together with discussing the evaluation of LoRa modulation performance, it has also been examined the architecture needs of the LoRa WAN communication protocol. Overall, the study provides a thorough analysis of LoRa technology's application in IoT systems and identifies the difficulties and requirements related to its deployment.

Gaddam *et al*. [4] The importance and use of LPWAN (Low Power Wide Area Networks), a modern wireless technology that has proven useful for constructing various IoT systems, is discussed. The growing demand for IoT and the growing need for automation prompted the study of wireless technology evaluation. The paper presents research on LPWAN technology, which employs wireless networks and has very low power requirements while enabling long-distance communication with a low bit rate and low bandwidth. LPWAN is a popular technology for IoT networks because it offers low power consumption, extended range, lower bandwidth, and low bit rates. The following article compares low power leading lights.

Saari *et al*. [5] The system main objective is to assess LoRa WAN technology for sensor network applications in the IoT space. In this case study, a thorough literature assessment was done, and more than fifty research publications were found. The questions that were developed based on the LoRa WAN study are presented in the methodology section. Researchers and practitioners have been provided recommendations on how LoRa-based technologies can be advantageous and completely exploited in the improvement of IoT solutions and creation of IoT systems. The most recent and useful applications of LoRa have been exposed. This report offers insightful information on the potential uses for LoRa WAN technology and how it may be put to good use in the IoT space.

Bouras *et al*. [6] The smart monitoring system, which deals with the analysis of numerous IoT scenarios, was discussed in this research. Although Wi-Fi and LoRa have been initially contrasted as wireless technologies, end devices require substantial power consumption for computation, necessitating the use of low power network solutions. The end devices have been connected to the Internet using the LoRa-based gateway and Wi-Fi router utilized in our scenarios. Real-time experiments show that LoRa might be the best solution for creating smart monitoring systems. By combining the usage of diverse software and hardware, this study marks the beginning of the development and deployment of LoRa technology in this sector.

Hanggoro *et al.* [7] The author designed and implemented a full-fledged system for monitoring and managing humidity in a greenhouse using an Android mobile application. It employed an Android smartphone to connect wirelessly to a central server, which was then coupled to a microcontroller and humidity sensor via serial connection. They claimed that 802.11g was the third wireless LAN modulation standard and that Wi-Fi was widely used throughout the world. It operated in the 2.4 GHz range with a maximum raw data rate of 54 Mbit/s and net throughputs of roughly 19 Mbit/s (like 802.11b). A wireless G connection was used to connect the Android to the server. In their study, A. Hanggoro et al. separated the hardware system into three components: an Arduino microcontroller, a sensor, and IEEE wireless 802.11g.

Using serial communication and a wireless connection, the microcontroller delivers the sensor's value to the computer.

Gangurde *et al.* [8] The study evaluated numerous network topologies, including Bus, Star, Ring, and Grid, and devised a novel precision agricultural technique based on wireless sensor networks. They discovered that the star topology had significantly less latency than the other three topologies. Across the four cases, the average network latency was 45 milliseconds for the star topology, 71 milliseconds for the grid, 81 milliseconds for the bus, and 98 milliseconds for the ring architecture. As compared to the other three topologies, the star topology reduces latency by around 50%. This study might help to increase the reliability and efficiency of wireless sensor networks used in precision agriculture.

Sacaleanu *et al.* [9] This study investigates the use of data compression to extend the life of LoRa wireless sensor nodes. The authors analyzed the energy requirements of the LoRa, Enhanced Shock Burst, and ZigBee protocols. According to the findings, LoRa with data compression offered the largest energy improvement of 31%, while ZigBee and Enhanced Shock Burst protocols produced energy improvements of 20% and 7%, respectively. The wireless sensor nodes' energy consumption was decreased as a result of the data compression technique utilized in this study since less data was transferred.

Gregoretti *et al.* [10] Presents a cost-effective wireless drip irrigation system control solution using LoRa technology. A customized data transmission protocol that stratifies the requirements has been deployed as part of the system that makes use of LoRa modules to provide dependable radio links. It is demonstrated that this technique is more cost-complexity efficient for this particular application than the current LORAWAN protocol.

Zhao *et al.* [11]. Smart irrigation system based on LoRa technology, which enables rapid implementation and low-cost upkeep. Experiments that show the advantages of utilizing LoRa technology in irrigation systems have validated the system. The irrigation node with a hydroelectric generator, which can run for decades, and the communication distance of up to 8 km between the node and gateway, which enables the system to cover a huge area of up to 200 hectares, are also mentioned by the authors. Users can remotely control the system and instantly check on its status by using a smartphone app. The authors contend that while there is still work to be done to make the system more intelligent and accurate in its operation, implementing LoRa technology in smart irrigation systems might considerably promote the growth of smart agriculture.

Zheng *et al.* [12] Describes how an air quality monitoring system was put into place utilizing cutting-edge IoT methods. The system regularly uploads air quality data to the IoT cloud after collecting it across a significant coverage area. The gateway monitoring hubs can run on solar or battery power and are made to be easily deployed. The system is put into use on an SDR platform that is based on GPP. The IoT cloud analyses the gathered data once it has been stored in a database. To verify its dependability, the suggested system has been tested in metropolitan settings. After comparing the study's findings with other comparable data, the air quality patterns revealed some intriguing insights. It is thought that extensive, long-term air monitoring will greatly aid our understanding of air pollution and enable us to take action to at least partially address the issue.

Atzori *et al.* [13] The Internet of Things (IoT) could change how we interact with our surroundings. The Internet of Things (IoT) facilitates communication with and among smart items by connecting them to the internet, opening a new level of connection and perhaps paving the way for "anytime, anywhere, any media, anything" interactions. The paper outlines the main IoT components and points out the pressing questions that need more investigation. To satisfy the requirements of real-world applications, the authors emphasize the need for IoT technology to be more flexible and efficient. They assert that the increased need for IoT applications will act as a substantial impetus for both business and academic research, resulting in fresh developments in networking and communication.

Manimurugan *et al.* [14] It appears that the author created a smart irrigation system for water that is meant to assist farmers in increasing their yields and decreasing losses. They conducted a survey of farmers to learn about their actual issues before concentrating on using sensors and other cutting-edge technology to solve the biggest issue. One of the main objectives was to make the system as affordable to install as feasible so that as many farmers as possible could use it. The system's overall goal is to assist farmers and enable them to produce more with less danger and expense.

Jakhotiya *et al.* [15] The application of LoRa technology and the LoRa WAN protocol in smart agriculture to digitally monitor, analyze, and manage every part of the industry is exciting to observe. The LSN50 nodes' usage of sensors and actuators aids in data collection and controls for several agricultural system elements, including automatic sprinklers, valve on/off, etc. As it is simple to implement and supports farmers in expanding their businesses, this offers a strong foundation for the future of smart agriculture. Another remarkable aspect of this system is how it uses the TTN network to deliver commands and receive data from the sensors.

3. CONCLUSIONS

Traditional farming practices could be revolutionized by the use of IoT and LoRa-based smart agriculture systems. By collecting and analyzing real-time data from the field, these technologies allow farmers to increase crop yields, cut down on waste, and conserve resources. LoRa technology can
enable remote monitoring and management of agricultural operations because to its long-range and low-power characteristics, making it particularly well-suited for application in rural settings. The advantages these systems offer make them a potential path for the future of agriculture, even though there are still issues to be resolved, such as the high initial expenses of installing these systems. IoT and LoRa-based smart agricultural systems have the potential to greatly boost production and sustainability in agriculture with further research and development.

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