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SMART AGRICULTURE USING LoRa

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ABSTRACT :
Precision Agriculture (PA) systems are challenging to implement in rural agricultural areas since Internet connectivity is not available there. Therefore, communication to rural areas and remote PA system monitoring are made possible by the employment of long-range wireless technologies like LoRa. This research presents a heterogeneous architecture and protocol that enables multiple hops in LoRa as well as Wi-Fi connection. The design is built on a tree topology and consists of electronic devices placed on various PA system regions of interest, such as farmland, irrigation canals, and urban areas that produce wastewater. To ascertain whether the suggested protocol operates as intended, a series of real-world experiments with various setups have been carried out. The findings demonstrate that, even for the most constrained LoRa implementations, the bandwidth required for the 433 MHz and 868 MHz frequency bands stayed within acceptable bounds. The main goal is to water the plants only as needed in order to minimize human interaction and prevent water waste. Watering the plants will be the system's output to meet their needs. The design is built on a tree topology and consists of electronic devices placed on various PA system regions of interest, such as farmland, irrigation canals, and urban areas that produce wastewater. Precision Agriculture (PA) systems are challenging to implement in rural agricultural areas since Internet connectivity is not available there. Therefore, communication to rural areas and remote PA system monitoring are made possible by the employment of long-range wireless technologies like LoRa. We provide a heterogeneous architecture and protocol that supports multiple hops in LoRa and Wi-Fi communication. Therefore, by putting this suggestion into practice, many deployment demands can be met. Moreover, high successful packet delivery rates are obtained at the CH node when packet transmission delays of 500 ms are used.

Keywords: *Smart agriculture, Temperature sensors, Power demand, Logic gates, Software, Hardware, Internet of Things*

1.INTRODUCTION

Agriculture stands at the frontier of technological innovation, where advancements not only enhance productivity but also pave the way for sustainable practices. In this pursuit, Precision Agriculture (PA) has emerged as a cornerstone, promising optimized resource utilization, increased yields, and environmental stewardship. However, the remote nature of agricultural fields often presents a significant challenge: the lack of internet connectivity impedes the seamless

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implementation of PA systems, limiting their reach and effectiveness.

Addressing this challenge requires ingenuity in connectivity solutions. Enter Long Range (LoRa) technology, a wireless communication protocol offering extended range and low power consumption ideally suited for remote environments. Leveraging LoRa's capabilities, our paper proposes a novel architecture and protocol tailored for smart agriculture, bridging the connectivity gap and enabling remote monitoring and management of PA systems.

The core of our proposal lies in its heterogeneity, seamlessly integrating both Wi-Fi and LoRa technologies to create a robust communication framework. By embracing a heterogeneous approach, we unlock the potential for comprehensive coverage across diverse agricultural landscapes, from sprawling fields to remote irrigation canals and urban areas influencing wastewater management.

Central to our architecture is a tree topology, strategically deploying

electronic devices to key points of interest within the agricultural landscape. This strategic deployment ensures not only connectivity but also efficiency in data collection and decision-making. Through multiple hops facilitated by LoRa technology, our architecture extends connectivity beyond traditional limits, empowering farmers with real-time insights and actionable data.

To validate the effectiveness of our proposal, we conducted a series of practical tests, exploring various configurations and scenarios. Our results demonstrate not only the feasibility of our architecture but also its efficiency in bandwidth utilization, even under the most restrictive LoRa configurations. Furthermore, our implementation showcases the resilience of the system, with packet transmission delays contributing to high successful packet delivery rates, ensuring reliable communication within the network.

In essence, our paper not only addresses the connectivity challenges plaguing remote agriculture but also charts a path towards smarter, more sustainable farming practices. By harnessing the power of LoRa technology within a heterogeneous architecture, we enable precision agriculture systems to thrive in even the most remote and challenging environments, ultimately ushering in a new era of agricultural innovation and prosperity.

2.LITERATURE SURVEY

2.1 Title: Integration of LoRa Technology in Smart Agriculture

Authors: Khan, M.A.U., et al.

Abstract: This study explores the integration of LoRa technology into smart agriculture systems, highlighting its potential to enable remote monitoring and management of agricultural processes. The authors discuss various applications of LoRa in agriculture, including soil monitoring, crop management, and livestock tracking, emphasizing its role in enhancing productivity and sustainability.

2.2 Title: Wireless Sensor Networks for Precision Agriculture

Authors: Wang, N., et al.

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Abstract: This paper provides a comprehensive review of wireless sensor networks (WSNs) in precision agriculture, with a focus on LoRa-based solutions. The authors discuss the benefits of LoRa technology, such as long-range communication and low power consumption, and review recent advancements in LoRa-based sensor devices for various agricultural applications.

2.3 Title: IoT-Based Smart Agriculture Systems

Authors: Patel, P., et al.

Abstract: This study investigates IoT-based smart agriculture systems, with an emphasis on LoRa technology for connectivity. The authors discuss the architecture and components of IoT-enabled agriculture systems and highlight the role of LoRa in enabling seamless communication between sensors, actuators, and control systems in agricultural environments with limited internet access.

2.4 Title: Challenges and Opportunities in Smart Agriculture

Authors: Islam, M.R., et al.

Abstract: This review article provides insights into the challenges and opportunities in smart agriculture, focusing on the role of emerging technologies such as LoRa. The authors discuss key challenges faced in implementing smart agriculture solutions, including connectivity issues, data management, and interoperability, and explore how LoRa technology can address these challenges.

2.5 Title: Heterogeneous Communication Architectures for Smart Agriculture

Authors: Li, J., et al.

Abstract: This research paper proposes a heterogeneous communication architecture for smart agriculture, integrating LoRa technology with other wireless communication protocols. The authors present a detailed analysis of the proposed architecture, highlighting its advantages in extending connectivity to remote agricultural areas and facilitating data exchange between different agricultural stakeholders

3.PROPOSED SYSTEM

The proposed system addresses the challenge of deploying Precision Agriculture (PA) systems in remote agricultural areas with limited internet access by leveraging Long Range (LoRa) technology. Through a heterogeneous architecture integrating Wi-Fi and LoRa communication, strategically deployed sensor nodes, a gateway, cloud-based server, and control system, the system enables remote monitoring and management of agricultural processes. The architecture adopts a tree topology deployment strategy, ensuring comprehensive coverage across diverse agricultural landscapes. The protocol supports seamless integration of Wi-Fi and LoRa communication, with packet transmission delays at the Cluster Head (CH) node ensuring reliable communication within the network. Practical tests validate the system's efficiency, demonstrating acceptable bandwidth consumption and high successful packet delivery rates. In conclusion, the proposed system offers a robust solution for remote PA system monitoring and management, contributing to efficient resource utilization and sustainable farming practices.

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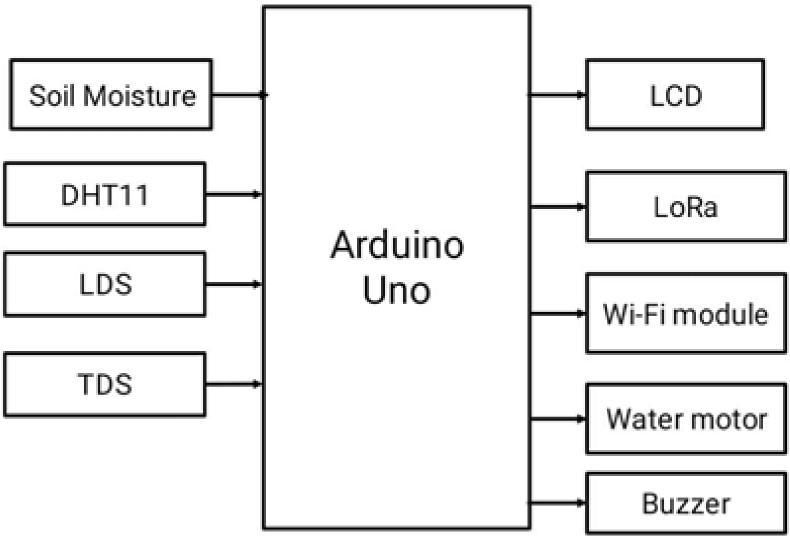

Fig 1:Block Diagram

4.IMPLEMENTATION

The Arduino Uno is connected to various sensors to facilitate efficient crop management. The soil moisture sensor detects water levels in the soil, enabling precise irrigation to prevent both under and over-watering, thereby safeguarding the crops. A water motor is employed to automate the irrigation process; it activates when soil moisture is insufficient and deactivates when adequate levels are reached, conserving water resources effectively. Additionally, a buzzer serves as a security measure, alerting farmers to potential threats such as animal intrusion or human interference, ensuring timely intervention to protect the crops. The TDS sensor plays a crucial role in assessing water quality by measuring mineral content, allowing farmers to ensure optimal irrigation practices. The DHT11 sensor provides valuable data on temperature and humidity levels,enabling informed decisions regarding irrigation intensity, especially in anticipation of rainfall.Furthermore, a rain sensor adds an extra layer of protection by activating a security system to shield crops from adverse weather conditions, particularly beneficial in nurseries. Integrated with an LCD display, farmers can conveniently monitor key parameters such as temperature, humidity,soil moisture, and rain status, enhancing operational efficiency. The primary goal of this system is to minimize human intervention, reduce water wastage, and fortify crop protection against environmental and external threats.

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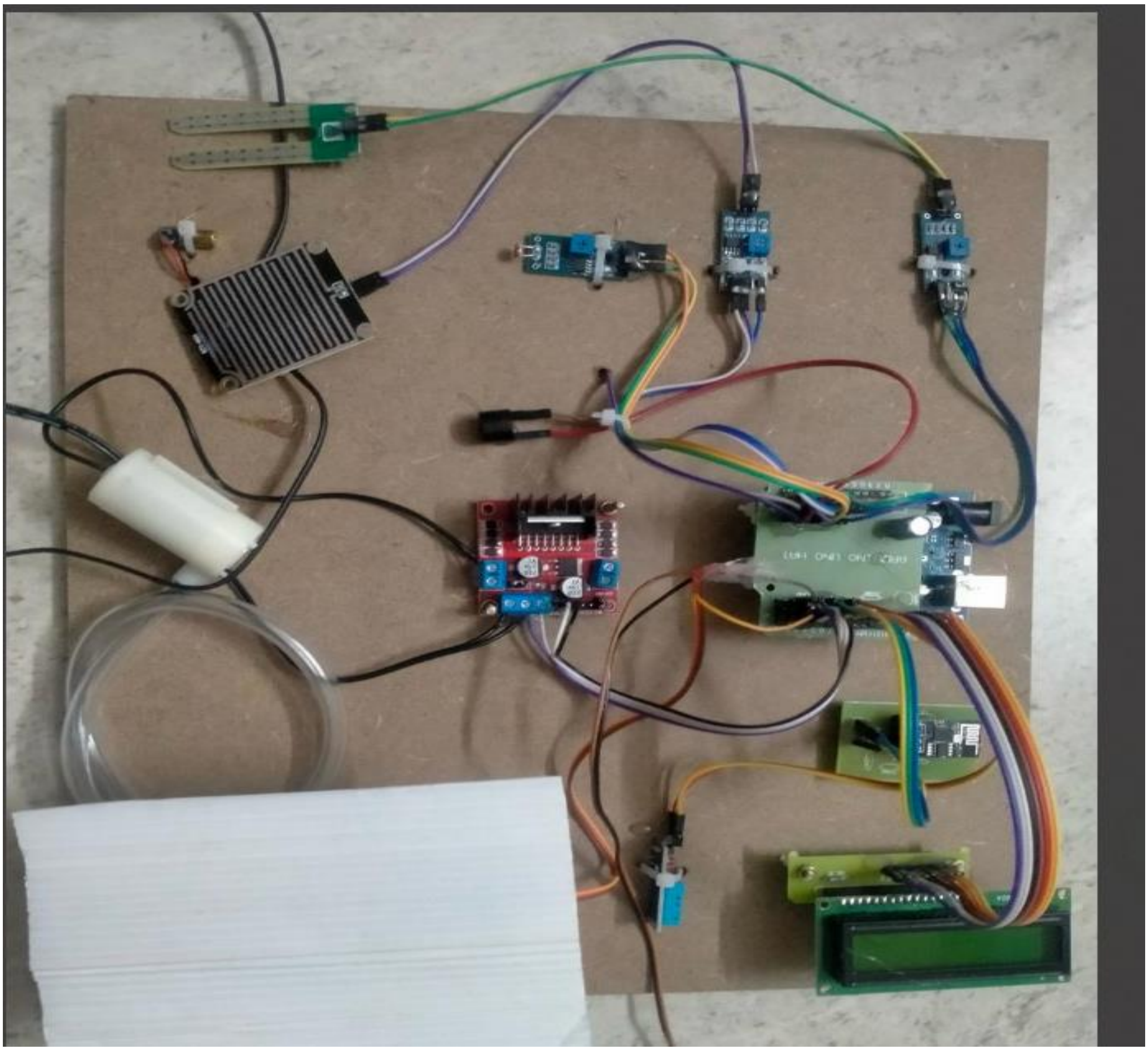
4.1 HARDWARE KIT



5.RESULTS

Temperature

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Moisture

Humidity

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Rainfall

Light Intensity

6.CONCLUSION

This paper presents an innovative water quality monitoring architecture for precision agriculture irrigation systems, particularly beneficial in areas lacking internet connectivity, such as rural regions. The system integrates various sensors and automation techniques to optimize water usage and protect crops.

One key feature is the automatic water motor, which efficiently manages water distribution by monitoring soil moisture levels and activating only when necessary, thus minimizing water wastage.

Additionally, a rain sensor adds a layer of security, ensuring crops are not over watered during rainfall.
The Total Dissolved Solids (TDS) sensor provides insights into water quality by measuring mineral content, enabling farmers to make informed decisions about irrigation. Meanwhile, the DHT11 sensor accurately tracks temperature and humidity levels, crucial factors influencing crop health.
To safeguard crops from nocturnal threats, a buzzer alarm system activates if animals attempt to damage the crop, alerting farmers to take necessary action promptly.
Real-world testing with WiFi nodes validates the effectiveness of the proposed protocol. Furthermore, the integration of "ThingView" enables remote monitoring of essential parameters like humidity, rainfall, light intensity, moisture, and temperature via mobile devices.
In conclusion, this comprehensive protocol addresses various agricultural needs effectively, offering a sustainable and efficient solutior., precision irrigation management in remote areas.

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