Smart Irrigation Decision Support System

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Abstract

This paper addresses the practical challenges of incorporating user demands in IoT agriculture, such as cost, data privacy, and easy configuration for farmers. It explores the possibilities of modifying IoT solutions while maintaining compatibility with the existing LoRaWAN standards. The research focuses on a specific use case and aims to enhance functionality and usability by understanding the unique requirements of farmers. By considering affordability, data security, and ease of setup, the study aims to extend the capabilities of the LoRaWAN protocol without compromising interoperability. The goal is to contribute to the advancement of IoT solutions in agriculture by incorporating user-driven modifications while adhering to established standards.

1 Introduction

The use of IoT (Internet of Things) agriculture sensors in the farming industry has the potential to greatly improve crop yields, increase efficiency, and reduce waste. These sensors are equipped with various types of sensors that can collect data on important factors such as soil moisture levels, temperature, humidity, and light intensity. By analyzing this data, farmers can optimize irrigation systems, monitor crop health, and predict weather patterns. Additionally, by connecting these sensors to the internet, the data they collect can be accessed and analyzed remotely.

Water is a vital resource for agriculture, as it is necessary for the growth of crops and the raising of livestock. However, water is a finite resource and it is essential to use it efficiently in order to sustainably feed a growing global population. There are several reasons why water conservation is important in agriculture:

By using water efficiently, farmers can help ensure that this vital resource is used sustainably and help to meet the growing demand for food while preserving the environment. The aim of this thesis is to develop a cost-effective IoT hardware solution that is affordable for farmers and provides a high rate of return in terms of both yield and input cost. The goal of this project is to utilize IoT technology, specifically soil moisture sensors, to aid in water conservation efforts within the agricultural industry.

- Water scarcity: Many regions around the world are experiencing water scarcity, making it crucial to use this resource efficiently.
- Climate change: Climate change is affecting the availability and distribution of water, making it more important than ever to use water wisely.
- Cost: Water is often a significant cost for farmers, and using it efficiently can help reduce these costs.
- Environmental impact: Irrigation can have a significant impact on the environment, both in terms of water usage and the potential for pollution. Using water efficiently can help mitigate these impacts.

2 Challenges in Agricultural Sensor Network

Implementing agriculture IoT faces challenges in connectivity, data management, standardization, security, power supply, cost, and technical expertise. Reliable and robust connectivity is needed for real-time data transmission. Managing and analyzing large volumes of data require effective data management and user-friendly platforms. Standardization is necessary to ensure seamless integration of IoT devices. Security measures are crucial to protect sensitive agricultural data. Power supply and energy efficiency are important considerations. Cost can be a barrier, so affordability measures are needed. Technical expertise and training are essential. Addressing these challenges will enable successful implementation of agriculture IoT and optimize farming practices.

3 Related Communication Technologies

In IoT agriculture, communication options for connectivity include cellular networks like 3G, 4G, and 5G, which offer reliable connectivity in both rural and urban areas. Low-Power Wide-Area Networks (LPWANs) such as LoRaWAN and NB-IoT provide long-range communication with low power consumption. Satellite communication is ideal for remote areas with limited terrestrial network coverage. Wi-Fi is commonly used in agricultural settings with reliable internet access, while Ethernet offers stable and high-speed communication within localized areas. Bluetooth and Zigbee are suitable for short-range wireless connections within close proximity.

The choice of communication option depends on factors like geographic location, infrastructure availability, power requirements, data transmission needs, and budget constraints. In some cases, a combination of communication technologies may be used to ensure connectivity across different parts of an agricultural operation.

Data Rate	BLE	ZigBee	WiFi	3G/4G	SigFox	NB-IoT	LoRa
Transmission Range	100 m	20 m	100 m	Network	40 Km	15 Km	20 Km
Data Rate	2 Mbps	20-250 kbps	0.3 Gbps	1 Gbps	100 bps	250 kbps	50 kbps

Table 1: Comparison of Wireless Sensor Network

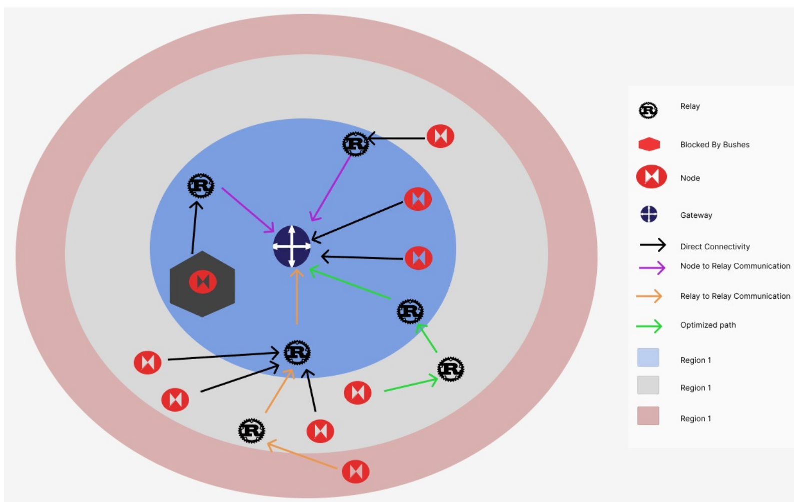

Figure 1: Implementation Scheme of Proposed Architecture [1]

4 Research Problem

Crop cover in agriculture can pose challenges to communication between IoT sensors. Dense vegetation can interfere with signal transmission, leading to reduced signal strength and potential data loss. Line-of-sight communication may be obstructed, limiting the effective range of wireless technologies. Placing sensors within the crop canopy and ensuring accurate readings can be difficult. Additionally, the power consumption of sensors may increase due to the need for stronger signal transmission. However, strategic sensor placement, alternative communication technologies, mesh networks, and specialized approaches can help mitigate these challenges and enable reliable data collection and transmission in crop-covered environments.

This paper discusses a specific use case in agriculture where there is no available free LoRa or LoRaWAN network. To address this, the concept of an intermediate device called a Relay is introduced. The Relay serves as a bridge between the agricultural nodes and the gateway, enabling long-range communication in dense fields. It is assumed that the Relay is strategically installed at a fixed location with a high antenna, allowing for efficient data forwarding to the gateway.

5 Implementation Challenges

This research focuses on developing a path optimization algorithm that can be implemented on a device to improve real-time path selection within a network. The algorithm takes into account factors such as available power, network congestion, and message size when optimizing the path for data transmission.

We will study the LoRaWAN protocol and experiment with a modified communication scheme that enables direct message transmission to a client server without relying on the central server of the LoRaWAN network for routing data. Additionally, we will explore the implementation feasibility of optimizing the path in real-time to forward messages to the nearest gateway and ensure LoRaWan standard.

However, it's important to consider security, authentication, and data integrity since this approach bypasses the standard infrastructure of the LoRaWAN network. These aspects need careful attention and consideration during the implementation.

References

[1] Vasileios Moysiadis, Panagiotis Sarigiannidis, Vasileios Vitsas, and Adel Khelifi. Smart farming in europe. *Computer science review*, 39:100345, 2021.