Implementing LoRaWAN into an Agriculture Sensor Network

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# Abstract

IoT4Ag developed a system for organizing and distributing sensor data in agriculture environments. The system’s ground base station collects and organizes data, coordinates autonomous drones, controls wireless power transmission, and monitors battery health. Communication between the base station and sensor nodes uses a range-limited and power-intensive Wi-Fi protocol. This project aims to integrate LoRaWAN into the base station and sensor nodes.

# Introduction

The agriculture industry needs an efficient solution for collecting, organizing, and distributing sensor data in a natural environment. In [1] sensor data is shown to allow the industry to recognize, target, and treat yield-effecting conditions. IoT4Ag is developing a system to meet this need.

In 2020, [2] published similar use of LoRaWAN in IoT4Ag for monitoring food storage. Their process differs in both external systems and environmental constraints. Like our design, their nodes transmit sensor data over LoRaWAN. The sensors monitor food storage in a powered environment, whereas our sensors will operate underground using stored power. Their Internet connection uses Wi-Fi, whereas ours uses a Starlink modem. Eliminating the idle Wi-Fi connection allows us to achieve lower power use and operate in fully Our ambition is to make a LoRaWAN node to operate with the lowest power consumption we can manage whilst still transmitting our sensor data at the frequency we need it.

# Technical Objectives

The IoT4Ag system, described in Figure 1, illustrates the existing system’s Wi-Fi protocol for communication. Wi-Fi is neither energy efficient, nor able to transmit long distances. LoRaWAN meets these requirements and needs to be integrated into the system. Designing and integrating a LoRaWAN sensor network into the existing requires completing two tasks. The first is creating a LoRaWAN node that can receive sensor data and transmit it to the base station. The second task is creating a LoRaWAN hub that captures the node signals and relays them to computer for display and storage.

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| [1] | P. Rajak and e. al., "Internet of Things and smart sensors in agriculture: Scopes and challenges," *Journal of Agriculture and Food Research,* vol. 14, p. 100776, December 2023. |
| [2] | B. C. C. S. K. E. G. S. Esma Kokten, "Low-Powered Agriculture IoT Systems with LoRa," *IEEE Microwave Theory and Techniques in Wireless Communications,* 2020. |

**LoRaWAN Drone Base Station Integration**

The coordinating node for the LoRaWAN communication (LoRaWAN Hub) will be centralized amongst the field nodes to:

* Effectively receive sensor/battery health data.
* Send it to a local PC over USB to display on the GUI.
* Transmit back ACK responses and any configuration changes made in the GUI.

**LoRaWAN Sensor Node Design and Build**

The sensor node is a subterranean hermetically sealed system capable of collecting and transmitting sensor data. The node will achieve the following:

* Collect sensor data through or UART protocols.
* Report system data including battery health.
* Transmit data via the LoRaWAN protocol.
* **A close-up of a diagram

  Description automatically generated**Wirelessly charge a Li-ion battery.

Figure - IoT4Ag system overview with LoRaWAN integration. The existing system, shaded blue, uses Wi-Fi to transmit data via a satellite connection. The sensor network, shaded orange, implements the LoRaWAN protocol.