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AN OPEN-SOURCE, UNIVERSAL ARDUINO LIBRARY FOR LORAWAN INTEGRATION WITH LOW-COST, LONG-RANGE AGRICULTURAL SENSOR NETWORKS

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Abstract.

An open-source Arduino library was developed to add LoRaWAN connectivity to the low-cost, open-source Data-Gator sensor platform through the RYLR993 module. The library abstracts the module's attention (AT) command protocol into a high-level interface for configuration, point-to-point Long Range (LoRa) messaging, and full LoRaWAN operation. Data delivery was confirmed through a gateway on the US915 frequency plan, giving agricultural sensor networks a practical path into areas without wireless infrastructure.

Keywords. *LoRaWAN, LoRa, wireless sensor networks, precision agriculture, open-source, Arduino*

Introduction

The Data-Gator is a low-cost, open-source ESP32 sensor platform for precision agriculture that supports I2C, analog, and Bluetooth Low Energy (BLE) sensors without coding (Wells et al., 2024). It has returned field data only over WiFi, however, which limits where it can be deployed. LoRaWAN offers long-range, low-power connectivity without local infrastructure (Križanović et al., 2023). The objective was an open-source, portable Arduino library, adding LoRaWAN to the Data-Gator, and to any Arduino host, over a simple serial link.

Materials and Methods

Hardware

An RYLR993 module on the RYLR993_Lite board (Reyax Technology Co., Ltd., Taipei, Taiwan), which embeds a Semtech SX1262 radio (Semtech Corporation, Camarillo, California, USA), was connected to a Data-Gator ESP32 Feather host (Adafruit Industries, New York, USA) over a two-wire Universal Asynchronous Receiver/Transmitter (UART) link through a four-pin connector (Fig. 1).

Library architecture

The library abstracts the AT command protocol into a high-level interface covering configuration, point-to-point LoRa messaging, and LoRaWAN operation, including over-the-air activation (OTAA), Class A and Class C, adaptive data rate, and multiple regional plans. Communicating over a standard serial link, it is portable to any Arduino-supported host.

Field validation

The node was configured for OTAA on the US915 plan and joined a SenseCAP M2 gateway (Seeed Technology Co., Ltd., Shenzhen, China); periodic uplinks were then transmitted and observed at the gateway.

Results

End-to-end delivery was confirmed: the node joined via OTAA and delivered payloads through the gateway. Uplinks were received at −32 dBm RSSI and 14 dB SNR (spreading factor 7, 125 kHz, US915), and an automated test suite passed for all command, join, and transmit cases. The library exposed the full feature set required for field use (Table 1).

Table 1 Capabilities exposed by the open-source RYLR993 Arduino library

Capability	Supported
Module configuration and diagnostics	Yes
Point-to-point LoRa messaging	Yes
LoRaWAN OTAA activation	Yes
LoRaWAN ABP activation	Yes
Class A / Class C operation	Yes
Adaptive data rate (ADR)	Yes
Multiple regional frequency plans (e.g. US915, EU868)	Yes

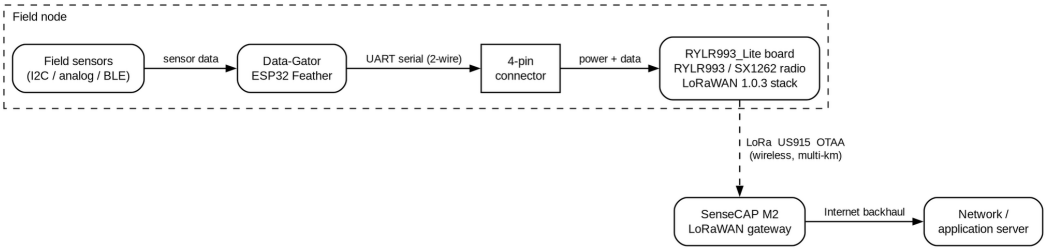

Fig. 1 System architecture: field sensors feed the Data-Gator ESP32 Feather host, which drives the RYLR993_Lite board over a two-wire UART link; the module transmits over LoRa (US915, OTAA) to a SenseCAP M2 gateway and onward to network and application servers

Conclusions and Future Work

An open-source Arduino library extended a low-cost sensor platform with standards-based, long-range LoRaWAN connectivity, reaching sites without WiFi. Future work will integrate the RYLR993 onto a revised Data-Gator carrier board supporting both WiFi and LoRaWAN, and will quantify communication range, packet delivery ratio, and power consumption in the field.

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References

Križanović, V., Grgić, K., Spišić, J., & Žagar, D. (2023). An advanced energy-efficient environmental monitoring in precision agriculture using LoRa-based wireless sensor networks. *Sensors*, 23(14), 6332.

LoRa Alliance (2018). *LoRaWAN 1.0.3 specification*. Fremont, California, USA: LoRa Alliance.

Semtech Corporation (2021). *SX1261/2 long range, low power, sub-GHz RF transceiver: datasheet*. Camarillo, California, USA: Semtech Corporation.

Wells, G., Everett, M., & Shovic, C. J. (2024). Data Gator: a provision-less network solution for collecting data from wired and wireless sensors. In *Proceedings of the 16th International Conference on Precision Agriculture*. Monticello, Illinois, USA: International Society of Precision Agriculture.