Flexible Nitrate Sensors: Uses in Aqueous Environments and Implementation of LoRa Wireless Communication System

Jose Waimin, Hongjie Jiang, Dr. Rahim Rahimi
School of Material Engineering, Purdue University, West Lafayette IN

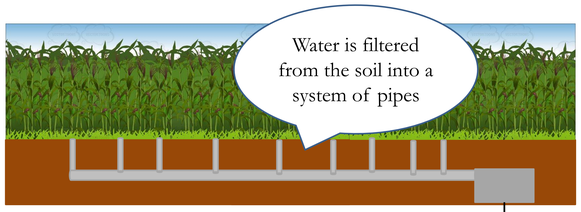
I. Background & Motivation

Accurate measurement:
- Real-time, in-field and non-destructive measurement
- Low-Cost
- Easy field deployment and operability

LoRa Wireless Modules:
- Consistent & accurate readings
- Resistance to interference for in-field deployment
- Operational for long term use (power efficiency)

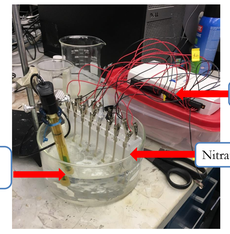
II. Nitrate Sensing in Water

Field Deployment



It is then collected into a container equipped with a nitrate sensor that can give live measurements of nitrate levels

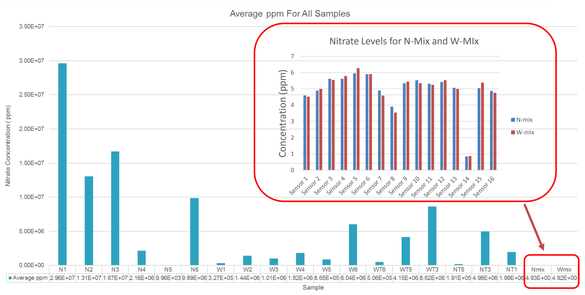
Lab Testing



16 sensors are connected in array to an NI Module. This allows for simultaneous readings which helps monitor the accuracy and consistency of the sensors.

TPAC Samples Testing

- 19 water samples collected in different areas in the field

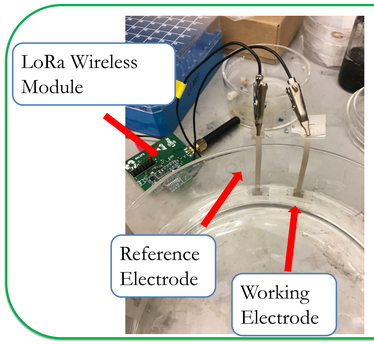


- Nitrate levels for all 19 samples plus a mixture of N-samples and W-samples

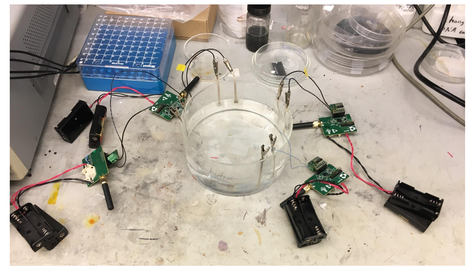
Importance of Optimizing Testing Procedure

Large inconsistencies between sensors measuring the same sample can be attributed to interference from equipment in the lab, mechanical noise, or poor contact between the sensor and the analyte.

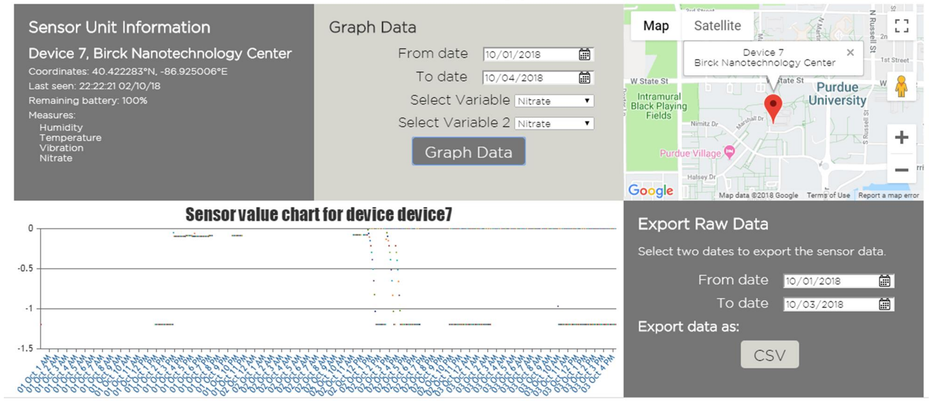
III. LoRa Wireless Communication Setup



- 4 LoRa Wireless Modules are connected each to a pair of nitrate sensors
- In each pair of sensors, one acts as a reference electrode (not sensitive to nitrate) and the other acts as the working electrode (sensitive to nitrate)
- The modules measure nitrate levels every 5 minutes and send the information to a receiver across the room
- All the data is uploaded into a database and can be accessed through a website



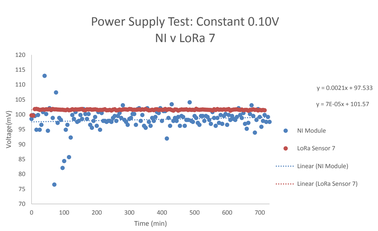
Live Website for Data Management

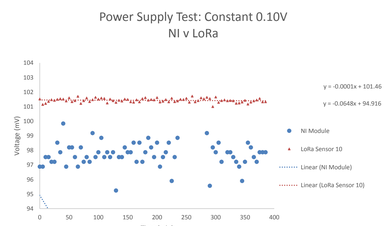


- Data logging to local drive with real-time data plotting
- Currently connected to 11 sensors
- 2-way communication allows easy control sending commands to reading electronics

- Software can be tailored to fit any measurement application
- Capability of adding/removing features
- "Export Raw Data" feature allows for quick and easy download of data for analysis

Comparison of NI Module vs LoRa Wireless Module in Power Supply Test





Experimental Setup:
- All 4 sensor pairs were connected to a power supply machine set at a constant output of 0.10 V
- Voltage was measured in parallel by both the NI module and LoRa Wireless module
- Results show greater stability in the readings made by the LoRa Module in comparison

IV. Conclusion and Future Work

- Nitrate sensors show high sensitivity to different nitrate levels in water samples
- Optimizing the testing process in the lab is crucial in order to get reliable data
- Use of LoRa Wireless Modules will provide the means for wireless management of sensor in the field
- Use of commercial nitrate sensors to test water samples is necessary to measure accuracy