SPECIES: Smart Penetrometer with Edge Computing and Intelligent Embedded Systems

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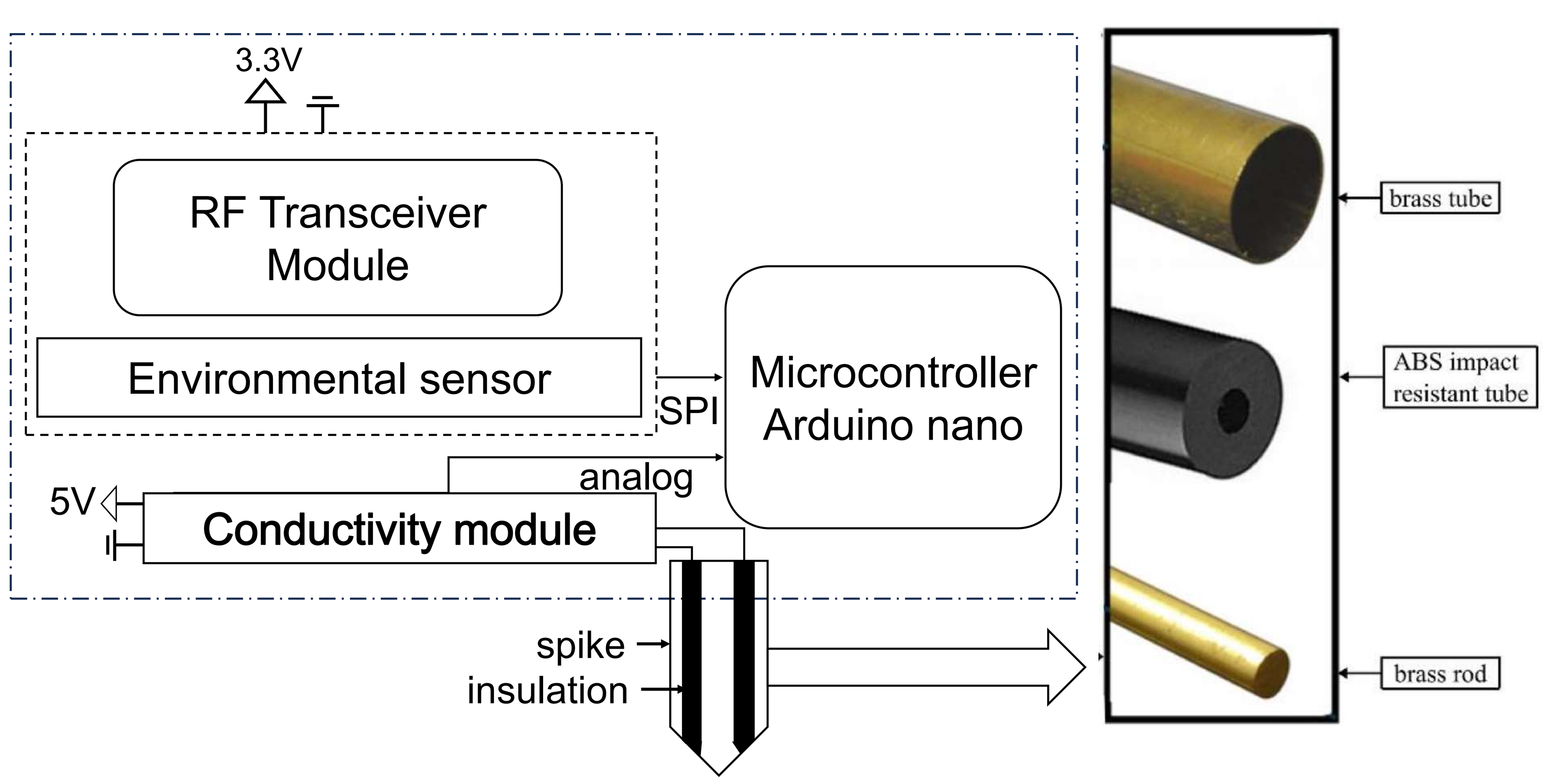
Abstract

- Create a cheaper compact UAV-deployable sensor package with basic components to monitor levees as a part of a larger effort to develop a data-driven fragility framework for risk assessment of levee breach.

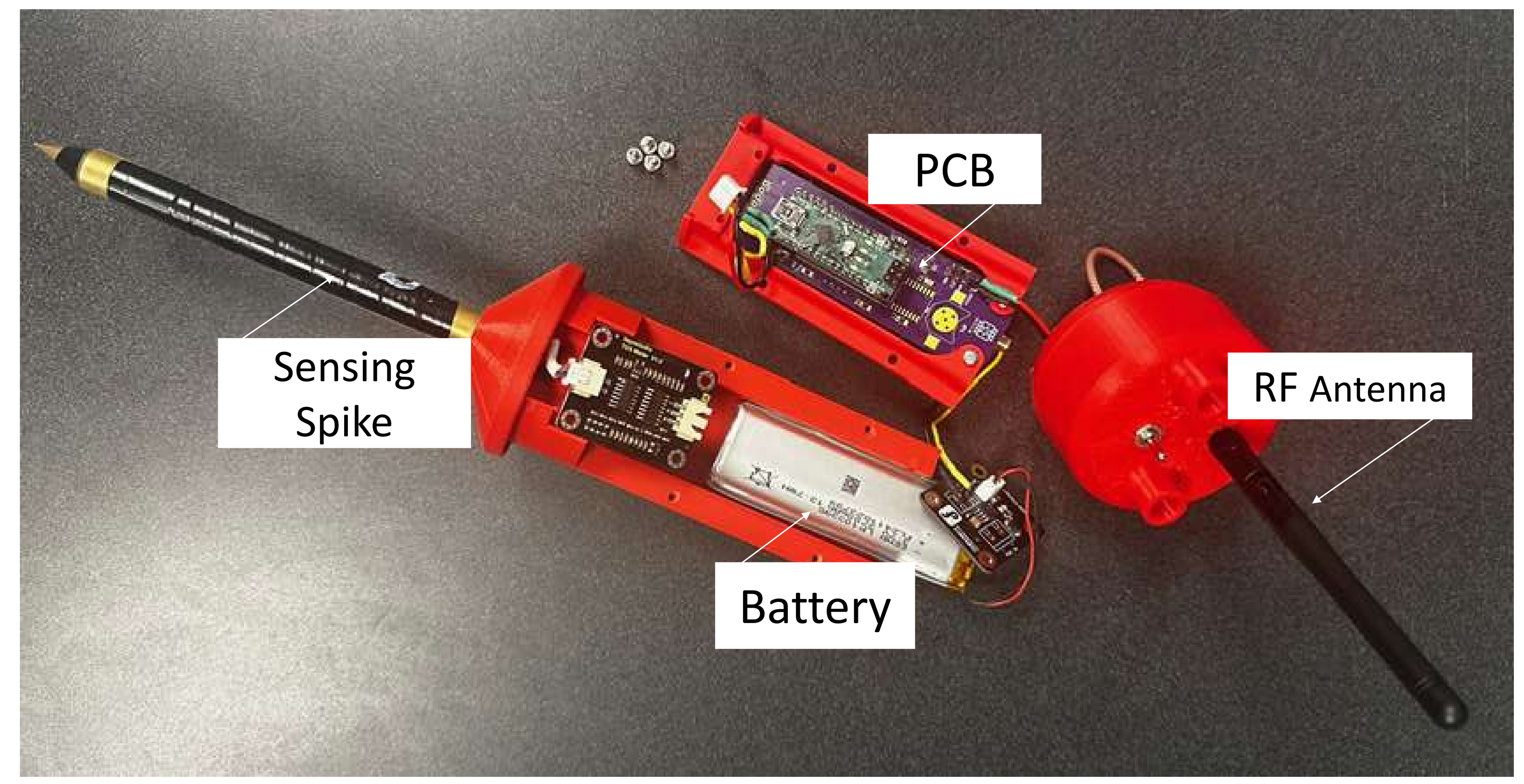
Background

- Levees are earthen structures built parallel to water bodies, such as rivers, to control water levels and protect low-lying land and people.
- Current levee monitoring consists of extensive and expensive wired geophones and ground sensors.
- Tracking the conductivity and ground velocity inside levees can sooner alert authorities of damage and pending danger.
- The package uses radio frequency (RF) to send data collected by the spike from the levee to a nearby base station for collection and analysis.



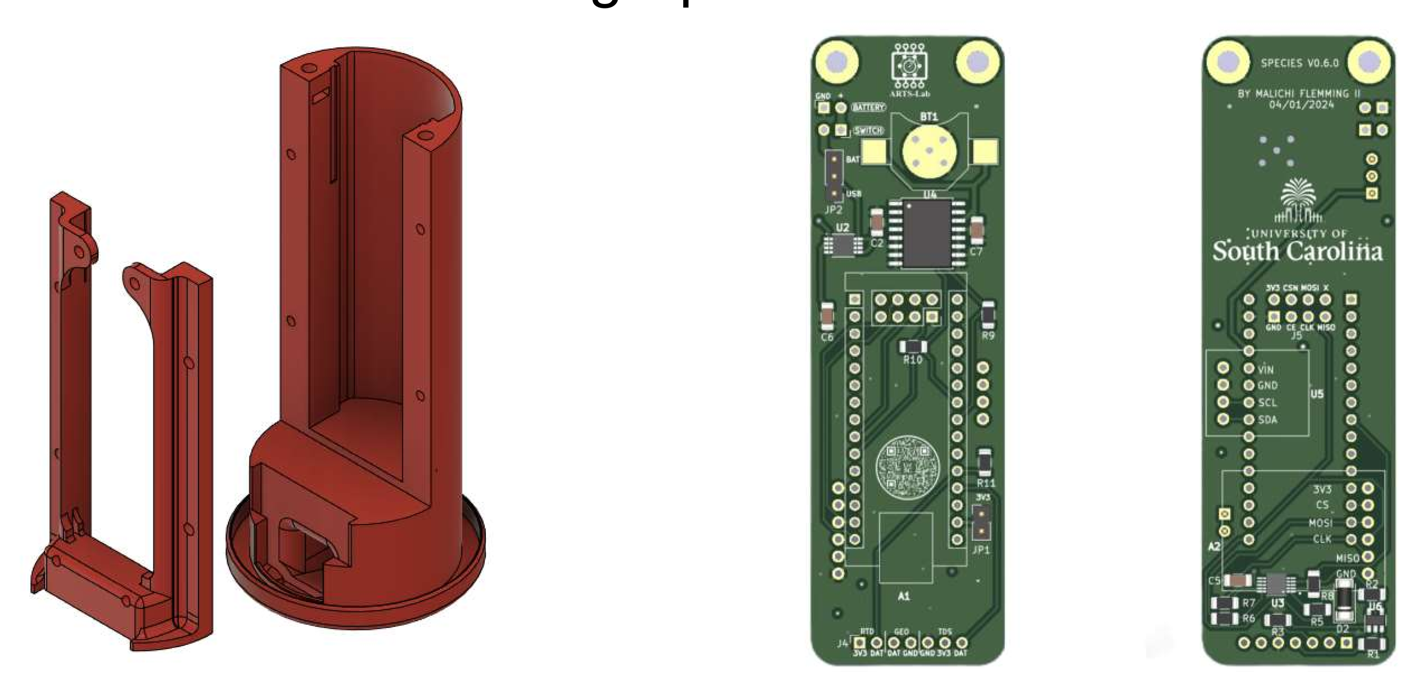
Block diagram outlining connections

Design



The package includes the following components:

- Arduino Nano ATMEGA328 Microcontroller
- nRF24L01+ PA LNA Wireless Transceiver Module
- 3.7V 3700mAH Lithium Polymer Battery
- BME280 Environmental Sensor Module
- Total Dissolved Solids Module
- Insulated Brass Sensing Spike

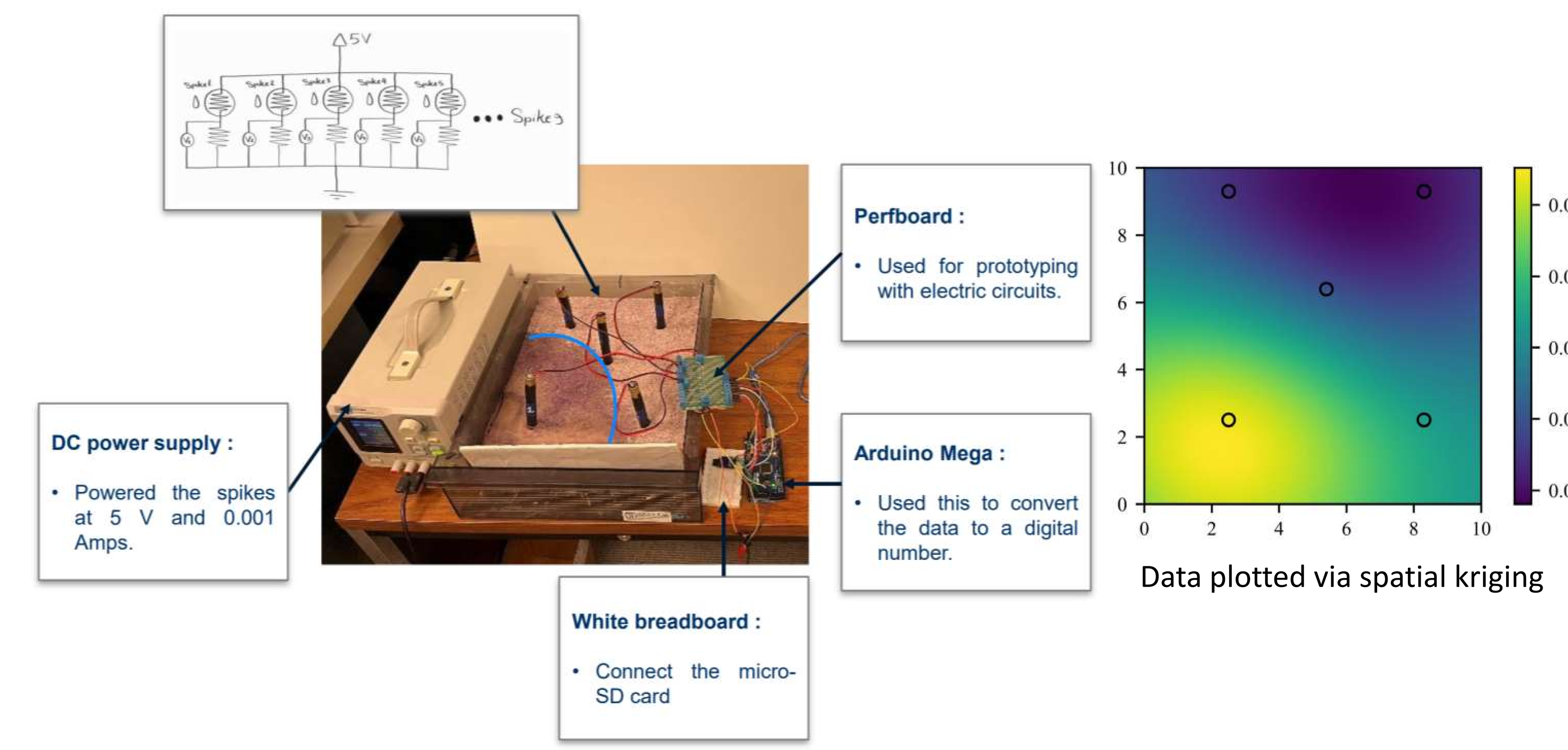


Fusion 360 Housing CAD and KiCAD PCB design

- Housing unit is 2 parts; The screw-in front plate holds the PCB and the back is a storage slot for the battery.

Testing and Results

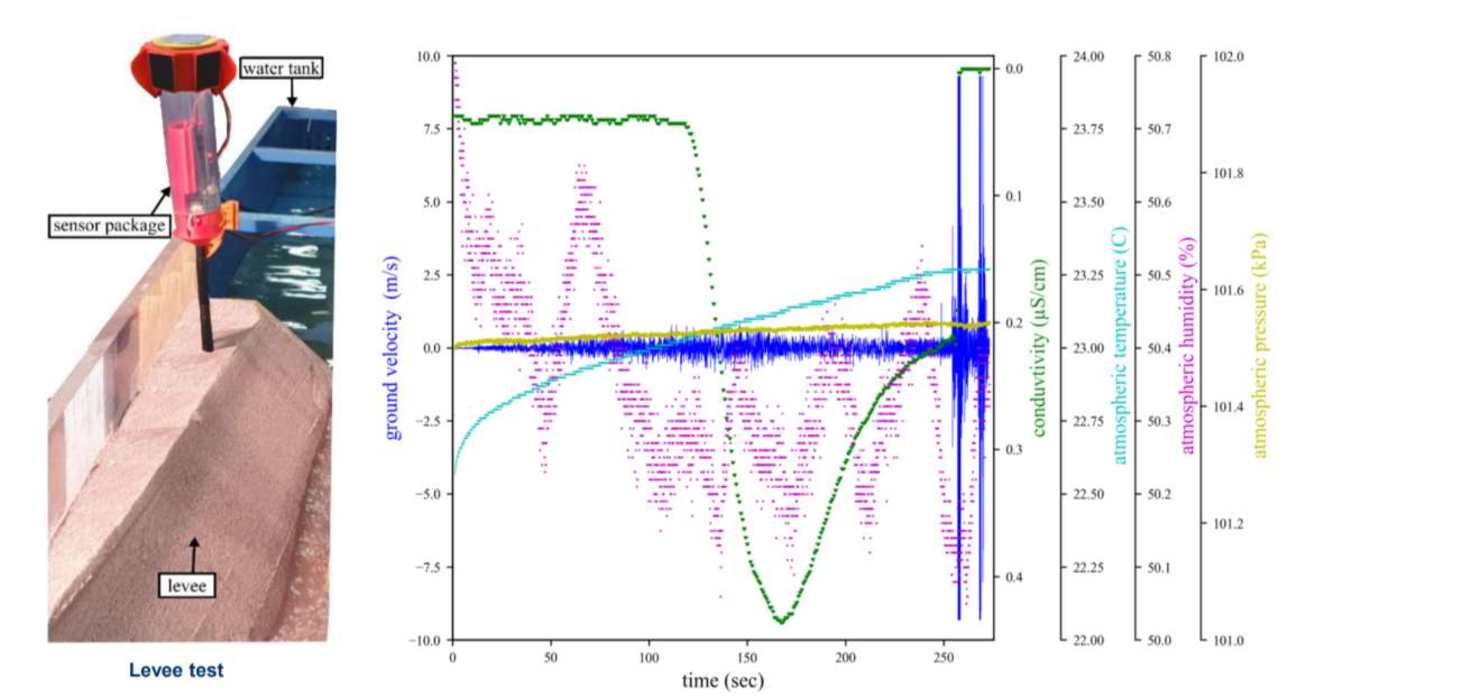
- Tested 5 spikes in sand to verify the electrical conductivity (EC) tracking through moisture testing by pouring water in the corner and comparing the values.



Data plotted via spatial kriging

- The test verifies the EC capabilities as the voltage value was highest where the water content was the highest.

- Tested a single spike in an indoor flume to simulate realistic levee breach.



- Noting the dark blue and green lines, the data validates that ground velocity and conductivity are proportional to seepage and beneficial to monitoring levee failure.

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