A Sensor Network For Monitoring Sagebrush

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Introduction

Sagebrush, and their Volatile Organic Compound (VOCs) emissions, are of great interest to the scientific community at large. These emissions resemble a form of communication that is distinct between different species of sagebrush. This project aims to create a network that is capable of measuring VOCs covering large areas to listen to these different forms of communication. The network would have the capabilities of multiple sensor tags sending their data to a central reader node for ease of access to be used in conjunction with a laser induced graphene (LIG) sensor that will measure the VOC emissions.

Previous Iteration

- Prototype communicated using Bluetooth low energy (BLE) and was based on the TinyPICO Espressif express board
- BLE was able to communicate peer to peer with low energy consumption but was difficult to make into a network of sensors successfully
- Was able to read from attached LIG sensor

New Version Using ESP-NOW

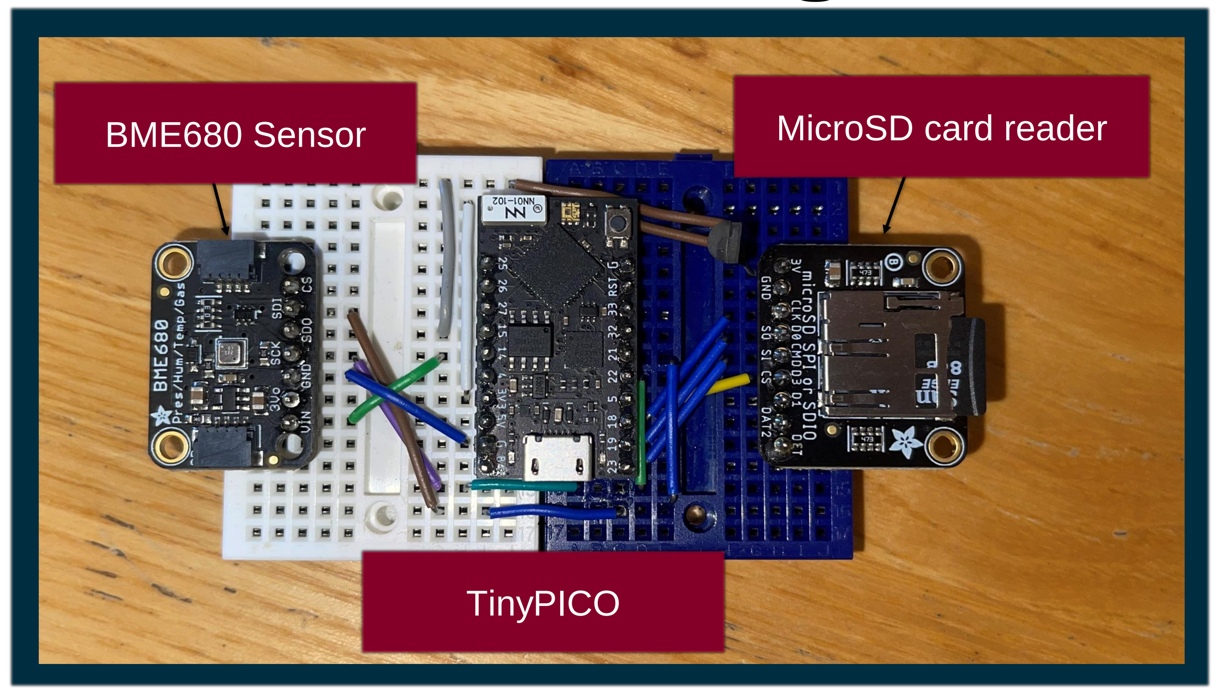

Figure 1: Sensor Prototype consisting of a TinyPICO wired to a BME680 Sensor and MicroSD card reader.

- Same TinyPICO board used in the previous version, but instead of the LIG sensor, BME680 sensor was used to demonstrate sensor network communication.
- Replaces BLE communication with the ESP-NOW wireless communication protocol due to easy network capabilities
- Network created for this project has three modes that can be configured for use

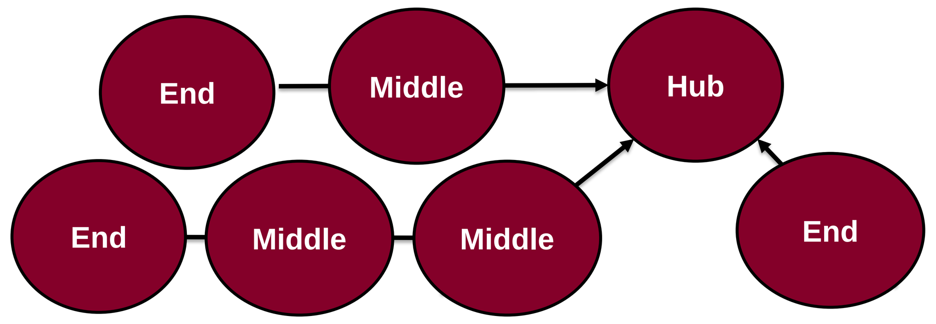

Figure 2: Example of network in different chain compositions.

Operational Block Diagram

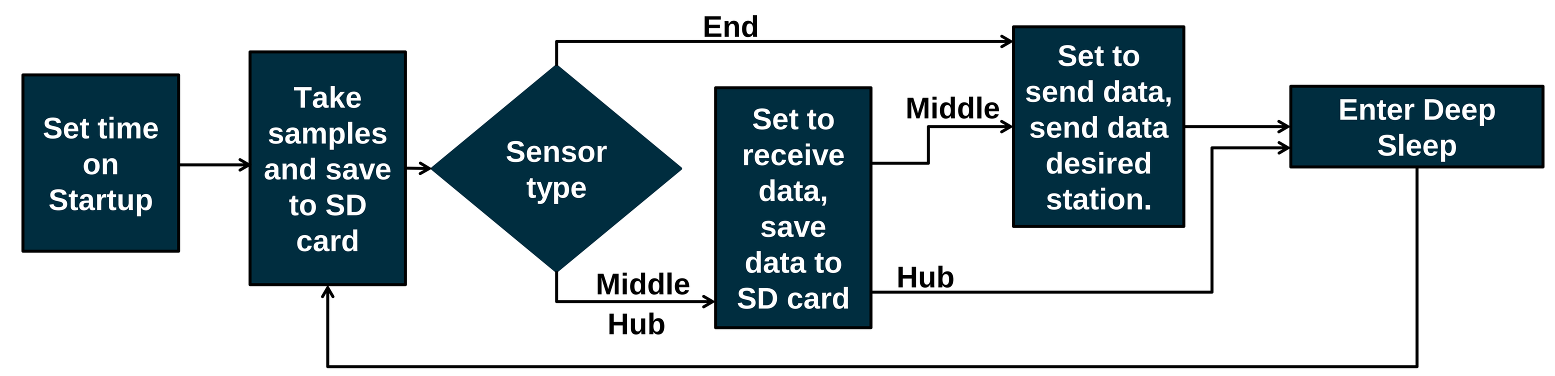

Figure 3: Block diagram of sensor operations.

Electrical Current Draw

- Measurements were taken using a Keithly 2700 multimeter.
- Each graph shows a normal operation cycle with its different functions and resulting current consumption
- Current consumption and battery life calculations made from these graphs

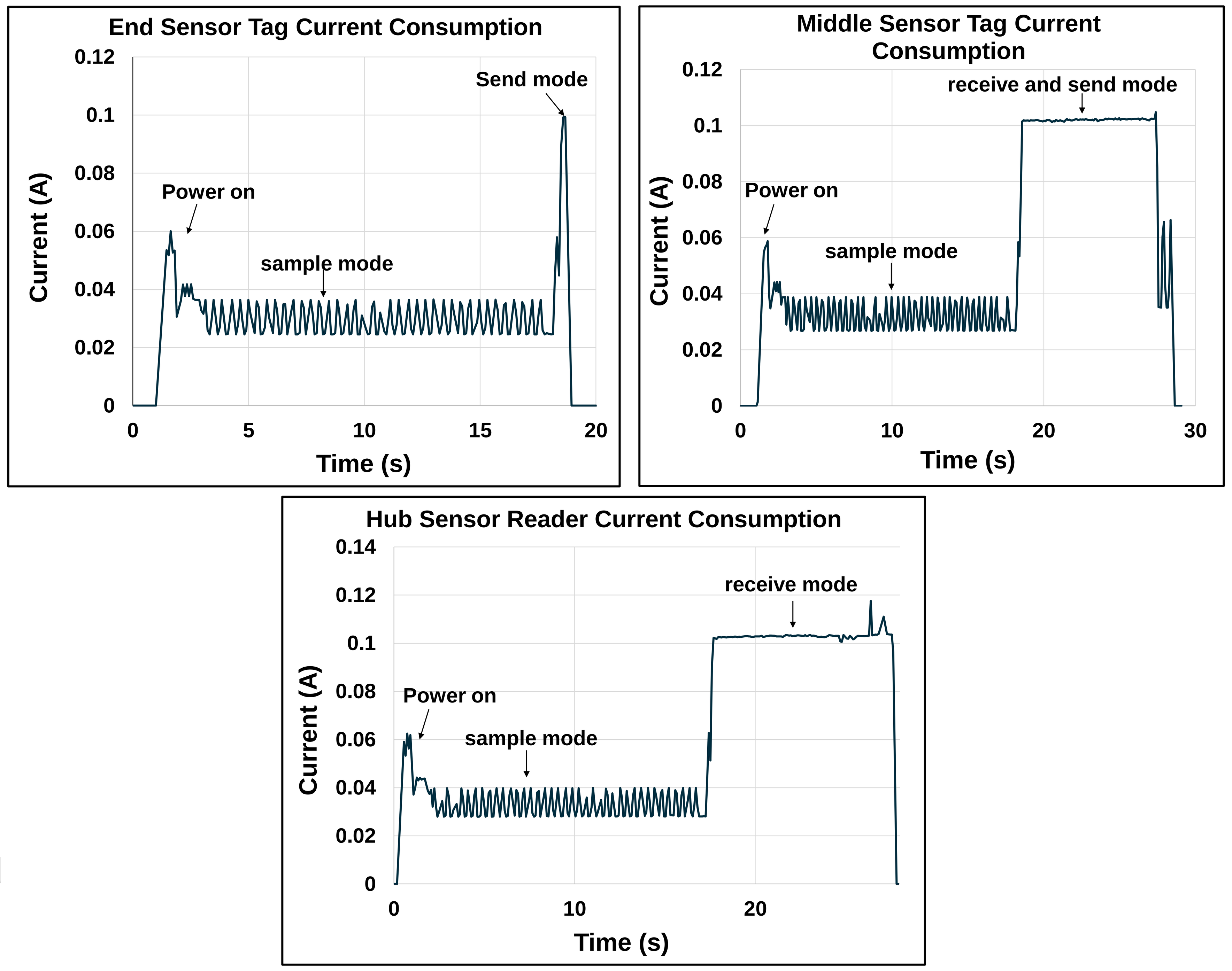

Figure 4, 5 and 6: Current Measurement graphs for a normal cycle of operations

	Sample Mode (mA)	Transmit Mode (mA)	Daily Amp Hour (mAh/day)	Days on a 3000 mAh battery
Hub Sensor Reader	31.11	93.56	8.86	338
Middle Sensor Tag	33.61	103.24	9.05	331
End Sensor Tag	37.26	105.17	7.25	413

Table 1: Current Measurement Table comparing the average current draw for each mode in operation and a calculation for a battery life for each sensor. Averages were taking during each mode and then multiplied by the time it takes to perform each action. Using this a daily amp usage can be calculated assuming a sample taken every hour to then get a total on how many days the battery will last. This does not take into account the non-linear degradation of the battery discharge while in use.

System Demonstration

Three sensors were placed on the Northwest Nazarene campus covering a total distance of around 340 meters. Samples were taken and sent every 30 seconds. The system was set to run for a 24 hour test.

Figure 7: Google Earth image of Sensor Tag placement with approximate measurement.

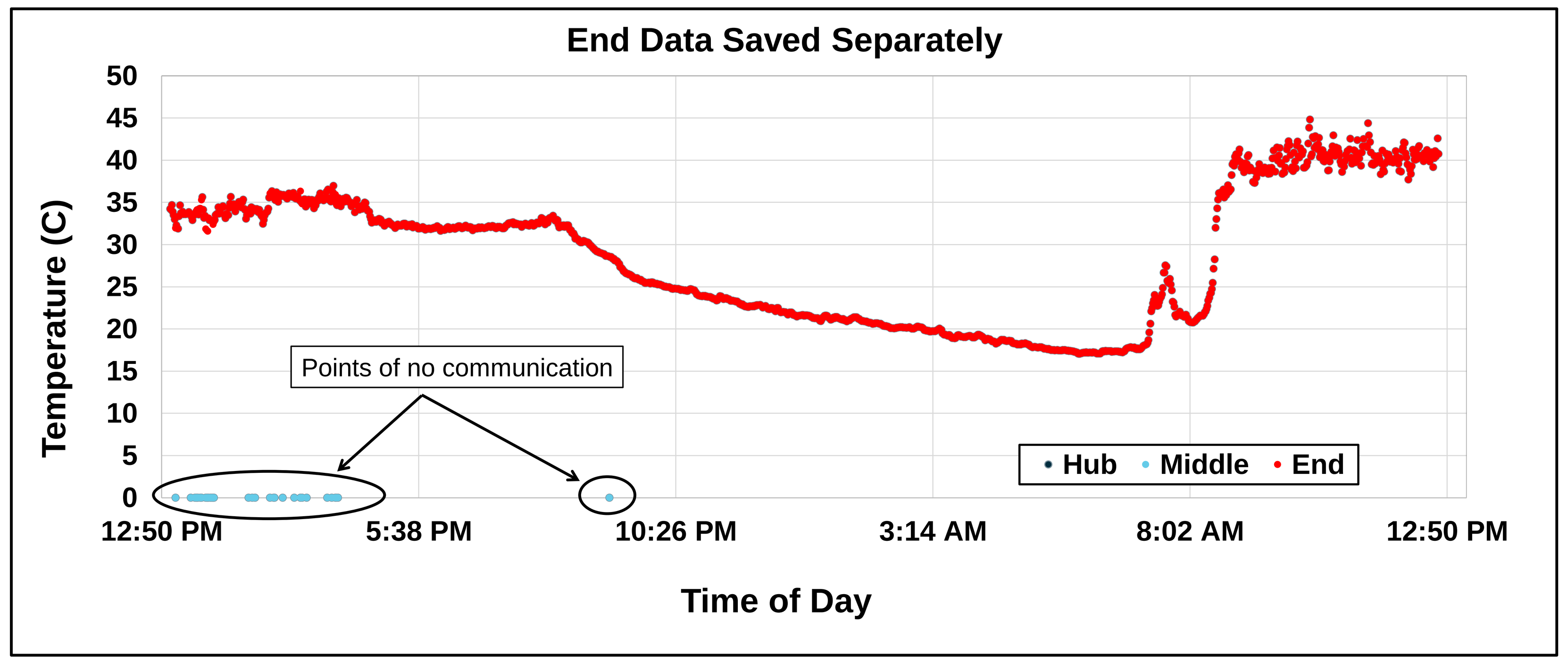

Figure 8: Time-aligned temperature data that was read from the End Sensor saved on each sensor in the chain. Points of missed communication are circled above.

Future Work

- Solar power integration – In progress
- Switching to printed PCB
- Reduce power consumption in code, looking into using LoRa communication

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