

Wireless Sensor Network Localization

Spring Quarter Kickoff

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4/1/2022

Project overview

- Sensor data (sound, temperature, etc.) is most useful when localized.



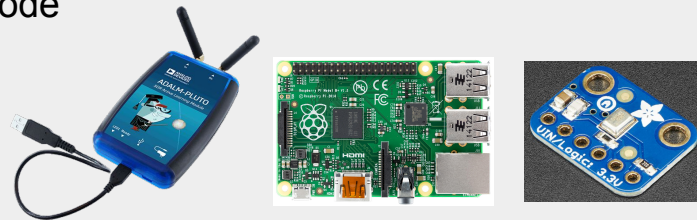
- Most localization techniques require additional hardware (e.g., GPS modules) that add to system SWaP-C.
 - The ideal solution would add no hardware to an existing sensor network.
- Goal: Create full system of Pluto-based sensor network + localization
 - Will be measuring and visualizing noise levels



Approach

- HW:
 - Pluto SDR - Have qty 3
 - Already have 3 units for minimum viable prototyping
 - Leaves door open for frequency-varying techniques not available on e.g. BLE chipsets
 - Has built-in FPGA for small-scale hw acceleration
 - Adafruit I2S MEMS Microphone Breakout - Have qty 6
 - Sound sensor, I2S interface
 - Raspberry Pi 3B - Have qty 3
 - Interface between Pluto and sound sensor
- SW:
 - Localization is composed of 2 high-level pieces:
 - Per-link distance measurements
 - I.e., the distance between each pair of nodes
 - Chose ToF and RSSI as dual measurements
 - Network shape synthesis
 - Combine per-link measurements to reconstruct overall node arrangement
 - Chose multi-dimensional scaling as algorithm of choice
 - Network layer
 - Charon: open source mesh network software
 - Layer 1: OFDM, liquidSDR library
 - Layer 2: BATMAN-adv

Node



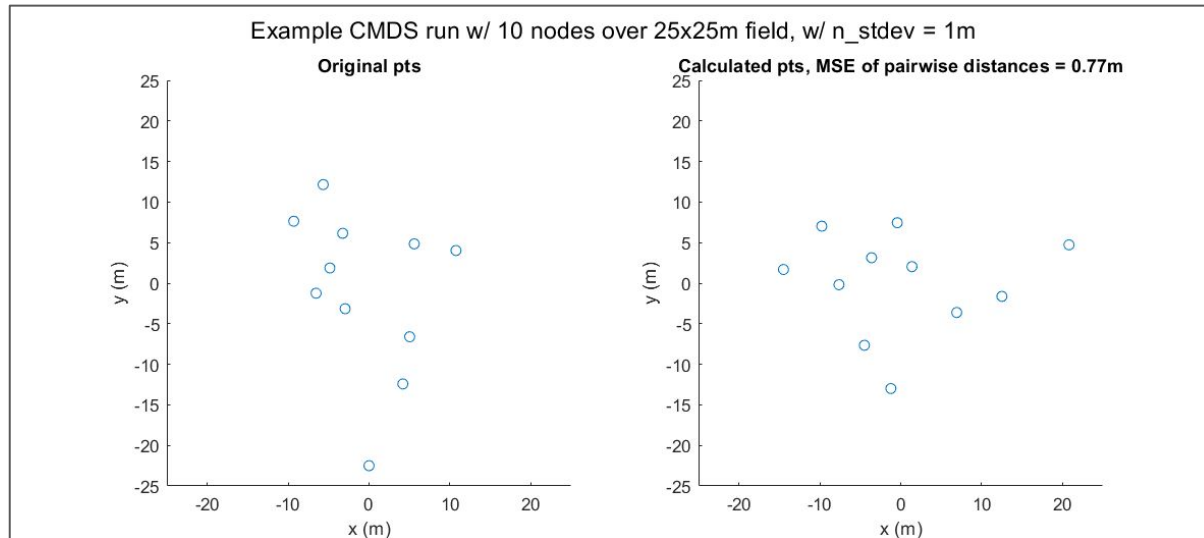
Schedule

- Overall summary: **on schedule**
 - **Complete:** specs, architecture, sims, testbed
 - **In progress:** wrapping up link distance measurements experimentation
 - **This quarter:** final implementation, sensor interfacing, testing

Category	Task	Quarter 1				Quarter 2		
		Jan	Feb	Mar		Apr	May	June
Project Management	Project scoping	■						
	Final presentation							■
Systems Engineering	Operational requirements analysis		■					
	System/Sub-System Specs + Architecture		■					
Development	Sensor evaluation		■					
	Algorithmic development (simulation)		■					
	Pluto bringup			■				
	Network setup			■				
	Link distance measurement			■	■	■		
	Algorithmic implementation				■	■		
	Sensor interface + calibration						■	
Test and Evaluation	Small scale indoor tests (+ debug)						■	
	Large scale field tests (+ debug)							■

Results - Simulation

- Validated choice of multi-dimensional scaling as synthesis algorithm
- Showed that noisy link measurement of $\pm 1\text{m}$ (so $99.7\% < 3\text{m}$) causes manageable MSE
 - So target goal of link accuracy is maximum 3 m error



Results - Testbench

- Up and running: 2 Plutos in mesh network
 - Will add more Plutos as part of sensor bringup later in quarter
- Characterized RSSI-to-distance relationship
 - Roughly follows expected $1/r^2$ behavior, though needs somewhat significant averaging to get a reliable measurement
- Still working on ToF characterization