Location estimation of Bluetooth devices using software-defined radios

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**Intro**

BlueFinder is a prototype hardware/software platform that enables limited-range location tracking of Bluetooth devices without requiring any additional information from GPS, Wi-fi, etc. It can be used as a supplement to location-tracking using other signals or all on its own. It expands upon the work of last year’s BlueDentist project.

**How it works**

BlueFinder uses two software-defined radios to collect wireless signals from the 2.4 GHz spectrum and filter out Bluetooth data. The data is decoded for piconet access codes used to identify a unique connection between multiple devices. The MUSIC algorithm is applied to data gathered from both radios to determine the distance and direction of each device. The location, piconet, and timestamp data is saved for later use or display.

**Key hardware**

- **STM32L4 MCU**: manages power
- **XTRX SDR**: collects wireless data
- **Antenna assembly**: correctly positions antenna
- **Nvidia Jetson AGX Xavier**: processes the data
- **Custom mainboard**: brings it all together

**Direction-finding algorithm**

MUtiple Signal Classification (MUSIC) algorithm is used to estimate the Angle of Arrival (AoA) of the Bluetooth signals. The algorithm requires a linear array of antennas with equal spacing, and assumes the signals arrive at the antennas in the form of a plane wave. With a sufficiently large number of antennas, MUSIC can estimate the AoA for multiple signals with high resolution.

In BlueFinder, two antennas are used to estimate a single signal source.

**Software**

- **Capture Thread**: captures Bluetooth data
- **Data Store Thread**: stores data
- **Data Filter Thread**: filters data
- **Analysis Thread**: analyzes data
- **Display Thread**: displays data

**Hardware**

- **Nvidia Jetson Xavier SCiM**: collects and processes data
- **XTRX SDR**: collects wireless data
- **STM32L4 MCU**: manages power

**Results**

UNDER CONSTRUCTION

Plan is to put some ***combination of***

- **Final results**
- A picture of the final setup
- ******?

- We are still working on correcting the transparency for the image accompanying the direction-finding algo section
- We might change colors in hardware diagram so it looks better in this context

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