Device-Free Target Localization

Magic Room RFID Sensing & MIMO-OFDM Joint Radar-Communication

Haoyan Zeng | Rutgers University
Advisors: Prof. Aggelos Bletsas, Anastasios Kleniatis, Georgios Andreadis

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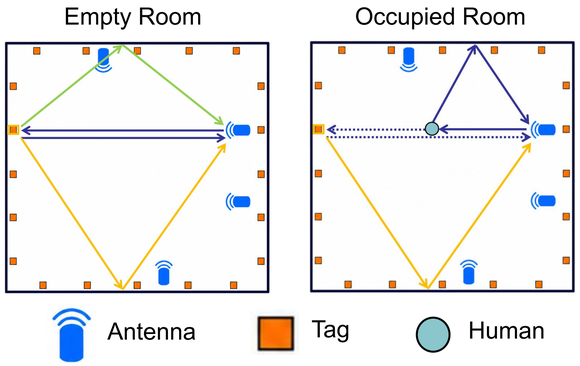
Magic Room: Background & Goal

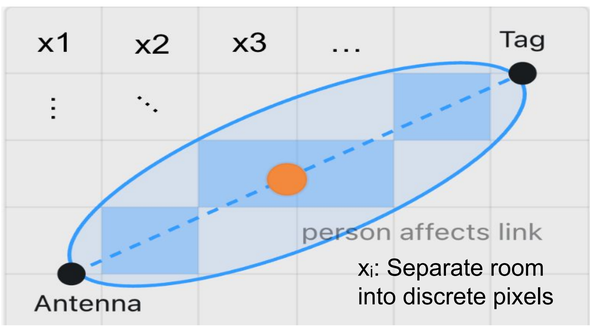
Background
- Passive RFID tags reflect signals
- People presence alter antenna-tag multipath

Goal
- Estimate occupant count and location from RSSI, phase, and read-rate changes

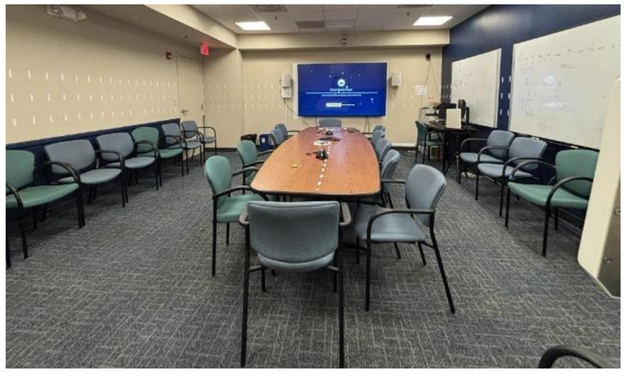


Two Existing Methods

1 **RSSI:** Localization from link-wise signal-strength changes.
2 **Phase:** Localization from phase shifts and read-rate variations.



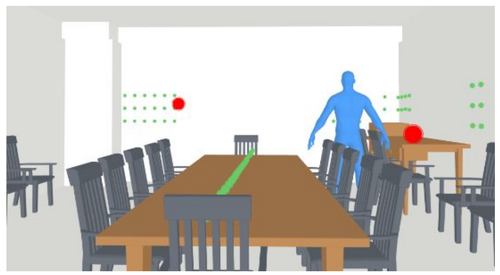
Real Data Collection



Setup:
- 4 reader antennas • 257 tags • 50 channels (902-927 MHz)

Raw event:
- RSSI • phase • timestamp • channel • reader • tag
- Empty-room and Human-occupied measurements

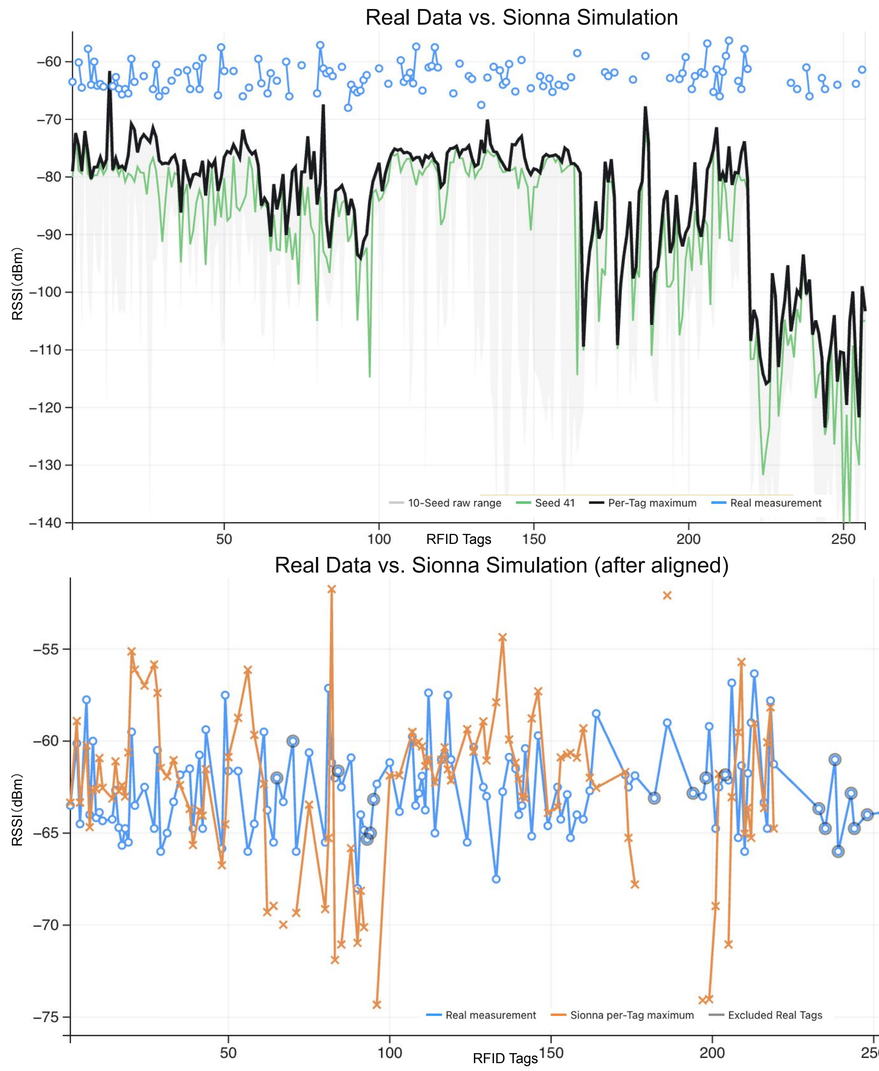
Sionna Simulation



Real measurements are expensive to collect.

Sionna generates scalable synthetic data.
- More flexible configurations
- Predictable geometry and propagation

Data Calibration

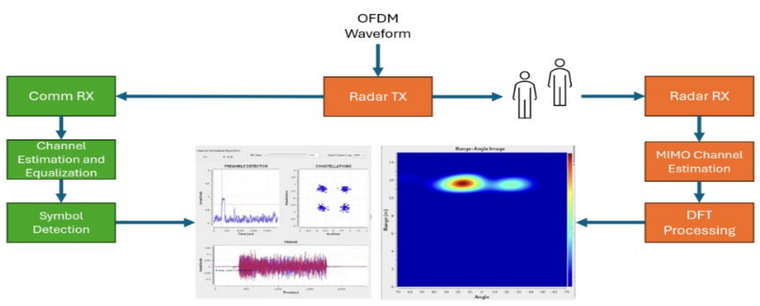


- Use multi-seed maximum reduces path misses
- Mean alignment corrects offset; variation remains

JRC Project: Background & Goal

Background
- A single MIMO-OFDM waveform (28GHz) supports communication and radar sensing.

Goal
- Use signal echo to resolve targets accurately.

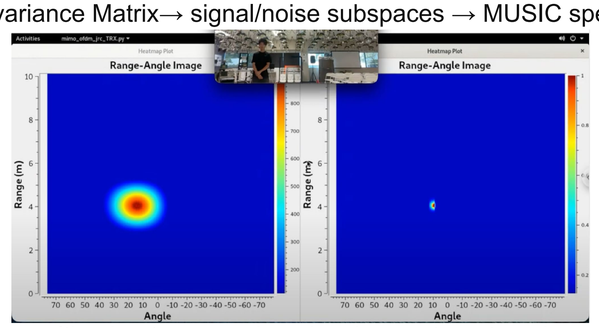


Implement Music Algorithm

Original DFT method (Discrete Fourier Transform)
- IFFT across subcarriers
- FFT across antennas

MUSIC method (Multiple Signal Classification)
Covariance Matrix→ signal/noise subspaces → MUSIC spectrum

DFT



MUSIC

The resulting heatmap produced a sharper target peak and improved range-angle resolution.

Magic Room: Future Work

- Refine the two-way RFID channel model with real case
- Validate across more rooms and positions.
- Use simulations for localization training.

JRC Project: Future Work

- Suppress close-range Tx–Rx leakage.
- Validate MUSIC in multi-target scenarios

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