miniRadar: A Low Power IEEE 802.15.4 Transceiver Based Implementation of Bistatic Radar
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Goal

- Passively detect all (or a subset of) prominent RF reflective surfaces using 802.15.4 Radios in a 2D grid environment

Proposed System

- Employ a rotating directional antenna to collect directional samples for 360 degree orientation
- Use known gain pattern to approximate the location of the reflective surfaces

MLE Formulation: Log Likelihood Value based Estimation

\[ r'_v = \{ r'_{\theta + i \cdot \delta} : i \in \mathbb{Z} \text{ and } \theta \in [0, 360/\delta) \} \]

\[ r'_{\theta_0} = \sum_{\theta \in [-180, 180^\circ]} C.A_g(\theta - \theta_0) \cdot P_{T_x} \cdot 10^{\gamma/10} \cdot d^{-\gamma} \]

\[ \log \mathcal{L}(r_o | X_R = X'_G, X_T_x) = \sum_{\theta \in [-180, 180^\circ]} \log P(r'_{\theta_0} = r_{\theta_0} | X_R = X'_G, X_T_x) \]

\[ X_R = \arg \max_{\{X_R, X'_G, k\}} \log \mathcal{L}(r_o | X_R, X_T_x = X'_G, N = k) \]

\[ X_R = \arg \max_{\{X_R, X'_G, k\}} \sum_{\theta \in [-180, 180^\circ]} P(r'_{\theta_0} = r_{\theta_0} | X_R, X_T_x = X'_G, N = k) \]

Future Method

\[ r_o = G \cdot P \]

\[ \Psi = \text{diag}(\psi_1, \psi_2, \cdots, \psi_{200}) \]

Use one dimensional MLE to calculate the distance travelled by the radio signal: \( d_{a_i} \)

\[ \arg \min_{d_a} \left| d_{a_i} - \left( d_o + \sqrt{(d_o^2 + d^2 - 2 \cdot d_o \cdot d \cdot \cos(\theta_a))} \right) \right| \]