Transmitter Localization with a Phased Receiver Antenna Array and Radiation Gain Estimation

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Motivation Behind System

Localization and tracking has applications across industries:

- Feedback for beam steering to improve communications with a moving target (ie flying drone or satellite)
- Track a transmitting target without detection (ie surveillance)

This system can be used to localize and track a transmitter by measuring its transmitted signal directly:

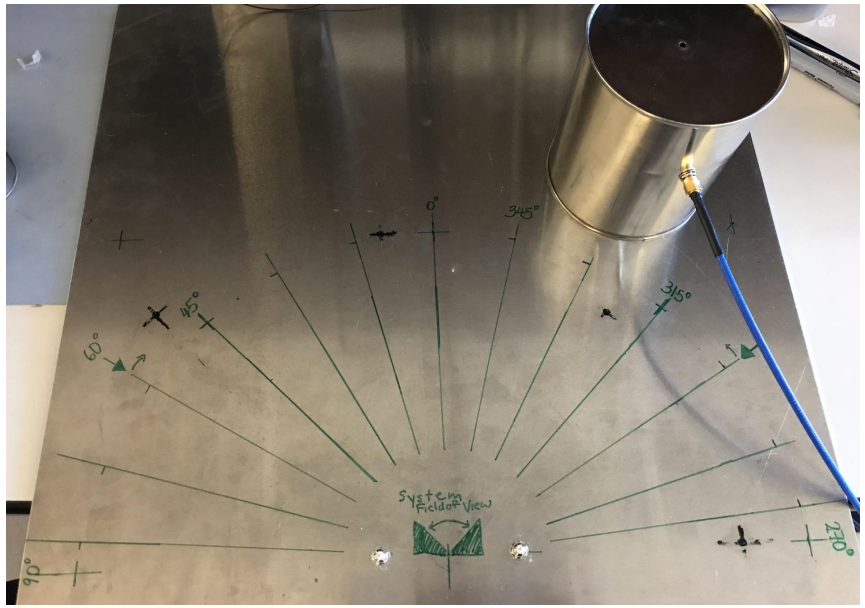
- Reduces dependence on range and reflectivity compared to RADAR
- Reduces total path length → decreases path loss
- Less detectable

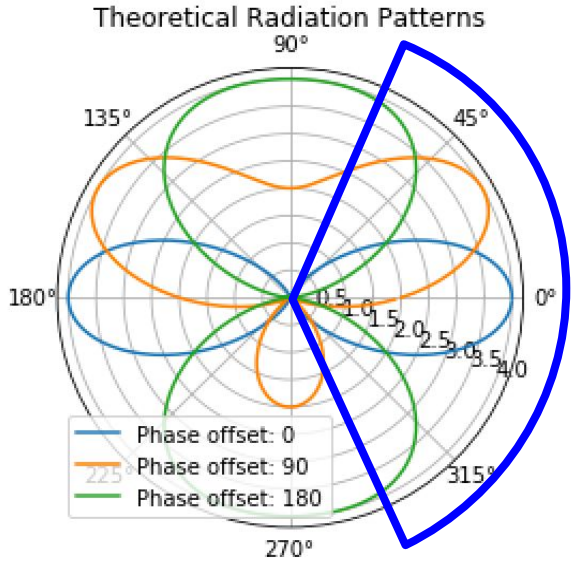
System Design

Overview: 2 monopole phased array receiver on a ground plane with SMA connectors for phase offsets of 0, 90, and 180 degrees

Calibration step: measure insertion loss on VNA with one monopole to set receiver gain

Limitations: can predict transmitter locations between +/- 60 degrees to within 10 degree accuracy (symmetry in rad. pattern -> degenerate measurements)





Region of operation

System Operation - Electromagnetism

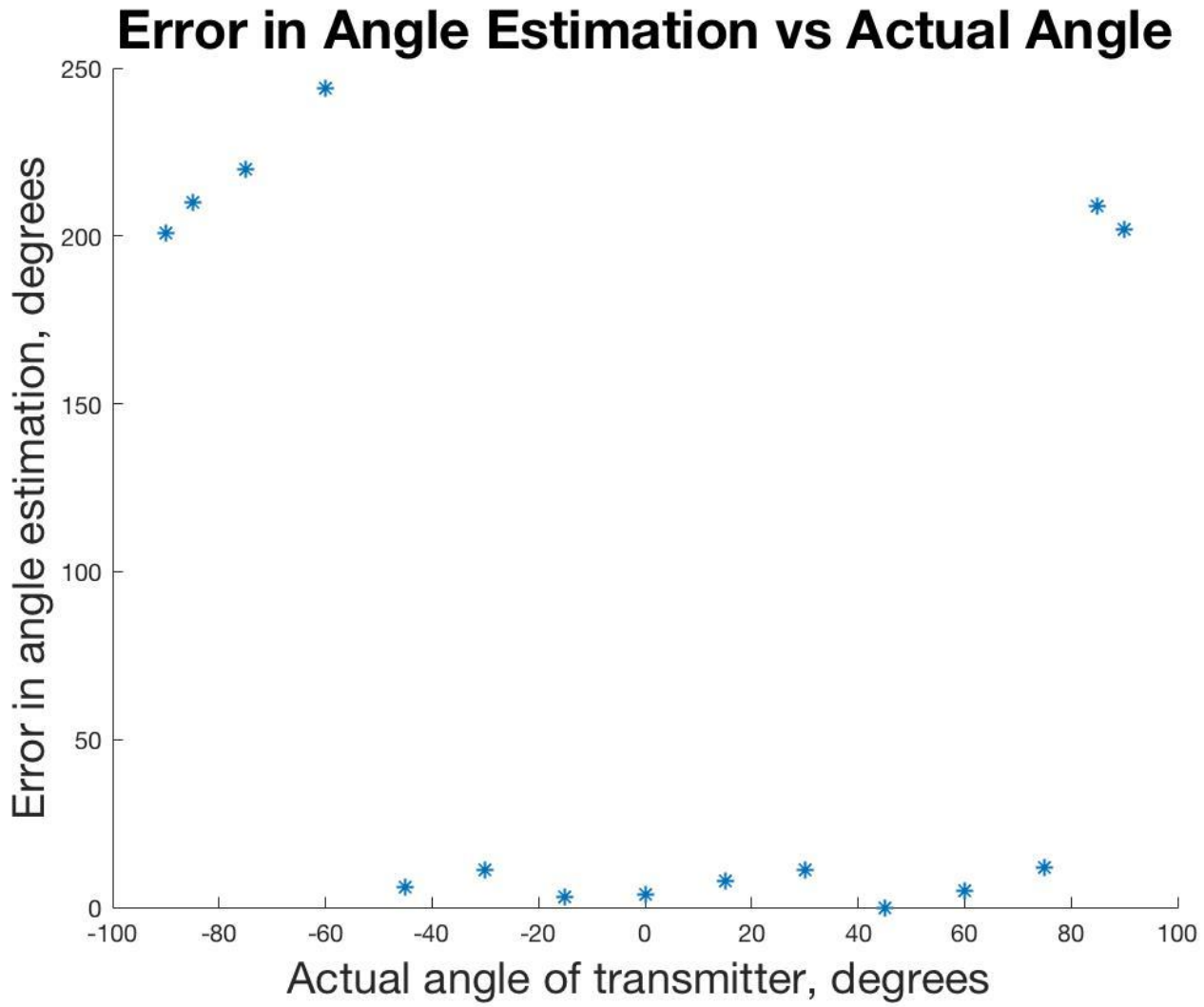
1. Place transmitter at an angle between +/- 60 degrees
2. Measure insertion loss at phase offsets of 0, 90, and 180 degrees
3. Compare to theoretical calculations:

$$Gain_{theoretical}(dB;\theta) = \sum_{i=0}^{N-1} e^{-jkDsin\theta i + j\phi i}$$

$$IL_{predicted}(dB) = 10\log_{10}(\frac{P_{rx}}{P_{tx}}) = 10\log_{10}(\frac{G_{tx}}{4\pi r^2}\frac{G_{rx}\lambda^2}{4\pi})$$

4. Predict transmitter angle which has least total error from three phase offset measurements

Conclusions: average error ~7 degrees

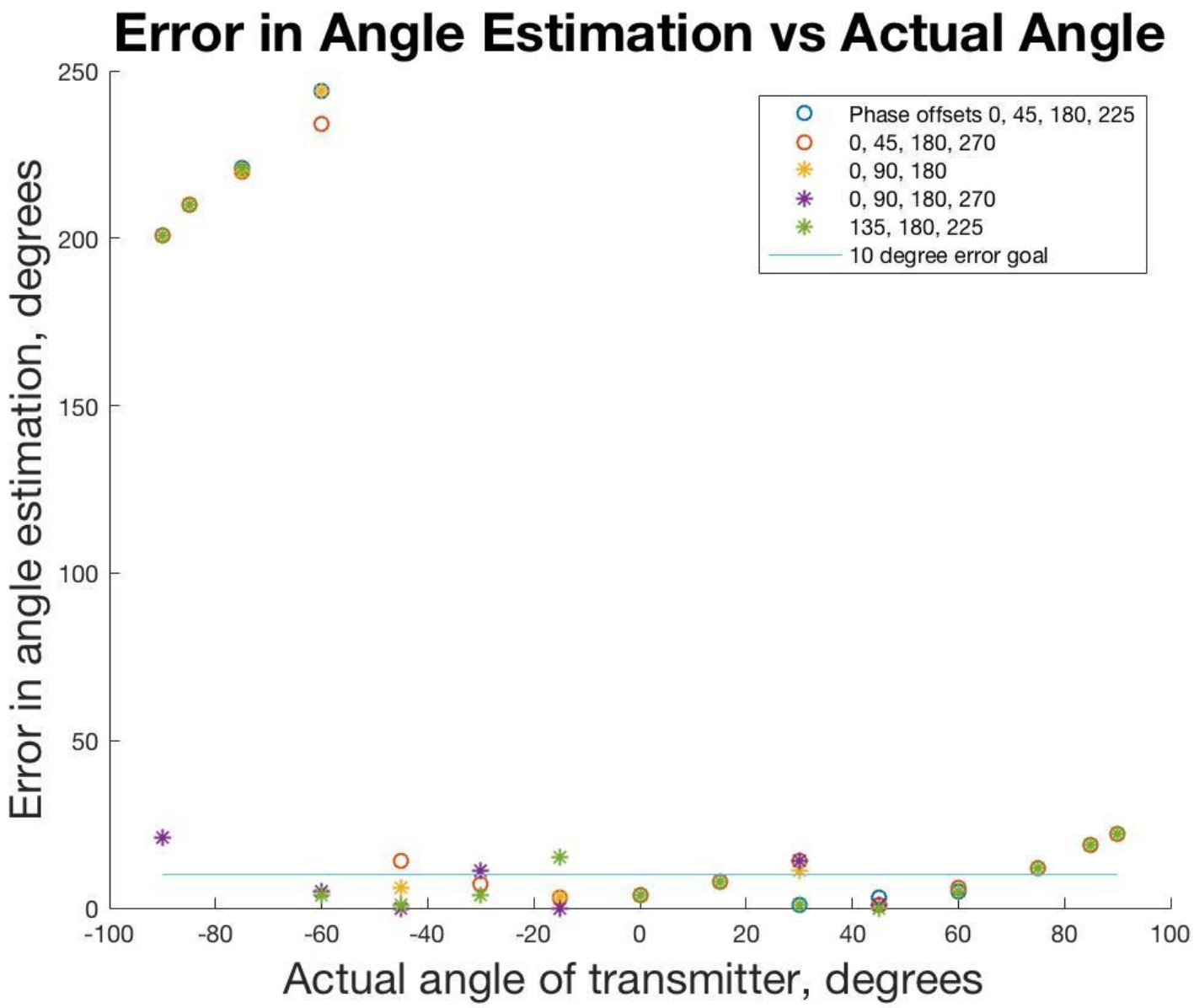


Next steps:

- Solve for range and power transmitted in addition to angle
- implement digital phase shifts to improve operation time, radiation pattern options

Backup

phase offset settings were chosen by measuring the estimation error for many phase offset combinations:



Demo Plan B -

https://drive.google.com/open?id=1vXpEH9kmyrxvRYASCSCoahNMHTD9vJhF