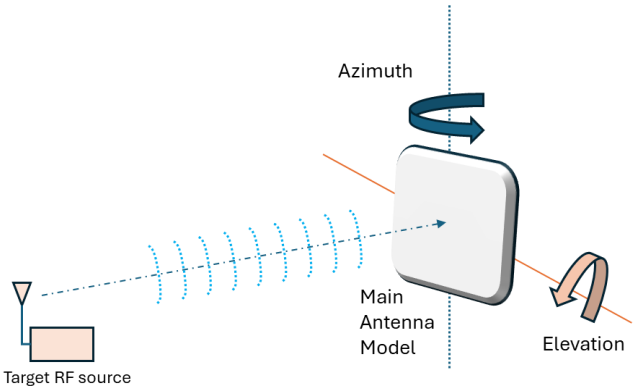
RF-based Antenna Tracking System (RFATS)

The goal of this project is to develop a robust antenna tracking system for long-range wireless communication applications, capable of functioning without location data. The system will mechanically rotate a lightweight receiver panel along the azimuth and elevation axes. This rotation enables continuous reliable communication by guiding the panel toward a transmitting target unit.



The system consists of

- A mobile target unit equipped with an omnidirectional antenna that serves as the transmitter.
- A tracker system with one or more receiver units on the panel and the corresponding directional antennas for tracking the signal from the transmitter.

The project includes the design of a custom communication waveform optimized for tracking low-power RF signals even in the presence of jamming. Software Defined Radio (SDR) products provided by the sponsoring company will be used for RF communication. Model-based software tools (e.g., MATLAB, and Python) may be used for signal processing and decision-making algorithms.

- There are no restrictions on waveform parameters such as bandwidth, signal duration, or data rate other than the center frequency being kept constant (no frequency hopping) as long as the parameters are within SDR capabilities.
- The system must achieve tracking within 3 seconds after powering on (or losing track). After initial track locking time, angular error below 5 degrees (RMS) must be maintained.
- It must support a target angular velocity of at least 15 degrees per second in azimuth.
- The system should operate under single-source noise jamming with a 100 kHz bandwidth and -80 dBm power (at the antenna port) within the system's operational frequency band.
- The tracking system must incorporate mitigation techniques that prevent false tracking, vibratory behavior or shudders due to reflected signals, interference or jamming so that the tracker mechanism moves smoothly.
- The tracking system must be compact, modular, and user-friendly. Antennas used for tracking should be small, lightweight, and easily mountable.

A crucial component of this project is the computer-controlled signal generator for in-lab system validation. The signal generator, based on the same SDR platform, will simulate RF signals from the target unit and feed them to the system for testing under various conditions. The target’s trajectory can be input through a GUI.

Extra Features

- Smart tracking algorithms that enhance accuracy and reliability, allowing for continuous tracking even if the signal is briefly lost (up to 3 seconds)
- Advanced mitigation techniques for spoofing attacks ensuring that the system can continue operation when exposed to fake transmitted signals copied and retransmitted by adversaries