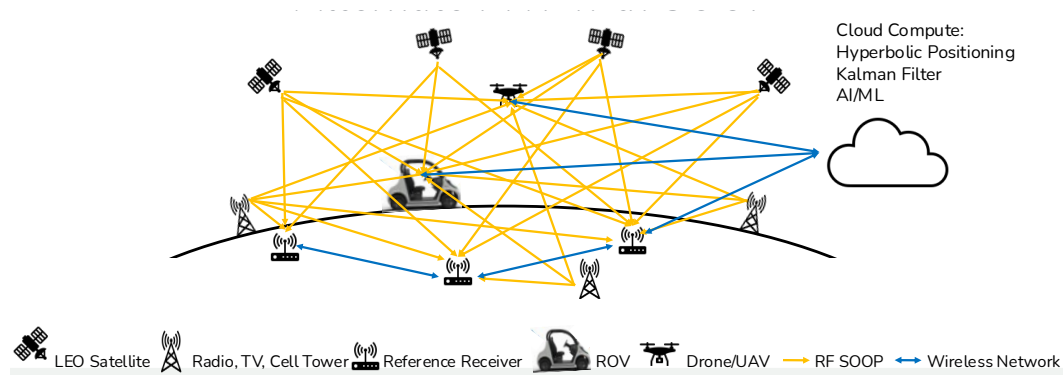MS Research Opportunity

Navigation of Autonomous Systems Using Low Earth Orbit Satellites

Background

We have all become so dependent on GPS and other Global Navigation Satellite Systems (GNSS) that it makes these satellites attractive targets for attack by malign actors. This has huge national security implications to the United States, and poses a potentially devastating threat to military operations, commercial and civilian transport, and autonomous vehicle navigation. In this project, we will investigate using Hyperbolic Positioning as a robust alternative to GPS/GNSS that is readily fieldable in national security, commercial and civilian use cases.

Project Overview

Hyperbolic positioning is an advanced mathematical method that involves time-stamping the Time-of-Arrivals (TOA) of a source signal by four or more geographically dispersed receivers. In this project, the source signals emanate from any of the thousands of Low Earth Orbit satellites. These signals are known as LEO Signals Of OPportunity (SOOP). Differencing the LEO SOOP TOA against a chosen common receiver creates Time-Difference of Arrival (TDOA).

There are multiple project areas for students to participate in this research project:

- Simulating scenarios using LEO SOOP for Autonomous Navigation
- Coding and optimizing TDOA Hyperbolic positioning algorithms
- Developing and coding filters, such as Kalman filters, to estimate the motion of LEO satellites
- Using raw GNSS data in TDOA mode to test algorithms and provide additional optimization
- Developing Machine Learning and AI to detect and mitigate anomalies
- Determining scalability as a function of number of satellites, references, and clients
- Developing and building LEO SOOP receivers

These efforts require a familiarity with linear algebra, dynamical systems, MATLAB, Python, optionally, C. Linux OS experience is desirable. SOOP receiver development requires familiarity with RF systems, Software Defined Radio (SDR) and GNUradio.

MS students interested please contact Dr. Marc Weiss at mweiss2@ucsc.edu or Dr. Charles Barry at chbarry@ucsc.edu.