Next Generation PNT via Automatic Calibration of Dynamic Coherent Radar UAV Swarm Arrays

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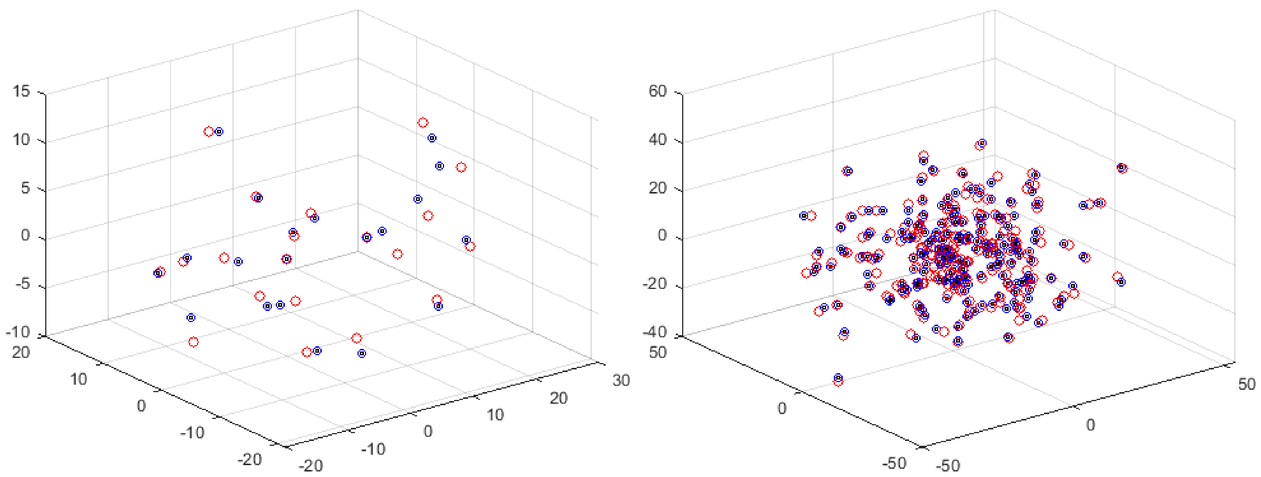

Simulated swarm arrays of 20 UAVs (left panel) and 200 UAVs (right panel), with the large red circles denoting the initial GPS estimates, the medium-sized blue circles giving the Newton-Raphson estimates, and the small black circles showing the true UAV positions.

Proposed Methodology

- The theoretic and mathematical feasibility of the automatic calibration of a swarm of radar UAVs has been developed.
- The developed solution does not require any surface fiducial points in the field, as such fiducials do not exist for many naval CONOPs.
- The required measurements for the algorithmic solution are based upon estimates of the radar ranges between pairs of the UAVs.
- This technique initially applies Newton-Raphson methods, wherein lower accuracy GPS estimates are used as an initial condition for the iterations.
- Finally, this work effort will integrate various advanced signal processing methods to yield a robust framework for estimating UAV positions for a next-generation PNT capability.

Background and Deliverables

- Background:
  - There exist errors in the platform position due to atmospheric turbulence along the path of the radar's trajectory of a synthetic aperture array.
  - Recent research by the PI has revealed that phase-based distance estimation methods can be applied to the radar return data.
  - The proposed work offers to apply similar distance estimation and compensation techniques to the problem of calibrating a swarm array.
- Deliverables:
  - Final report containing a description of the resulting techniques for generating and maintaining a dynamically calibrated array of UAVs.
  - Source files for important engineering codes can be included as well.

Objectives

- The objective of this work is to develop the signal processing methods necessary to enable a swarm of UAVs that are configured with radars to perform dynamic automatic calibration to obtain a coherent radar array.
- The primary impediment in maintaining such a coherent swarm array is the locally-varying atmospheric turbulence which induces statistical fluctuations in the true ephemeris position of each individual UAV radar platform.
- The functionality of a coherent radar array requires that these independent UAV ephemeris fluctuations to be estimated accurately so that resulting calibration errors can be removed.
- In the proposed work, advanced signal processing methods are applied to correct for the atmospherically-induced and dynamically changing positions of the radar phase centers on each of the UAVs in the swarm.

NPS PRAESTANTIA PER SCIENTIAM

FY19 Call for Proposals

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