Subharmonic Tags for Drone Localization

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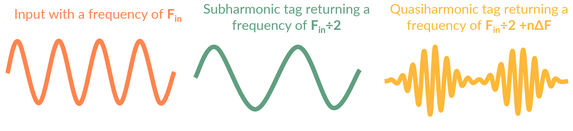
Abstract

In our project, we experimented with quasiharmonic tags (qHTs), which rely on parametric frequency dividers (PFDs) coupled with resonators, for localization applications. Once interrogated, qHTs return frequency combs with spacing relative to the qHT's displacement from its interrogator. Thus, we can compute the exact location of a qHT by simultaneously interrogating it with several IoT basse stations in different positions.

Background

Unmanned Air Vehicles (UAVs), along with other types of self-driving robots, constantly need to know their position in order to complete tasks autonomously. Localization platforms must be compact, energy efficient, cost-effective, and accurate

Most ranging solutions (GPS, LIDAR, ultrasonic sensing, IMUs) do not meet these criteria. This is where harmonic tags come into play.



Experimental Methods

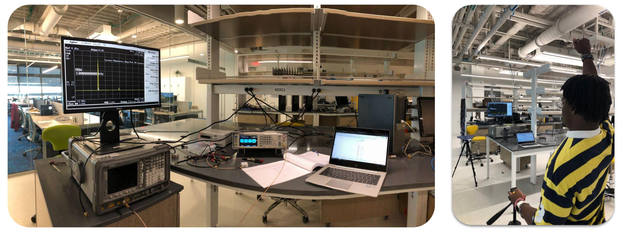
We created an interactive simulation of the drone localization process using several Python libraries (numpy, scipy, matplotlib).

- We generated combs by solving coupled complex differential equations with python.
- We developed a trilateration algorithm to calculate a simulated drone's position.
- We created an real-time interactive demonstration.
- We conducted tests on real subharmonic tags.

Results

We were able to create several different drone simulation models: an interactive drone-to-comb model, a comb-to-drone model, and an animation of a simulated drone and its respective combs

The five graphs above are a screenshot of one model in our drone simulation.
The two graphs to the top right show some data gathered from real subharmonic tags.
The images on the right shows our experimental setup



Conclusion and Future Steps

Our drone localization simulation confirms the integrity of this application for qHTs. While this process was theorized, this simulation gives us the confidence for real life drone localization. A next step would be to apply the techniques used in the simulation to a real drone and to fully demonstrate that this use case of qHTs is possible. After this technology is fully developed, we would like to see it used in:

- Track and Field times
- VAR in Soccer
- Cold Chain
- Find My iPhone/Google Find My Device

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