Collaborative Localization in GNSS Denied Environments

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Background

Modern society relies heavily on GNSS for precise localization. However, recent events have shown that GNSS is susceptible to **jamming** and **spoofing**.

This project explores how **alternative signals** can be utilized to localize a swarm or group of collaborating agents.

Research questions include:

- What information sources are suitable for positioning in GNSS-denied environments?
- How can the geographical spread between agents be leveraged to improve positioning?

Contributions to SEDDIT Goals

Zero carbon emission and resilient transportation systems:

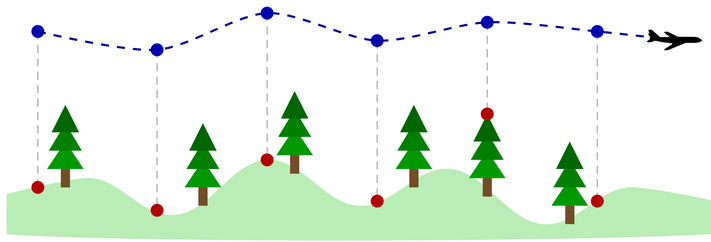
- Accurate positioning is necessary for autonomous and efficient transport operations.
- Autonomous transportation must remain reliable even when satellite signals are unavailable.

Societal security and environmental monitoring:

- Maintain the operation of societal services that rely on positioning during GNSS denial.
- Support environmental monitoring by enabling data collection with autonomous systems in remote or infrastructure-limited areas.

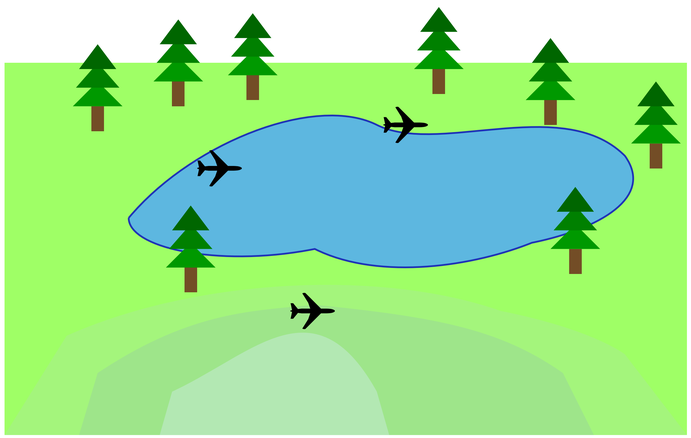
Collaborative Terrain-Aided Navigation

In *terrain-aided navigation* (TAN), measurements of the terrain elevation are collected and compared to a *digital elevation model* (DEM) to obtain a position estimate.



Using the geographical spread of the agents, collaborative TAN has the potential to:

- Increase positioning accuracy.
- Reduce the requirements on high-quality inertial navigation.
- Increase robustness in feature-poor environments.



Early Results

In **Exploring the Properties of Multi-Agent Terrain-Aided Navigation**[‡] we investigate the effect of a number of properties on collaborative TAN.

For instance, it is shown that

- Increasing the number of agents beyond a few has a large positive impact.
- Using a formation of agents cannot compensate for poor terrain measurement sensors.

‡ Eric Sevonius, Fredrik Gustafsson, Gustaf Hendeby, "Exploring the Properties of Multi-Agent Terrain-Aided Navigation", 28th International Conference on Information Fusion (FUSION), 2025.

Future Work

- Consider collaborative TAN with a control loop maintaining the formation.
- Other types of map-based localization methods, such as magnetic anomaly navigation.

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