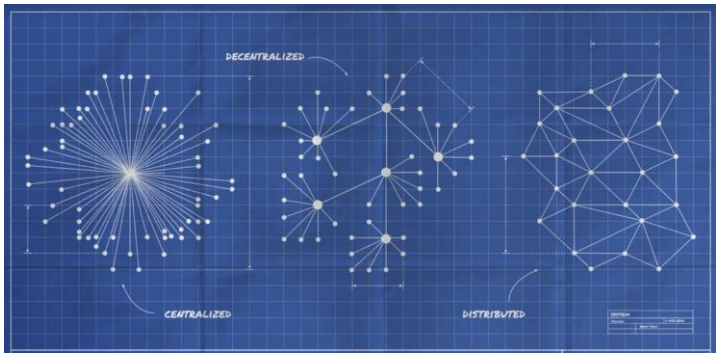
Master of Science Project

Geoscience and Remote Sensing

Theme: GNSS

Distributed estimation for multi-user GNSS navigation



Comparison of Centralized, Decentralized and Distributed concepts.

Background information

Several different errors affect the GNSS precise positioning. For instance, satellite orbital displacements, clock offsets and biases, along with other receiver-specific errors and atmospheric delays on the GNSS signal transmission. Some errors are specific to each user, e.g. receiver thermal noise, while others are in common to the different users, especially when located in harsh contexts such as urban areas.

In such environments, swarms of GNSS receivers compute their position independently from each other, even if they are most likely affected by similar errors. This holds for multiple vehicles or mass-market smartphone devices navigating in large cities, but even for space-based users, e.g. constellations of communication satellite that are located in low Earth orbit (LEO).

Research gap

The so-called concept of GNSS-based cooperative navigation has been largely studied in the past years. However, it often relies on an exchange of inter-vehicular range measurements, later jointly processed in a Centralized approach. Decentralized solutions can also be computed, e.g. *master-slave* models, but they still require central nodes where the estimation occurs. With the Distributed estimation approach (different from a "distributed computing") it might be possible to avoid such design bottlenecks, still enabling a rigorous solution to the collaborative navigation problem.

Description of tasks

The candidate will firstly perform a literature review, focusing on GNSS models, precise point positioning algorithms and distributed estimation theory. This will allow developing novel mathematical algorithms for tackling the distributed problem, which will then be implemented and numerically evaluated. A test scenario, based on synthetic and/or real world data, will be proposed by the candidate for the evaluation of these novel methodologies.

The ultimate research goal of this M.Sc. thesis work is to develop a new theoretical framework for multi-user GNSS precise positioning by leveraging distributed estimation solutions. The latter ones can benefit from recursive-type of algorithms, while minimum amount of information is exchanged between users. In this way, effective and quasi-optimal positioning solutions could be computed.

Requirements

The candidate shall have a good knowledge of estimation theory and fundamental principles of GNSS data processing. Moreover, the candidate shall have good programming skills (in MATLAB or Python), preferably with experience in GNSS positioning.

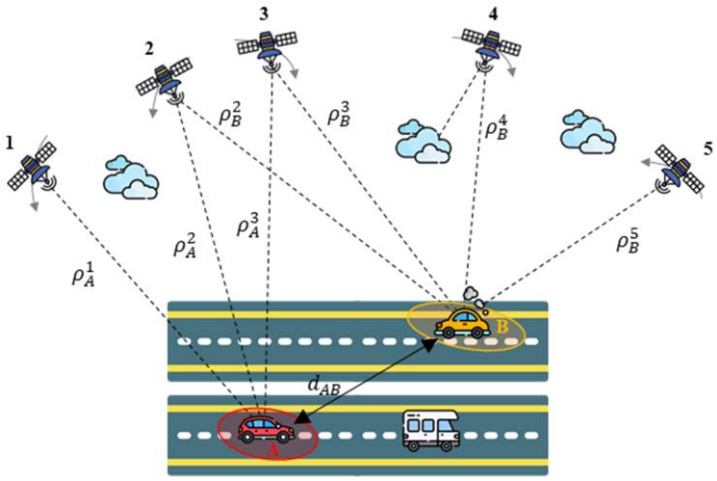


Illustration of a multi-user scenario for GNSS cooperative navigation.

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