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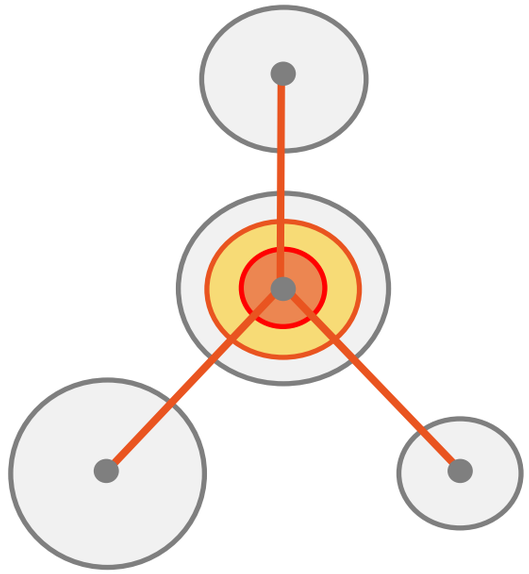
Description of the funded research project

1st Call for H.F.R.I. Research Projects to Support Faculty Members & Researchers and Procure High-Value Research Equipment



Title of the research project:

RobPos4VApp: A methodological framework for low-cost cooperative DGNSS/INS-based Robust Positioning in safety critical connected Vehicle Applications

Principal Investigator: *Vassilis Gikas*

Reader-friendly title: *RobPos4VApp*

Scientific Area: *Geodesy and Navigation*

Institution and Country: *NTUA, Greece*

Host Institution: *National Technical University of Athens*

Collaborating Institution(s):

Technical University of Crete, Greece
Politecnico di Torino, Italy
University of Helsinki, Finland

Budget: *166,863.63 €*

Project webpage: *robpos4vapp.survey.ntua.gr*

Duration: *36 months*

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Research Project Synopsis

Global Navigation Satellite Systems (GNSS) have a significant potential in the development of Intelligent Transportation Systems (ITS) and mobility services, expected to deliver many benefits including reducing congestion, increasing capacity and improving safety. However, the excessive error budget accumulated in low-cost receivers and the low availability in the city environment bound their use, especially for vehicular, safety-critical applications. As a result, low-cost GNSS receivers cannot reach the full potential of the system and, therefore, their contribution to integrated positioning systems is significantly downgraded. This project aims to develop solutions for maximizing the potential of low-cost GNSS systems in the context of safety-critical connected vehicle applications. A unified methodological framework will be developed for this purpose that will focus on the three main objectives / challenges: (i) definition of technical requirements in terms of positioning metrics, performance classes and data communication needs, (ii) development of novel cooperative, differential GNSS algorithms introducing concept of multiple moving base stations, and (iii) strategy generation for optimal evaluation and validation of the method based on GNSS laboratory, field and record & replay tests. The proposed methodological framework is expected to pave the way for utilizing the value of low-cost DGNSS cooperative terminals in connected vehicles, which is expected to contribute in a significantly accelerated use of GNSS-based ITS and mobility applications.

Project Originality

RobPos4VApp revisits the concept of GNSS collaborative positioning by proposing a novel approach, in which all GNSS-derived information within a neighborhood of vehicles is used in an optimal way. It introduces a new vision of CP for vehicular applications, which can be summarized as follows:

- *the location of the target vehicle is computed using **low-cost GNSS observables from multiple moving base stations** (other vehicles) in the vicinity and in a dynamic manner.*
- ***the update of the PVT state of the target vehicle is derived in an optimal way** while retaining its dynamic character. For this purpose, a decision algorithm for the optimal selection of the moving base stations is introduced.*
- *contrary to the tightly coupled approach usually found in many geodetic-grade navigation systems **the use of loosely coupled (LC) EKF** approach offers computational simplicity leading to increased operational efficiency and stability.*
- ***the distributed character of the proposed CP algorithm** results in small computational requirements, reduced delays in data transmission while it retains flexibility at operational level.*
- ***the system is scalable and can easily be integrated to a unified C-ITS service** via contributing its PVT information in real time.*
- ***the establishment of a unified framework for the evaluation and verification of the proposed positioning engine** using the quality metrics and performance classes of vehicle PVT, while the performance evaluation of the system features a combination of simulation, field testing and record & replay techniques.*

Expected Results & Research Project Impact

The driving force for this research is the pressing scientific, economical and societal issues related to the development of C-ITS services in the concept of green, safe and smart mobility. This research project aims at contributing towards this goal through the development and testing of the proposed collaborative positioning (CP) C-DGNSS system. In this regard impact is expected in many facets including safer, more efficient, economical and sustainable transportation. On the scientific/technical field, the project can serve several needs the most important can be summarized as follows. The proposed CP engine can impact the development of more advanced localization algorithms based on this core idea as well as support other application areas, for instance, personal mobility use cases. The detailed performance analysis framework of the proposed CP engine, will produce valuable results for describing positioning quality features. This type of information can impact the way transportation modeling software operates and help in transportation model calibration. The execution of the project comes in line with the introduction of emerging GNSS services. Consequently, the exploitation of these new tools is expected to provide better quality positioning suggesting positive impact on the applicability of the system.

The Importance of this Funding

This funding provides the avenue to serve the goals of the proposed research in many aspects. Firstly, it provides the opportunity to develop and test new research ideas relating to geodetic and positioning science, the implementation of which expands the specific objectives of the project. Because this funding aims directly at supporting academic research, it provides the opportunity to support young, talented scientists at Doctorate and Post-Doctorate level and to pave the road to pursue new avenues in their carrier development. Moreover, it provides the opportunity to acquire state-of-the-art scientific equipment to serve research goals that expand the goals of this study. Finally, this funding is enhancing the institution's educational corridors, as the research findings will be suitably incorporated into the course syllabi of the graduate and undergraduate programs, to educate students and enrich their scientific background.

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