Cooperative positioning and navigation in harsh environment  
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**Research context and motivation**

- **GNSS** (Global Navigation Satellite Systems), GPS, Galileo, GLONASS, BEIDOU, nowadays are at the core of any positioning platform. GNSS receivers are integrated in mobile devices and GNSS positioning is a pervasive technology.

- Standards for high speed and low-latency point-to-point communications (i.e. Vehicle-to-Vehicle, Vehicle-to-Building) are nowadays under development, thus being a key opportunity for advances in navigation technologies.

- The limited availability and continuity of GNSS positioning service due to harsh environments is a critical issue for several applications as for example Intelligent Transport Systems in urban environment.

**Addressed research questions/problems**

- The integration of additional measurements with the GNSS-based Position, Velocity and Time (PVT) solution is a well-known countermeasure to the lack of availability and continuity.

- Research addresses the integration of the relative distances (baseline) between users.

- Third party RF ranging systems allow to determine the distance between two users in Line of Sight (LOS) only.

- Exchanging explicitly the coordinates of each user involved in the cooperative localization is a violation of the privacy of the cooperating participants.

- Visibility of a common GNSS satellites can be exploited to obtain the relative distance also in NLOS, guaranteeing a certain level of protection.

- Cooperation with INGV (Istituto Italiano di Geofisica e Vulcanologia) and Department of Physics and Technology of Tromsø University (UiT) for data collection oriented to the analysis of ionospheric scintillations through GNSS signal

- Signal Processing and Analysis of Interfering GPS Non-Standard Code from satellite SVN49

**Submitted and published works**


**Novel contributions**

- **Inter-Agent range (IAR) estimation is based on GNSS measurements**

  \[ l_{IA} = \sqrt{\rho_A^2 + \rho_B^2 - 2\rho_A \rho_B \cos(\theta_{AB})} \]

  - Partial protection is provided by exchanging steering vectors to the satellite and measurements
  - Reconstruction of the position of the other user is prevented.
  - Kalman Filtering prediction compensates for communication delays in dynamic applications
  - Further protection is introduced by the use of a virtual position, \( \hat{x}_{\bar{A},k} \)

**Research methodologies**

- Development of a theoretical framework for the positioning problem
- **MATLAB® Simulation Environment** for multi-users dynamic scenario
- Analysis of dilution of precision introduced by geometrically correlated information
- On-field test with commercial receivers and NavSAS software receiver

**Future work**

- Study of collaborative distributed positioning algorithm (i.e. Extendend/Unscended Kalman filter, particle filter)
- Real implementation for road applications such as autonomous and cooperative driving system
- Integration within next generations telecommunication networks (i.e. 5G) and protocols definition

**List of attended classes**

- 01RYHRV - Disruption Tolerant Networks: Routing Algorithms and Protocols
- 01NSGGN - Front-end technologies and antennas
- 01NSJGN - Integration of satellite navigation and other positioning technologies
- 01QRXIU - Multimedia communications: technological advances and social implications
- 01QUMRU - Pattern recognition and neural networks
- 01PJRMRU - Communication I
- 080ITRWT - Public Speaking
- ESA/JRC Summer School on GNSS 2017 – Longyearbyen (Svalbard)