Stage M2 - Techniques de classification et de caractérisation d'interférences GNSS (LOCSP)

The evolving landscape of intelligent mobility in next-generation transportation systems aims to enhance autonomy, connectivity, and coordination for improved mobility. For this transformation, GNSS emerges as a crucial asset for achieving these objectives. Its significance spans from facilitating less critical functions like offering real-time passenger information for users to track their chosen mode of transport, to supporting highly safety-critical functionalities such as providing control and navigation functions for autonomous vehicles. In the latter context, the localization function must exhibit high performance which requires coping with inherent phenomena/threats that could lead to possible underestimated error bounds.

Among the significant threats to GNSS receivers is radio frequency interference from man-made devices, categorized as non-intentional or intentional interference commonly known as jamming. The jamming signal profoundly affects receiver functionality at the acquisition, tracking, and navigation levels. Our recent research proposes a promising approach, utilizing deep learning techniques for optimal parametrization of Adaptive Notch Filter (ANF) for effective mitigation of the interference signal. This work has been the topic of several top-rated publications [1-2] focusing on two classes of jammers, namely frequency hopping and linear chirp. We aim to extend this work by incorporating two additional layers namely the classification and the characterization, adapting the mitigation filter for a broader range of jammer classes [3-6]. The classification stage broadly categorizes the type of interference signal, while signal characterization involves detailed features of the signals. The first phase of this internship aims to explore AI-based classification approaches. In the subsequent phase, a signal characterization will be proposed, 1) defining the number of characteristic parameters for a given interference type and 2) accurately estimating each parameter. The goal is to obtain optimal parameters from a pre-trained model to fine-tune the mitigation filter.

This internship will be conducted under the framework of a national project LOCSP (https://locsp.univgustave-eiffel.fr/) and contributions may lead to scientific publications. Our laboratory is well-equipped for this work, with tools including a GNSS simulator with interference capabilities (Stella HIL-ITF), a Record and Playback system (Stella RP) to replay the pre-acquired signal and a customized jammer transmitting various interference signals (monotone AM, chirp, frequency hopping, pulse and others).

Don't wait any further and reach out to us in case this internship call catches your attention and you are eager to learn and explore the scientific ecosystem! We will be happy to have you onboard our research group.

Requirements

Applicant must be in a Master 2 degree program. Proficiency in machine learning techniques (SVM, CNN, KNN, etc.) and Python and/or Matlab language is essential for this role. Additionally, proficiency in digital signal processing and filtering techniques would be advantageous. Proficient English skills are expected for effective scientific communication with associated PhDs.

References and additional resources

Discover recommended articles related to the topic that offer valuable insights into the work. Feel free to incorporate other sources that you find interesting and beneficial for a deeper understanding of the subject. Take the next step in your scientific journey, reach out to us and become a valuable part of our research group.

Send CV and motivation letter to Juliette Marais, juliette.marais@univ-eiffel.fr

[1] Kazim, Syed Ali, Juliette Marais, and Nourdine Aït Tmazirte. "On the parameterization of single pole adaptive notch filter against wide range of linear chirp interference." Proceedings of the 36th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2023). 2023.

[2] Kazim, Syed Ali, Juliette Marais, and Nourdine Ait Tmazirte. "Interferences in Safety Critical Land Transport Application: Notch Filtering vs Wavelet Transform, an Experimental Analysis." Proceedings of the 35th International Technical Meeting of the Satellite Division of The Institute of Navigation (ION GNSS+ 2022). 2022.

[3] R. Morales-Ferre, P. Richter, E. Falletti, A. de la Fuente and E. S. Lohan, "A Survey on Coping With Intentional Interference in Satellite Navigation for Manned and Unmanned Aircraft," in IEEE Communications Surveys & Tutorials, vol. 22, no. 1, pp. 249-291, Firstquarter 2020, doi: 10.1109/COMST.2019.2949178

[4] W. Qin and F. Dovis, "Situational Awareness of Chirp Jamming Threats to GNSS Based on Supervised Machine Learning," in IEEE Transactions on Aerospace and Electronic Systems, vol. 58, no. 3, pp. 1707-1720, June 2022, doi: 10.1109/TAES.2021.3135014

[5] Mehr, I. A. E., & Dovis, F. (2023). A Deep Neural Network Approach for Detection and Classification of GNSS Interference and Jammer. Authorea Preprints.

[6] Bastide, F., Chatre, E., & Macabiau, C. (2001, September). GPS interference detection and identification using multicorrelator receivers. In Proceedings of the 14th International Technical Meeting of the Satellite Division of the Institute of Navigation (ION GPS 2001) (pp. 872-881).