PhD position

Offre d'emploi ISAE-SUPAERO | DEOS | NaviRes

PhD position in	Environmental context-adaptive navigation for autonomous vehicles
Direction	ISAE-SUPAERO | DEOS | Navires
Co-direction	ONERA | DTIS
Start date	From october 2023 (admission deadline by the end of 2023)
Constraint	The candidate must successfully pass the security investigation of the French Ministry of Defense.

L'ISAE-SUPAERO

ISAE-SUPAERO, a renowned aeronautical and space engineering school, is focused on research that aligns with the future needs of industries in aerospace and high technology.
The Department of Electronics, Optronics, and Signal Processing (DEOS) is dedicated to developing and creating payloads for the advanced aerospace and space applications of tomorrow. Our teams possess a wide range of expertise, from silicon sensor design to interplanetary scientific payloads, and from theoretical signal studies to advanced communication and navigation systems.
The "Navigation, Radar and Remote Sensing" (NAVIR²eS) group focuses on the theoretical study of information sources and hybridization approaches within the realm of autonomous navigation for vehicles and robots. Join us in shaping the future of robust autonomous exploration and innovation in dynamic and challenging environments.

PhD context

The widespread adoption of autonomous terrestrial and aerial robots in diverse fields, including military operations and real-life scenarios like transportation, logistics, infrastructure inspection, and disaster relief, has opened up new horizons. However, the practical application of these robots has been limited by the complexity of navigation safety, particularly in challenging and dynamic environments.

One of the paramount challenges faced in this domain revolves around establishing a reliable navigation capability across various environmental contexts. While many autonomous vehicles depend heavily on GNSS (Global Navigation Satellite System) for outdoor navigation accuracy, the inherent limitations of GNSS become evident in indoor but also in environments like urban settings, where satellite masking and multipath effects can render GNSS-based positioning unreliable.

To address this fundamental issue, efforts have been invested from two distinct research communities. Firstly, the GNSS navigation research sector has been crafting robustification algorithms to counteract specific limitations, such as multipath interference, thanks to Doppler aiding and shadow matching algorithms. These algorithms are tailored to mitigate unique GNSS constraints that arise in specific environmental contexts. The integration of GNSS with IMU (Inertial Measurement Unit) is another widely used approach.

On the other hand, the robotics community has been exploring vision-based navigation methods like visual odometry and visual SLAM (Simultaneous Localization and Mapping) to offer an alternative positioning solution in GNSS-deprived environments. However, this approach introduces an added computational burden due to the need for intensive image processing.

PhD subject

To ensure safe, accurate, and efficient navigation, it is relevant to reconfigure the sensor set and the navigation filter based on the environmental context.

Knowing the environmental context in which a ground or aerial drone operates—whether urban, wooded, indoor, densely urban, and so forth—provides the rationale for changing the sensors used (LiDAR, camera, GNSS, IMU, RGB-D, etc.) and consequently the navigation filter. Indeed, different environments pose specific challenges.

Our focus is on developing a context-aware navigation system that can recognize the prevailing navigation context and adapt its configuration accordingly. The work will focus on a sensor suite consisting of IMU, GNSS, and vision components (camera, LIDAR and Radar).

The initial phase of this endeavor, conducted as part of a previous Ph.D. thesis spanning from 2020 to 2023, was concentrated on detecting the environmental context using distinctive features extracted from GNSS signals only. This PhD position offers a unique opportunity to investigate a new navigation system reconfiguration strategy in tandem with environmental context detection system.

Expected Skills

> Good knowledge in signal processing, information theory and robust estimation (Kalman filtering)
> Proficiency in C++/Python/Matlab programming.
> Familiarity with ROS2 is a plus.

Application Procedure

> Résumé (CV) and motivation letter
> Contacts : damien.vivet@isae.fr, yoko.watanabe@onera.fr
> Start date : From october 2023 (admission deadline by the end of 2023)