

PostDoc subject: Estimation and adaptive control for a tethered kite for vessel propelling

This PostDoc is proposed in the context of the KiWin project led by the Beyond the Sea company. The goal of the project is to give sailors the control over the force of the wind to propel all vessels, optimize their energy consumption and reduce their greenhouse gas emissions. A reduction of fuel consumption by 20% for transatlantic trips is targeted.



The KiWin project is a joint project between Beyond the Sea, KleyFrance (company expert in mechatronics systems), University of Bordeaux (IMS-lab, in charge of designing the control and supervision algorithms), University of Montpellier (development of an experimental test-bench), École de l'Air et de l'Espace (specialized in aerodynamic modelling). The project is funded by Bpifrance (Banque Publique d'Investissement) and several PhD thesis will start in September 2023.

The proposed PostDoc will be held at the IMS-lab (Integration from Material to Systems), which brings together fundamental research, engineering and technology, emphasizing an integrative systems approach in the disciplines of Information Technologies. IMS is a joint research unit for the French National Center for Scientific Research (CNRS), University of Bordeaux and Bordeaux INP. The PostDoc researcher will integrate the Automatic control group in the CRONE thematics team. The general subject of thematics research is the (real or complex) non-integer derivative as operator and modelling tool, its synthesis extended to complex field and also its applications in the engineering sciences. More precisely, in reason of the affiliation of this thematics to the Automatic control group, which is constituted of 3 components, one particularly privileged research axis is in applying fractional order derivative in automatic control, notably in system identification through non integer model, and in robust control through the CRONE control (Commande Robuste d'Ordre Non Entier, a French acronym for Robust Control of Non Integer Differentiation).

Previous research related to the KiWin project:

A first PhD thesis carried out at the IMS-lab in collaboration with Beyond the Sea and defended by Baptiste Cadalen in 2018 dealt with the modelling of the kite during its dynamic flight, the definition of acceptable trajectories and the design of robust linear control laws using the CRONE methodology. This study showed results confirming the feasibility of the industrial objective.

More recently, the PhD thesis of Asma Achnib (defended in 2019) and that of Evgeny Shulga (in collaboration with Stellantis company, defended in 2022), considered the addition to a linear robust control design methodology (CRONE) of an optimal/anticipative component, first linear and based on the optimization of FIR filters, then nonlinear and using an optimal trajectory planning inspired by MPC control.

Proposed PostDoc research:

To strengthen the research team working on the KiWin project at the IMS-lab, we are recruiting a one or two year PostDoc researcher. This work should be focused on one or several of the following subjects :

- Sensor data fusion for a numerical twin of the kite system and improving control and supervision algorithms;
- Real-time trajectory optimization based on extremum-seeking;
- Iterative learning control in order to enhance the feedback control algorithms.

Bibliography:

1. B. CADALEN, F. GRIFFON, P. LANUSSE, J. SABATIER and Y. PARLIER : A control solution for a tethered kite trajectory tracking with application to ship propulsion – Journal of Dynamic Systems, Measurement and Control, Vol 42, December 2020.
2. A. ACHNIB, T.B. AIRIMITOAIIE, P. LANUSSE, M. AOUN, S. ABRASHOV and M CHETAOUI : Discrete-time robust control with an anticipative action for preview systems – Journal of Dynamic Systems, Measurement and Control of the ASME (JCR), doi: 10.1115/1.4041711, 2018.
3. A. ACHNIB, T.B. AIRIMITOAIIE, P. LANUSSE : Robust Design of an Anticipative Feedforward-feedback Controller for MIMO Systems – International Journal of Control, Automation, and Systems, vol. 20, no. 3, pp 924-940, DOI: 10.1007/s12555-021-0034-z, 2022.
4. S. SHULGA, P. LANUSSE, T.B. AIRIMITOAIIE, S. MAUREL and A. TRUTET – Model Predictive Control of engine intake manifold pressure with an uncertain model – 7th NonLinear Model Predictive Control (NMPC'2021) – Bratislava, Slovakia, July 11-14, 2021.

Duration: 12-24 months.

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Application: send CV, letter of motivation, 2 letters of recommendations, copy of one of candidate's own publications that is related to the proposed subject, copy of the PhD defence report (if available) to all three supervisors.