

PROPOSITION DE STAGE EN COURS D'ETUDES

Référence : **DAAA-2024-17**

(à rappeler dans toute correspondance)

Lieu : Lille

Département/Dir./Serv. : Département
d'Aérodynamique Aéroélasticité Acoustique

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Responsable(s) du stage : Nicolas Vauchel

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DESCRIPTION DU STAGE

Thématique(s) : Exploitations des données expérimentales et numériques

Type de stage : Fin d'études bac+5 Master 2 Bac+2 à bac+4 Autres

Intitulé: Benchmark of online methods to identify parameters of a flight mechanics model at high angles of attack

Sujet:

Flight mechanics is the field of study focusing on the prediction of the trajectory and of the attitude of an aircraft. For a given aircraft geometry, simplified parameteric mathematical models of the forces and moments from the fluid on the aircraft are needed to perform the simulations. The dimensionless form of these forces and moments, called the aerodynamic coefficients, depends on aerodynamics variables as the angle of attack, the angle of sideslip and the rotation of the aircraft, and depends on control variables as the angular deflection of the control surfaces. These mathematical models are obtained with a set of input/output data, data coming from wind-tunnel experiments, computational simulation and/or free flight. The method to create a model usually splits into two categories : offline methods and online methods.

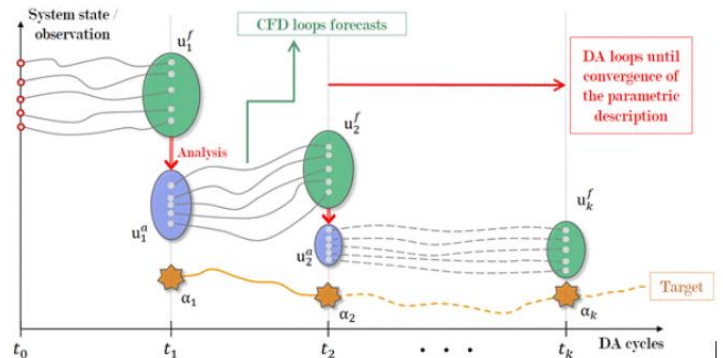


Figure 1 Schematic representation of the Ensemble Kalman Filter algorithm used in the context of the study of [3]

Offline methods aims to get a model with the help of a database constructed before the learning, with data coming from wind-tunnel experiments on a scale model of the aircraft and with data coming from computational simulations [1]. Online methods aims to get a model as data becomes available. In the field of aerospace, online method are very often used on free flight data of the real aircraft [2].

The internship focuses on the study of the online methods to identify parameters of a flight dynamics model at high angle of attack. A complete review of the methods will be effectuated. A model structure will be determined and the selected methods will be computed. An analysis of the advantages and of the drawbacks of the methods will be conducted in the form of a benchmark. The methods will not be tested with data coming from free flight, which are risky to obtain in the post-stall domain, but will be tested with simulations. An existing model of coefficients will be used for these simulations to mimic the stream of data.

Among the tested methods, a particular attention will be drawn to the Ensemble Kalman Filter methods, and notably on the new method developed by ENSAM (École Nationale Supérieure des Arts et Métiers) team of the LMFL (Laboratoire de Mécanique des Fluide de Lille) [3].

A thesis will be possibly conducted at ONERA Lille on the use of online methods to guide the design of experiments of wind-tunnel experiment at high angles of attack. The candidate of the intership will be in good position to apply to the thesis, if the thesis is accepted.

During the project, the intern will earn skills in Flight dynamics and in Data assimilation.

References :

- [1] Farcy, D., Khrabrov, A. N., & Sidoryuk, M. E. (2020). Sensitivity of spin parameters to uncertainties of the aircraft aerodynamic model. *Journal of Aircraft*, 57(5), 922-937.
- [2] Chowdhary, G., & Jategaonkar, R. (2010). Aerodynamic parameter estimation from flight data applying extended and unscented Kalman filter. *Aerospace science and technology*, 14(2), 106-117.
- [3] Villanueva, L., Valero, M. M., Glumac, A. Sarkic & Meldi, M. 2023 Augmented state estimation of urban settings using intrusive sequential data assimilation, arXiv: 2301.11195

Est-il possible d'envisager un travail en binôme ? **Non**

Méthodes à mettre en oeuvre :

- | | |
|---------------------------------------------------------|---------------------------------------------------------------------|
| <input type="checkbox"/> Recherche théorique | <input checked="" type="checkbox"/> Travail de synthèse |
| <input checked="" type="checkbox"/> Recherche appliquée | <input checked="" type="checkbox"/> Travail de documentation |
| <input type="checkbox"/> Recherche expérimentale | <input checked="" type="checkbox"/> Participation à une réalisation |

Possibilité de prolongation en thèse : **Oui**

Durée du stage : Minimum : 5 mois Maximum : 5 mois (sauf dérogation)

Période souhaitée : Mars 2024 - Août 2024

PROFIL DU STAGIAIRE

Connaissances et niveau requis :
Niveau M2 avec compétences dans les domaines suivants : système dynamique, mécanique des fluides, sciences de données

Ecoles ou établissements souhaités :
Ecole d'ingénieur ou université