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THE FRENCH AEROSPACE LAB

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PROPOSITION DE STAGE EN COURS D'ETUDES

Référence : **DAAA-2025-41**
(à rappeler dans toute correspondance)

Lieu : ONERA Lille

Département/Dir./Serv. : DAAA / ELV

Tél. : +33 3.20.49.69.71

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

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 parametric 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 simulations and/or free flights. The method to create a model usually splits into two categories: offline methods and online methods.

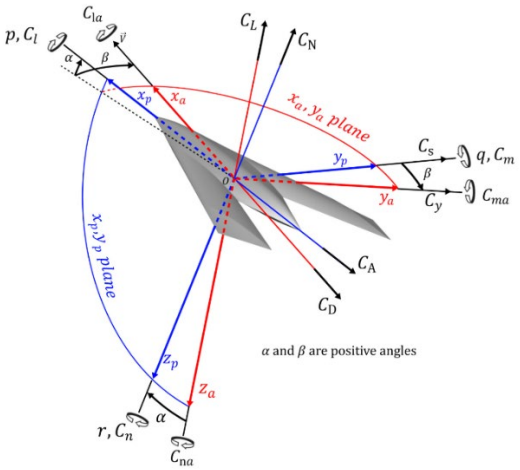

Figure 1 – Schematic representation of an aircraft and of the frames of study of Flight mechanics (from [1])

Offline methods aim 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/or with data coming from computational simulations [2]. Online methods aim to get a model as data becomes available. In the field of aerospace, online methods are very often used on free flight data of the real aircraft [3].

The internship focuses on the study of the online methods to identify parameters of a flight dynamics model and their possible extension to studies at high angle of attack.

- A review of potential online methods will be effectuated.

- Adapted model structures will be determined and the selected methods from the review 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, but will be tested with simulations of free flight. 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] and its adaptation to flight dynamics applications.

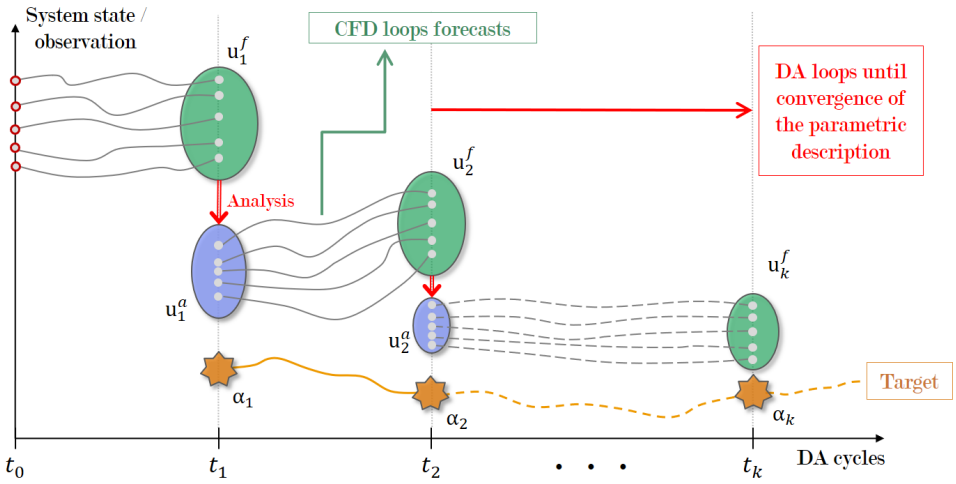

Figure 2 – Schematic representation of the Ensemble Kalman Filter algorithm used in the context of the study of [4]

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

A thesis will possibly be conducted at ONERA Lille on the development of a numerical twin to guide wind-tunnel experiments. Online methods to learn the parameters of a model will be at the centre of the study. The candidate of the internship will be in good position to apply to the thesis, if the thesis is actually conducted.

References :

[1] Isnard, B., Tanguy, G., Farcy, D., Dugeai, A., Garnier, E., & Foucaut, J. M. (2023). Comparison of Numerical Reduced Order Models of a Generic UCAV Configuration using a New Displacement Grid Method. In AIAA AVIATION 2023 Forum (p. 3269).

[2] 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.

[3] 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.

[4] 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 :

☒ Recherche théorique ☐ Travail de synthèse

☒ Recherche appliquée ☐ Travail de documentation

☒ Recherche expérimentale ☐ Participation à une réalisation

Possibilité de prolongation en thèse : Non

Durée du stage :	Minimum : 5 mois	Maximum : 6 mois (sur dérogation)
Période souhaitée : A partir de Mars 2025		

PROFIL DU STAGIAIRE

Connaissances et niveau requis :	**Ecoles ou établissements souhaités :**
Niveau M2 avec compétences dans les domaines suivants : système dynamique, mécanique des fluides, sciences de données, Python	« École d'ingénieur » or Master 2