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THE FRENCH AEROSPACE LAB

PROPOSITION DE POST-DOCTORAT

Intitulé : CFD-based reduced-order modeling of a turbine stage for parametric optimization

Référence : **PDOC-DAAA-2023-04**
(à rappeler dans toute correspondance)

Début du contrat : 1/9/2023	**Date limite de candidature :** 1/7/2023

Durée : 24 mois - Salaire net : environ 25 k€ annuel

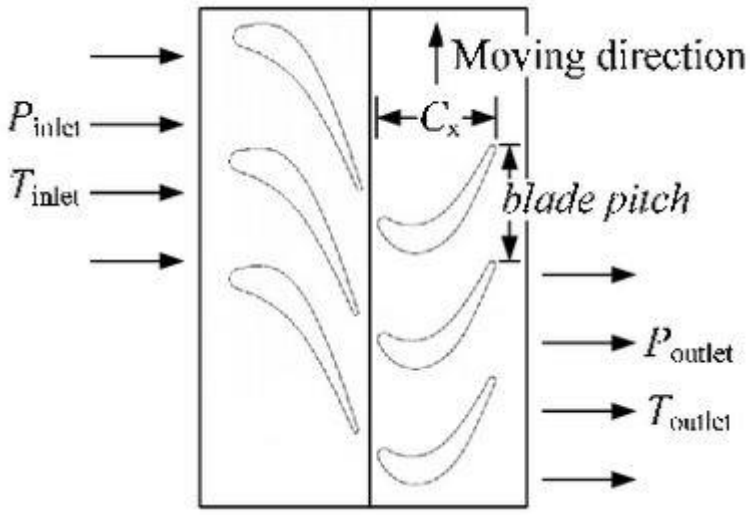
Mots clés

Reduced-Order-Models, Hyper-reduction, Domain-decomposition, CFD

Profil et compétences recherchées

PhD on CFD and numerical analysis.

Présentation du projet post-doctoral, contexte et objectif



Optimization in aerodynamics requires many CFD evaluations to adjust the many parameters that are involved in the design of propulsion systems. This justifies the development of reduced-order modeling strategies in order be able to perform the optimization at low-cost and in a short-time range. The most usual technique to address this is to build surrogate models (gPC, GP) that fit input-to-output data produced by a CFD code. One of the drawbacks is that these input-output models do not rely on physical principles, but on statistical regression techniques, which do not allow to control in an appropriate manner the error of the surrogate. One way to circumvent this short-coming is to use the CFD code, which contains the physical principles (here the Navier-Stokes equations), to also build the input-output relation. For this, after first identifying the subspace in which lies the flowfield with snapshots obtained with the CFD code (sampling of the parametric space), a reduced-order model may be obtained by projecting the governing equations (the CFD code) onto the identified subspace by hyper-reduction, which involves the evaluation of the residuals of the CFD code at few well-chosen points. The overall procedure yields reduced-order models that exhibit error guarantee, that are more accurate for interpolation and extrapolation in the parametric space as the classical surrogate modeling strategies.

The objective of the present post-doc is to apply this methodology within a domain-decomposition strategy, here a stator-shaft comprising multiple blades. First, a reduced-order model will be built for a single channel between two blades that is valid for variations of parameters (Mach, angle of Attack, etc) within a given design

space. Then an overlapping Schwarz method will be used to handle multiple channels to obtain a model that is representative of a whole stator-shaft. Error guarantees will in particular be discussed as a function of the number of sampling points used the determine the subspace, the size of the reduced-space, the number of points used in the hyper-reduction technique and the interaction with the overlapping Schwarz-method to account for multiple blades. Results will be compared to a non-intrusive technique, for which the input-output relation is based on classical regression techniques (GP). Also, a general assessment of the various reduced-order modeling techniques will be given to determine the pros/cons of the various methods.

The post-doc will share his time between INRIA/Memphis in Bordeaux and ONERA/DAAA in Châtillon.

Collaborations extérieure

Angelo Iollo/INRIA MEMPHIS, Jérôme Maynadier/SafranHE, Franck Mastrippolito/SafranHE

Laboratoire d'accueil à l'ONERA

Département : Département d'Aérodynamique Aéroélasticité et Acoustique (DAAA)

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