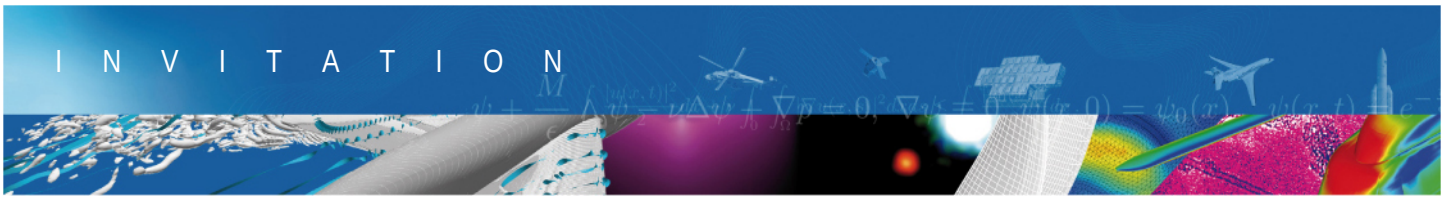

Advanced anti-windup flight control algorithms for fast time-varying aerospace systems

Soutenance de thèse – Sovanna THAI
Jeudi 25 novembre 2021 à 10h00
Salle des Thèses, ISAE-SUPAERO, 10 avenue Edouard Belin, Toulouse

Devant le jury composé de :

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Résumé

In the aerospace field, a major challenge related to the development of flight control algorithms consists in designing controllers for systems required to operate over a large flight envelope. The challenges stem from multiple factors, among which parameter-dependent nonlinearities, actuator saturations, and model uncertainties feature prominently. Beyond these technical aspects, the task of the control engineer is further complicated by industrial trends. Indeed, applications grow increasingly complex, while being subject to stringent requirements and cost constraints. Hence, control engineers must often resort to a costly iterative process involving controller tuning and simulations. Thus, there is a need for advanced algorithms and tools able to address the aforementioned nonlinearities and uncertainties in an efficient manner, while being applicable to realistic aerospace systems. The thesis takes place in this context. It aims at setting up a methodology for the control design of parameter-varying systems subject to actuator saturations and uncertainties. This is done by integrating elements of gain scheduling, robust H_∞ control theory, anti-windup synthesis, and robustness μ/IQC-analysis techniques in a cohesive way in the design process. With this goal in mind, theoretical and algorithmic contributions to probabilistic μ-analysis are proposed, bringing μ-analysis closer to industrial needs. Further motivating this work, a specific aeronautic application is considered, namely a novel guided dual-spin projectile concept, steered by four independently actuated canards. This class of systems is characterised by highly nonlinear and coupled dynamics, making control design challenging. The system is studied starting from the open-loop flight dynamics modelling, to nonlinear Monte Carlo closed-loop simulations for autopilot performance evaluation, allowing to illustrate the proposed control design methodology in a realistic context.

Mots clés

Robust control, anti-windup design, robustness analysis, parameter-varying systems, guided dual-spin projectile

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