
## DEPARTEMENT TRAITEMENT DE L'INFORMATION ET SYSTEMES

# Advanced control laws design and validation

## A set of methods and tools to bridge the gap between theory and practice

## Soutenance de HDR de

## Clément ROOS

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**Auditorium de l'ONERA Toulouse**

**Devant le jury composé de :**

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|---|---|---|
| Michel BASSET | Rapporteur | Professeur Université de Haute Alsace |
| Jean-Marc BIANNIC | Examinateur | Directeur de recherche ONERA |
| Patrick DANES | Examinateur | Professeur Université de Toulouse |
| Andrés MARCOS | Examinateur | Professeur Université de Bristol |
| Isabelle QUEINNEC | Directrice de HDR | Directrice de recherche LAAS-CNRS |
| Gérard SCORLETTI | Rapporteur | Professeur Ecole Centrale de Lyon |
| Peter SEILER | Examinateur | Professeur Université du Minnesota |
| Matthew TURNER | Rapporteur | Professeur Université de Leicester |

**Résumé :**

Many real-world applications suffer from strong cost constraints or weight limitations, which dictate the use of potentially low performance hardware (actuators, sensors, onboard computers). For example, the access to space is becoming significantly easier and cheaper with the advent of nanosats, and low-cost launchers must be developed to promote this new economic model. In the military domain, one of the most topical issues is to improve the precision and to enhance the range of traditional artillery shells in the modern battlefield, while significantly reducing costs. And UAV are now widely used to perform a large number of demanding missions. So there is a real need to control various kinds of systems on extended operational domains in the presence of hardware limitations, uncertainties, varying parameters as well as actuator saturations. In this context, our contribution lies at the frontier between research and engineering. Based on known theories and results in the fields of LFR modeling, μ/IQC/Lyapunov-based analysis, as well as analysis of saturated systems, we first try to develop validation methods that can be applied to real-world issues with a reasonable computational cost. Heuristics sometimes replace rigorous mathematical proofs, but we believe this is the price to pay for bridging the gap between theory and practice. Many efforts are also invested in the development of generic computational tools designed for control engineers. Then, we show how these methods and tools can be directly integrated into the control laws design process, so as to reduce a little bit the number of iterations between design and validation in an industrial context. The next step will be to face the implementation constraints. Thanks to our growing involvement in ONERA's UAV lab, the proposed control architectures will be implemented and validated first by hardware-in-the-loop simulations and then by flight tests. The feedback will allow us to take a fresh look at our design and validation methodologies, and to further improve them.