State of art of recent tools developed by ONERA/DCSD - SUPAERO

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Recent work undertaken within ONERA/DCSD - SUPAERO has emerged some lead modelling, analysis and control tools, which can be directly applied or adapted for space systems.

In the framework of **dynamical systems modelling**, a way to build linear dynamical models of a multi-body system (typically a satellite) has been already tested successfully. The key ideas were presented in [CC01]. The method is powerful because :

- the rigid six degrees of freedom are treated all together,
- the main body can have rigid or flexible appendages,
- and each of these appendages can be connected to the main body by a cantilever or a pivot joint.

Its coding simplicity lets us consider a generalized toolbox, which will generate a linearized dynamic model with external forces and torques as inputs, for any open mechanical chain. This toolbox would be useful for industry to analyse quickly modal properties of a complex mechanical system.
Another generalization of this toolbox is to interface it with the Linear Fractional Transformation (LFT) control toolbox [Mag06, BD06]. This modelling aspect allows to take into account uncertainties on inertia, mass terms or on flexible modes.

Once the uncertain model is built and available, our department has some experience in the μ computation, in order to analyze the **robust stability** and the **performance properties** of a closed-loop system subject to LTI parametric uncertainties and neglected dynamics [FB], [MDC$^+$99]. Many applications (flutter detection for an aero-elastic model...) prove the efficiency of these frequency methods.
Similarly but not with the same theoretical tools, algorithms are now available to analyze a regional stability and performance of a linear system subject to symmetric saturations [BTF06].

Finally , in the **robust control framework**, many control design methods have been developed and tested on quite realistic and industrial aerospace applications. Both direct an indirect approaches have been proposed to handle a multi-objective control problem with frequency-domain, time-domain and parametric specifications ([VDA$^+$03]). Generic controller structure ([AA99]) have been proposed for controller real-time implementation and to cope easily with controller switching for multi-mode mission ([GCP06]). In the field of non-linear control, an advanced algorithm is proposed in [FB07] to the synthesis issue of a robust anti-windup controller for an LFT model.

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