AUTOMATIC CONTROL NEEDS FOR FUTURE EUROPEAN LAUNCH VEHICLES

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Future European Launch Vehicles (LV), which are currently being designed, would benefit greatly from the significant advances that are being made in control theory. In its current state, LV control design, verification and validation is a laborious process which typically needs to be repeated with every design change in the LV and (latter on) for every payload that is launched. The difficulty in the design, verification and validation of the LV control laws is due to the time varying nature of the LV and also to the large uncertainties associated with the LV model used during the initial design.

In this presentation we describe how the use of modern control techniques could be an important step towards the design of tools that would greatly simplify LV control design, validation and verification process. For example, control theories such as Linear Fractional Transformations (LFT) represent a solid way of incorporating uncertainties into the modeling process; Linear Parameter Varying (LPV) theory is a simple and powerful way of designing self scheduled controllers with guaranteed robustness properties; mu-analysis is a strong tool for assessing performance robustness with respect to uncertainties. Furthermore, the aforementioned tools lend themselves naturally to missionization aspects: it is a simple procedure to include (for example) payload mass as one of the varying parameters in an LPV setting, and then use the LPV model for control design.

While the control theories mentioned above are extremely powerful and versatile, their incorporation into dedicated LV control design tools, which are user friendly, has still to be worked out. There is also a need to disseminate and convince the control community that the new techniques have the same if not better reliability as compared to the ones currently used in industry.

In this presentation we will also discuss new research directions to implement the aforementioned techniques, specifically the use of Linear Matrix Inequalities and Randomized Algorithms. We shall also provide some research directions and give a possible roadmap.