LPV/LFT MODELING AND IDENTIFICATION: OVERVIEW AND PERSPECTIVES

Exposé invité de

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The process of developing mathematical models of physical systems is a complex one, which in general implies a careful combination of prior knowledge coming from the physics of the system under study with information coming from experimental data.

This problem is particularly critical in view of the application of the derived models to robust and gain-scheduled control system design.

With specific reference to the derivation of Linear Parametrically-Varying (LPV) models, two classes of approaches have been developed in the literature, which might be classified as white- and black-box, respectively, as methods belonging to the former class rely on physical modelling, while methods belonging to the latter are entirely based on experiments.

Each of the two classes of methods can provide a solution for specific problems, but fail whenever the user could (or should) beneficially exploit information from both prior physical knowledge and experiments.

Combining these two strongly heterogeneous types of information corresponds to the so-called problem of grey-box model identification (see, for example, (Bohlin 2006)).

As recently discussed in (Ljung 2008), the critical issue in the development of an effective approach to grey-box modelling lies in the integration of existing methods and tools for physical systems modeling and simulation with equivalent methods and tools for parameter estimation.

More precisely, it is very difficult to define approaches to each of the two sides of the grey-box modelling problem which lend themselves to easy and natural integration: on one hand, formulating the parameter estimation problem directly at the level of a general purpose simulation environment leads to an optimisation problem which can be ill-posed and in general hard to manage; on the other hand, using a black-box model structure for parameter estimation leads to difficulties when it comes to incorporating prior information and physical insight in the model.

In this talk, the following points will be developed and discussed:

- An overview of the existing literature on control-oriented white- and black-box modelling will be given, with specific reference to LPV systems.
- Results obtained in the challenging problem of experimental LPV modelling for the dynamics of Web applications will be presented (see, e.g., (Abdelzaher et al. 2003) and (Tanelli et al 2008).
- An approach to the problem of integrated modelling and identification of physical systems will be proposed, based on the use of object-oriented modelling and symbolic manipulation

techniques. In short, the proposed approach can be described as follows (Casella Lovera 2008):

- Develop a physical model for the system under study, trying to isolate as clearly as possible the uncertain parameters the value of which might have to be fine tuned using information from experimental data.
- Use symbolic manipulation techniques to bring the physical model in Linear Fractional Transformation (LFT) form, more suitable for parameter estimation.
- Estimate the uncertain or unknown parameters using input-output data collected in dedicated experiments.

References

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