Towards real time analysis of parametric multiphysical models based on Model Order Reduction

Jose V. Aguado*, Domenico Borzacchiello* and Francisco Chinesta*

*****GeM Institute at Ecole Centrale Nantes
ESI Corporate International Chair
1, rue de la Noë, 44321 Nantes, France
e-mail: {jose.aguado-lopez;domenico.borzacchiello;francisco.chinesta}@ec-nantes.fr
web page: http://rom.ec-nantes.fr

ABSTRACT

At the conception phase of industrial equipment, engineers explore different alternatives to find a compromise between performance, cost and other criteria. The main concern is to evaluate different alternatives as quickly as possible. Numerical Prototyping uses numerical simulations as a tool to evaluate the performances of the equipment before it is manufactured. In many cases, multiphysical simulations [1] combining different physical phenomena have to be solved. However they are generally complex and time-consuming, restricting the chance of estimating a nearly optimal design.

In consequence, there is a need of reducing the computational complexity of multiphysical simulations with the aim of rendering the exploration of the parametric space fast. In this context, Model Order Reduction (MOR) methods find an interesting and innovative field of application. Two computational stages apply. First, the *offline* stage in which the *reduced* model is built upon the *full* model. Then, in the *online* stage the quantities of interest can be computed for a given parameter choice by performing almost inexpensive computations. We consider a *distributed approach*, that is, each physical model is solved separately, rather than a *monolithic approach*, in which the different physical models are solved all together. Observe that the distributed approach is more flexible as it facilitates selecting appropriate solvers as well as appropriate MOR methods for each physics. On the other hand, it provides the challenge of being able to couple reduced models. In this work, we combine Reduced Basis method (RBM) [2] and Proper Generalized Decomposition (PGD) [3, 4] and we demonstrate how different reduced models can be coupled.

To illustrate the methodology, we consider a multiphysical problem of practical interest, which is the design of a hot-wall Chemical Vapor Deposition (CVD) reactor [5].

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