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COMPUTATIONAL VADEMECUMS FOR REAL TIME SIMULATION, OPTIMIZATION AND CONTROL OF STRUCTURES, MATERIALS AND PROCESSES

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Despite the impressive progresses attained by simulation capabilities and techniques, some challenging problems remain today intractable. These problems, that are common to many branches of science and engineering, are of different nature. Among them, we can cite those related to high-dimensional models, on which mesh-based approaches fail due to the exponential increase of degrees of freedom. Other challenging scenarios concern problems requiring many direct solutions (optimization, inverse identification, uncertainty quantification …) or those needing very fast solutions (real time simulation, simulation based control …).

We are developing a novel technique, called Proper Generalized Decomposition (PGD) based on the assumption of a separated form of the unknown fields that has demonstrated its capabilities in dealing with high-dimensional problems overcoming the strong limitations of classical approaches. But the main opportunity given by this technique is that it allows for a completely new approach for addressing standard problems, not necessarily high dimensional. Many challenging problems can be efficiently cast into a multidimensional framework opening new possibilities to solve old and new problems with strategies not envisioned until now. For instance, parameters in a model can be set as additional extra-coordinates of the model. In a PGD framework, the resulting model is solved once for life, in order to obtain a general solution that includes all the solutions for every possible value of the parameters, that is, a sort of "Computational Vademecum". Under this rationale, optimization of complex problems, uncertainty quantification, simulation-based control and real-time simulation are now at hand, even in highly complex scenarios, by combining an off-line stage in which the general PGD solution, the "vademecum", is computed, and an on-line phase in which, even on deployed, handheld, platforms such as smartphones or tablets, real-time response is obtained as a result of our queries. See [1] for a recent review on this topic.

REFERENCES

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