

## COMPUTATIONAL VADEMECUMS FOR REAL-TIME SURGERY

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### ABSTRACT

The concept of computational vademecum is explored with applications on computational surgery. An emphasis will be placed towards real-time applications, including haptic feedback for educational systems.

Computational vademecums are obtained after the solution of a high dimensional parametric problem in which every possible parameter is treated as a new coordinate in the phase space of the problem. Such a high dimensional problem needs for an efficient numerical solver in order to overcome the *curse of dimensionality*, i.e., the exponential grow in the number of degrees of freedom associated to mesh-based techniques such as finite elements, volumes or differences.

In our case we employ Proper Generalized Decomposition techniques (PGD), which allow for a very efficient solution of this class of problems and their subsequent real-time exploration. Examples will be shown on the performance of the method including material and geometric non-linearities, dynamics, contact, cutting, ...

### REFERENCES

1. PGD-based computational vademecum for efficient design, optimization and control. F. Chinesta, A. Leygue, F. Bordeu, J.V. Aguado, E. Cueto, D. Gonzalez, I. Alfaro, A. Ammar, A. Huerta. Archives of Computational Methods in Engineering, 20(1), 31-59, 2013.
2. Real time simulation for Computational Surgery: A review. E. Cueto, F. Chinesta. Advanced Modeling and Simulation in Engineering Sciences, 1-11, 2014.