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REDUCED-ORDER MODELING, DIFFERENTIAL GEOMETRY AND PHYSICS-BASED NEAR-REAL-TIME PREDICTIONS

***Charbel Farhat[1] and David Amsallem[2]**

[1] Department of Mechanical Engineering
Stanford University
cfarhat@stanford.edu

[2] Department of Aeronautics and Astronautics
Stanford University
amsallem@stanford.edu

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ABSTRACT

Reduced-order models (ROMs) are usually thought of as computationally inexpensive mathematical representations that offer the potential for near real-time analysis. While most ROMs can operate in near real-time, their construction can however be computationally expensive as it requires accumulating a large number of system responses to input excitations. Furthermore, ROMs usually lack robustness with respect to parameter changes and therefore must be rebuilt for each parameter variation. Together, these two issues underline the need for a fast and robust method for adapting pre-computed reduced-order bases associated with pre-defined sets of model parameters in order to construct in near real-time new reduced-order bases corresponding to new sets of model parameters. To this effect, this lecture presents an interpolation method based on the Grassmann manifold and its tangent space at a point that is applicable to structural, aerodynamic, aeroelastic and many other ROMs based on projection schemes. This method is illustrated here with the interpolation of CFD-based aeroelastic ROMs of complete fighter configurations for new values of the flight conditions. Good correlations with results obtained from direct ROM reconstruction, high-fidelity nonlinear and linear simulations and flight test data are reported, thereby highlighting the potential of the proposed ROM interpolation method for near real-time predictions using pre-computed ROM data bases.

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