Data-Driven Adaptive Structural Dynamics

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ABSTRACT

In the previous (third) industrial revolution, "virtual twins" (emulating a physical system from the accurate solution of the mathematical model expected describing it) were major protagonists, making accurate designs possible. Numerical simulation is nowadays present in most of scientific fields and engineering domains, making possible the virtual evaluation of systems responses, alleviating the number of experiences on the real system that the numerical model represents. However, usually virtual models are static, that is, they are used in the design of complex systems and their components, but they are not expected to accommodate or assimilate data so as to define dynamic data-driven application systems. The characteristic time of standard simulation strategies is not compatible with the real-time constraints compulsory for control purposes and significant deviations between the predicted and observed responses are noticed, limiting the use of digital twins in many applications requiring online adaptation [1].

Thus, nowadays, it is generally accepted the urgent need of more reliable modeling approaches as well as the dynamic assimilation of collected data on running simulations, for defining efficient Dynamic Data-Driven Application Systems (DDDAS) [2].

The present work focuses in the Hybrid-Twin concept [3] applied to a dynamical system. The system is described using an approximated (coarse) representation of the real physical system that results in approximated mass and stiffness matrices and the associated modal basis. Data-driven modeling are then employed to fill the gap between the coarse dynamical system's deterministic solution, computed by using a new hybrid modal/harmonic integration scheme, and the measured fields. The hybrid-twin paradigm allows thus to adapt in real time the dynamical model according to the performed measurements.

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