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Implementation of State-Space and Super-Element Techniques for the Modeling and Control of Smart Structures with Damping Characteristics

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Abstract : Minimizing the weight in flexible structures means reducing material and costs as well. However, these structures could become prone to vibrations. Attenuating these vibrations has become a pivotal engineering problem that shifted the focus of many research endeavors. One technique to do that is to design and implement an active control system. This system is mainly composed of a vibrating structure, a sensor to perceive the vibrations, an actuator to counteract the influence of disturbances, and finally a controller to generate the appropriate control signals. In this work, two different techniques are explored to create two different mathematical models of an active control system. The first model is a finite element model with a reduced number of nodes and it is called a super-element. The second model is in the form of state-space representation, i.e. a set of partial differential equations. The damping coefficients are calculated and incorporated into both models. The effectiveness of these models is demonstrated when the system is excited by its first natural frequency and an active control strategy is developed and implemented to attenuate the resulting vibrations. Results from both modeling techniques are presented and compared.

Keywords : damping coefficients, finite element analysis, super-element, state-space model
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