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MODAL DERIVATIVES BASED REDUCTION METHOD FOR FINITE DEFLECTIONS IN FLOATING FRAME

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The floating frame approach, which follows a mean rigid body motion of an arbitrary flexible component, is widely applied in the flexible multibody dynamics [1]. The major advantage of floating reference, comparing with the corotational frame and inertia frame, is the ability to naturally use model order reduction (MOR): the local generalized coordinates are expressed as a linear combination of a small number of modes. However, the traditional linear MOR is limited to small displacements and low angular velocity applications. A linear combination of vibration modes (VMs), for instance, fails to reproduce the bending-stretching coupling occurring when the elastic rotations become finite.

In this contribution, the modal derivatives (MDs) [2] will be used in floating frame to readily include the axial-bending strain coupling items, as well as the centripetal forces. An reduction basis including both VMs and MDs in shell element are shown in Fig. (1). By adding the MDs in the basis together with VMs , the reduced system is able to capture the second-order nonlinear effects, and as a result accurately describe the nonlinear dynamic behavior. Therefore, the application of floating frame approach could extend to problems featuring arbitrary large rigid body rotations and finite elastic displacements and rotations.

The size of the complete set of MDs is quadratic with respct of the set of VMs used for the linear reduction, and therefore the size fo the reduction basis might become large and hinder the practicality of the method. However, it is possible to identify the most relevant MDs [3], without losing accuracy. The effectiveness of this investigation will be demonstrated in different beam examples, and compared to alternative approaches in corotational and inertial frames.

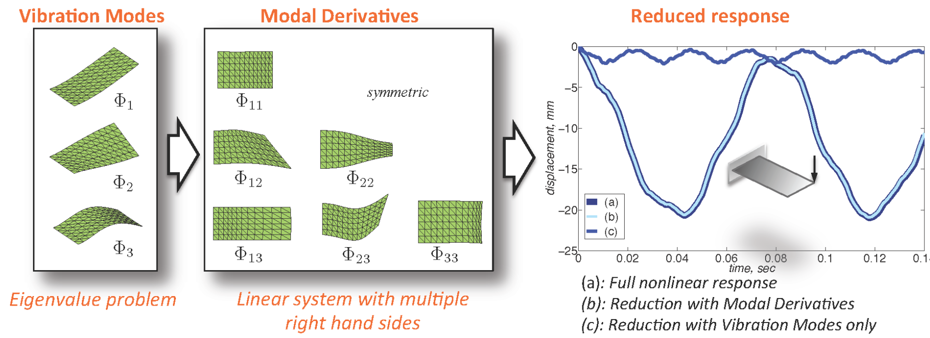

Figure 1: The first three VMs and corresponding MDs for a cantilevered plate. A reduction basis formed with few VMs and the correspoding MDs is able to accurately reproduce the full order solution very accurately.

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