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Reduced-order model for large amplitude vibrations of flexible structures coupled with a fluid flow

T. Flament[1,2*], J-F. Deü[2], A. Placzek[1], M. Balmaseda[1], D-M. Tran[1]

[1] ONERA, 29 Av. de la Division Leclerc, 92320 Châtillon (FRANCE),
{theo.flament,antoine.placzek,mikel.balmaseda}@onera.fr, https://www.onera.fr/en
[2] LMSSC, Cnam, , 292 rue Saint-Martin - 75141 Paris cedex 03 (FRANCE),
jean-francois.deu@cnam.fr, https://www.lmssc.cnam.fr/en

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The design of future aircraft engines with fans and blades of large dimensions leads to flexible structures. The geometric nonlinearities due to the large amplitudes of displacements alter significantly the level of vibrations and a nonlinear modelisation of the structure is therefore necessary to characterize aeroelastic phenomena such as flutter and forced response. An approach to carry out aeroelastic simulations is to couple two different solvers for the fluid and for the structure. The problems are the excessive computational time for industrial applications and the cumbersomeness of the coupling in terms of transfer of information from one solver to the other. An efficient approach to overcome those problems is to couple a nonlinear fluid solver with a reduced-order model (ROM) for the structural solver, the later being independent from the full model. In our case we consider only geometric nonlinearities. The ROM is build by projection on a reduced basis and the internal geometric nonlinear forces are approximated as a third order polynomial of the generalized coordinates whose coefficients are identified using the *Implicit Condensation and Expansion* (ICE) [1]. Nevertheless, for cantilever structures, this method has limited efficiency to capture the dynamics of the membrane stretching since the membrane displacement is rebuilt instead of computed. Our idea is to identify a pertinent set of dual modes [2] during the construction of the model and introduce it in the reduction basis in order to compute the membrane displacement instead of reconstructing it as in the expansion step of the ICE. Such a ROM was coupled with the fluid solver *elsA* to compute the dynamical response of a Timoshenko beam placed in the wake of a fixed cylinder and subject to the unsteady forcing of a Von Kármán vortex street.

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