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DYNAMICS AND CONTROL OF A FLEXIBLE CLAMPED-FREE BEAM ON A ROTATING HUB BY USING THE STATE-DEPENDENT RICCATI EQUATION (SDRE) STRATEGY

Abstract

In this paper, the mathematical model of a system constituted by an Euler-Bernoulli beam in a clamped-free configuration rigidly attached to a rotating hub is derived by using the Lagrangian formulation combined with the assumed modes method. Through this method the elastic displacement is approached by a discrete model so as to obtain a system described by ordinary differential equations only. The beam in a clamped-free configuration rigidly attached to a rotating hub is also referred as pseudo clamped-free beam. The boundary condition for this problem follows the rule for the assumed modes method in the sense that the admissible functions do not have necessarily to satisfy the natural boundary conditions but only the geometrical boundary conditions. This means that the admissible function does not have to be the eigensolution of the elastic motion, i.e., it does not have to be the analytical solution for the elastic equation of motion. A particular feature of the pseudo clamped beam is that it involves the moments of inertia once the system is under rotation. The problem formulation takes into account the moment of inertia of the hub and that of the beam. The non-linear control technique used in the study is the state-dependent Riccati equation strategy (SDRE). This strategy is very popular within the control community providing a very effective algorithm for synthesizing nonlinear feedback controls with nonlinearities in the system states and additionally allowing great design flexibility by using the state-dependent weighting matrices. The objective of the study is to investigate the effect of different inertia ratios between the moment of inertia of the hub and that of the beam in the oscillatory motion. To accomplish this goal the results of the simulations are compared for the rotational/vibrational system response taking into account different ratios of inertia for the hub and the beam.