ON THE EIGENFREQUENCIES OF A FLEXIBLE ARM DRIVEN BY A FLEXIBLE SHAFT

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ABSTRACT

The simulations of multibody dynamic systems with flexible components are generally based on solving the equations of motion by using approximate methods. This approach is taken because these systems' closed form solutions are often not directly available. These methods often assume a solution as a finite series in terms of modal functions with time-varying coefficients. The eigenmodes of the system under study are preferable as the set of the basis functions used in these series because such expansions provide greater accuracy with fewer terms. As a consequence, accurate estimation of system eigenfrequencies and eigenmodes is extremely useful (potentially necessary) in the effective modeling and simulation of these systems. In this paper a new general model consisting of rotor, shaft, hub, beam, and payload, as might be encountered in certain industrial robots, is presented and investigated. This model is similar in nature to those studied previously by a number of researchers, but it is more general in form. The authors believe that this model contains a more realistic (and higher fidelity) representation of the rotor-shaft-hub assembly of this system and its interaction with a flexible beam (arm) and associated payload. Through this model the relative influence of seven key dimensionless mass, stiffness and geometric parameters (ratios) on system eigenfrequencies and modes may be qualitatively and quantitatively investigated. These investigations may include many special cases such as flexible shaft + rigid beam, rigid shaft + flexible beam, cantilever-free beam, pinned-free beam, fixed-free shaft etc. Given the volume of numerical studies which may be performed to this end, this paper concentrates on the effect of the two parameters representing the mass and stiffness ratios of the system manipulator are to its driveline.