 Proceedings of ICCES'08, pp.403-403

Accurate Rigid Body Property Identification Based on Low-Frequency FRF Data

Mathematical models of the rigid dynamic behavior of mechanical structures play a role in various engineering applications. Common examples include control design for mechanical systems such as robots and the simulation and optimization of handling characteristics of vehicles. The rigid dynamic behavior of a mechanical structure is determined by ten inertia parameters: the mass, the coordinates of the centre of mass, and six moments of inertia. In cases where no accurate models of the shape and density distribution are available, the rigid body inertia parameters must be determined experimentally.

In recent years, experimental methods based on the measurement of Frequency Response Functions (FRFs) have been widely studied, yet there are limitations to effectiveness of each approach. The Residual Inertia Method (RIM) assumes a free-free boundary condition, which can lead to errors for test objects with low-frequency flexural modes. The Modal Parameter Method (MPM) and the Direct System Identification Method (DSIM) depend on FRF fitting of all six suspension modes. This approach is problematic because in many cases the suspension modes are not well separated. In this paper, we propose a method addressing these shortcomings.

In our method, the test object is suspended in a single elastic wire, which due to the gravity effect self-aligns with the center of mass. Taking advantage of the automatic alignment, the suspension behavior can be described in terms of only the wire length, the natural frequency of the vertical suspension mode, and the unknown inertia parameters. In this way, the boundary condition is accounted for with a minimum of experimental effort, and suspension mode fitting becomes unnecessary. Based on models of the suspension and inertia properties, in addition to information about flexural modes, the FRFs for a given inertia parameter iteration are reconstructed. Using nonlinear numerical optimization, the reconstructed FRFs are fitted directly to the experimental FRF data, in a low-frequency interval just above the suspension modes. Simulation and experimental results will be presented showing the effectiveness of this approach.