Explicit iteration based-MCS for random vibration of nonlinear systems

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The non-stationary random vibration analysis of nonlinear systems with multiple degrees of freedom is one of the most difficult topics in the field of nonlinear random vibration. A new approach to this highly challenging problem is developed in the present study. Motion equations of nonlinear systems are first transformed into quasi-linear equations by applying the concept of equivalent excitations and the decoupling techniques. Two explicit iterative schemes based on precise integration and Newmark-β integration are then proposed for fast Monte-Carlo simulation (MCS) of non-stationary random vibration of nonlinear systems. Two types of nonlinear systems, including Duffing systems and hysteretic systems, are investigated in this study. The coefficient matrices used for the solution need to be calculated just once and remain unchanged for different time steps and different samples. Therefore, the solution efficiency can be improved greatly, effectively breaking the bottleneck in MCS. Numerical examples are presented to show the accuracy and efficiency of the present approach. The proposed method provides a solid foundation for the application of random vibration analysis to large-scale nonlinear engineering problems.

Keywords: Non-stationary random vibration, Duffing systems, Hysteretic systems; Explicit iteration method, Monte-Carlo simulation