A Reduced Model for Impact of Flexible bodies Using Multi-Variable Method

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Abstract

The impact between moving bodies will interrupt the smooth overall motion and cause the complex dynamic phenomena. A lot of investigations had been done on the theoretical modeling, numerical simulations and experiments of flexible multibody system with impact [1-2]. The global rigid motion occurs on a slow time scale characterized by low frequencies, however, an impact happens on a fast time scale characterized by high frequencies. In order to keep the high frequencies character, thousands and even millions elements are usually adopted to describe the deformations of flexible bodies with contact/impact precisely, which leads to a large number of elastic coordinates and huge computational burden.

One important issue for the simulation of flexible multibody system with contact/impact is to reduce the flexible body's degrees of freedom and improve the efficiency of numerical simulation. However, as a strong boundary nonlinear dynamic problem, linear model reduction techniques cannot be used to flexible bodies with impact directly. Multi-variable method for impact in flexible multibody system try to get a balance between accuracy and efficiency. In this method, the flexible body is divided into two parts called contact region and non-contact region. The rigid body motion is described by floating reference frame. The deformations in contact region are described by finite element nodal coordinates to keep the local dynamic characters while the deformations in non-contact region can be described by reduced elastic coordinates based on Saint-Venant principle. Different model reduction techniques, such as modal truncation, modal cost analysis, Krylov subspace, are used to reduce the degrees of freedom of flexible bodied in non-contact region. The numerical results of the multi-variable method are compared with the reference results of the finite element method and experiments to verify the accuracy of this method. Moreover, the influences of different modal reduction techniques on contact force and velocities are investigated. It shows that multi-variable method is a valid approach to reduce the system degrees of freedom and improve the simulation efficiency of impact in flexible multibody system.

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References

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