ACOUSTICS2008/957
Considering the effect of hammer shank flexibility using a multibody dynamic simulation model of a piano action mechanism with string contact

Chandrika Vyasarayani, Stephen Birkett and John McPhee
University of Waterloo, Department of Systems Design Engineering, Waterloo, ON, Canada N2L 3G1

A piano action mechanism converts a pianist's mechanical input into acceleration of the piano hammer, which impacts the string for tone generation. We present a multibody dynamic model of the mechanism, considering the differences when hammer shank flexibility is included as compared to a rigid shank. The model is developed using the graph theoretic approach and includes the hammer-string interaction. A Rayleigh beam model including complete second order deformation field is used for simulating hammer shank flexibility. The governing partial differential equation is discretized using Ritz approach considering Taylor monomials as assumed modes. A convergence study confirms that two bending modes and one axial mode are sufficient to represent the hammer shank deformation. The vibrating string is modeled using a standard modal analysis procedure. The many contacts between components of the mechanism include significant sliding during contact; for these contacts a modified Hunt-Crossley law is used to represent the normal force, and interface friction is handled using a Cull and Tucker friction model. The results of parametric studies show the effect of hammer head friction on the dynamics of the mechanism during string impact, as well as the influence of hammer shank flexibility on the frequency response of the string.