SEMINAIRE DE MECANIQUE

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UFR Math/IRMAR

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« Bowed String Instrument: a Modal Based Indentification Technique for String Dynamical Motion and Friction Force »

Abstract:

For achieving realistic numerical simulations of bowed string instruments, based on physical modeling, a good understanding of the actual friction interaction phenomena is of great importance. Most work published in the field including our own has assumed that bow/string frictional forces behave according to the classical Coulomb stick-slip model, with an empirical velocity-dependent sliding friction coefficient. Indeed, the basic self-excited string motions (such as the Helmholtz regime) are well captured using such friction model. However, recent work has shown that the tribological behavior of the bow/string rosin interface is rather complex, therefore the basic velocity-dependent Coulomb model may be an over-simplistic representation of the friction force. More specifically, it was suggested that a more accurate model of the interaction force can be achieved by coupling the system dynamical equations with a thermal model which encapsulates the complex interface phenomena. A direct measurement of the actual dynamical friction forces without disturbing the string motion is quite difficult. Therefore, in this work we develop a modal-based identification technique making use of inverse methods and optimization techniques, which enables the identification of the interface force, as well as the string self-excited motion, from the dynamical reactions measured at the string end supports. The method gives convincing results using simulated data originated from nonlinear computations of a bowed string. Furthermore, in cases where the force identifications are very sensitive to errors in the transfer function modal parameters, we suggest a method to improve the modal frequencies used for the identifications. Preliminary experimental results obtained using a basic bowing device, by which the string is excited with the stick of the bow, are then presented. Our identifications, from the two dynamical string reactions, are consistent as attested by the comparison of the two available versions of the string dynamical motion and of the friction force. Furthermore, the method seems adequate to investigate the interface force for the bowed string.