MODELING STRING BOUNDARY CONDITIONS AND STRING COUPLING IN LUTE INSTRUMENTS

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ABSTRACT

An idiosyncratic feature of all lute instruments is the specific fixation of the strings leading to certain physical boundary conditions. Alongside the structural functionality of the string adjustment, the bridge and the nut, fixing the taut string at both ends, the string fixation transmits vibrational energy from the strings to the instrument's resonator and vice versa. An effect arising from this bi-directional coupling is a moving string fixation leading to time varying boundary conditions. In addition to this, the specific fixation of the strings leads to differing admittances in the respective transverse polarization of the string, giving rise to non-linear energy transfer between the polarizations. In this treatise, several fixtures are modeled, showing the influence of the boundary conditions on the string motion as well as the mechanical coupling strength in the respective direction of motion. The strings are modeled using finite difference approximations for the spatial domain and a locally symplectic integration scheme for the time domain discretization. The numerical results are compared to measurements taken with a high-speed camera and a piezoelectric transducer, giving insight to the feasibility of the proposed model parameters and showing the influence on the resulting sound.