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[The virtual workshop OpenWInD: Towards an optimal design tool of wind instruments for makers]

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Abstract

Our project develops an optimisation software (OpenWind) for wind instrument making. The approach is based on a strong interaction with makers and musicians, aiming at computing quantities and defining interesting criteria that should be optimized, from their point of view. Entry impedance is a well studied acoustical quantity that characterizes the linear response of the pipe. However, makers and musicians mostly rely on sounds produced in a musical framework in order to assess an instrument. These sounds can be modeled as a coupling between the pipe (resonator) and an embouchure (oscillator, as a reed for instance). We will present energy based time domain models and simulations where a reed embouchure is coupled with a linear pipe. State-of-the-art numerical techniques are used for the pipe discretization (finite elements for one-dimension Telegrapher's equations). Realistic radiation impedances are formulated in the time domain and an energy based model is derived along with a stable numerical scheme. Pipe junctions are also accounted for, by the means of extended Kirchhoff conditions that are shown to exhibit an inappropriate energy behavior in the time domain. A reed is coupled with the instrument and an energy-based time discretization is derived. Explicit and efficient algorithms are derived for the computation of the scheme's unknowns. Sounds can be heard while the pressure and flow inside the instrument can be observed during the note evolution.

Keywords: wind instruments, time discretization, finite element method, reed mechanism, radiation impedance