# PHYSICALLY-BASED DYNAMIC MORPHING OF BEAM SOUNDS

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**ABSTRACT**

This paper addresses the time-domain simulation of beams made of materials that mutate according to the dynamics. The physical model is based on a standard linear Euler-Bernoulli equation, combined with parameterized nonlinear damping models inside a class that preserves the eigen-modes of the conservative problem. Typical mutations between metal, glass or wood are achieved through a local-in-time interpolation of damping characteristics with respect to the energy. This results in a structured nonlinear beam model which proves to be passive. It is recast in the formalism of Port-Hamiltonian Systems, which naturally provides a power-balanced decomposition into conservative, dissipative and source parts and from which a guaranteed passive simulation can be derived. The paper is organized as follows. First, the linear Euler-Bernoulli model of a beam is recalled. A class of linear damping models that preserve the eigen-modes is proposed. The power balance of this model is derived. Second, a modal decomposition is derived, a pole analysis is presented with a special focus on the dependence on the damping parameters. Third, this linear model is recast in the formalism of Port-Hamiltonian Systems: both the infinite-dimensional problem and the finite-dimensional approximation based on a mode truncation are examined. A guaranteed passive simulation and numerical results are provided. Fourth, the extended class of nonlinear damping models based on interpolating functions is introduced. The consistency with the (linear) modal decomposition is examined. The nonlinear Port-Hamiltonian System is provided. Finally, numerical results for various configurations of mutating characteristics are examined, together with sounds.