15th INTERNATIONAL CONFERENCE

Dynamical Systems — Theory and Applications

December 2-5, 2019. Lodz, POLAND.

paper id: VIB187

Bending vibrations with boundary damping – unlike behavior of tactile sensors

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Abstract: The paper is devoted to an unlike behavior of natural frequencies in beam vibrations. Guided by the biological paragon vibrissa we investigate small vibrations of an Euler-Bernoulli beam and focus in particular on the question how the natural frequencies depend on the main features of this tactile system. Precisely, a clamped and boundary visco-elastically supported beam serves as a first model to determine the spectrum of natural frequencies (later using these frequencies to detect an obstacle contact). The damping element significantly increases the complexity of the two-point boundary-value problem and leads to a surprising phenomenon: there exist some natural frequencies which break down to zero for a certain range of parameters. This fact is well-known in 1-DoF systems (i.e., strong damping, creeping behavior). The study demonstrates that the oscillation behavior of an elastic beam differs remarkably from the behavior of such a classical system: a) The natural frequencies may increase with growing boundary damping; b) for specific damping parameter values, the natural frequencies grow for decreasing boundary stiffness.

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