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System-level modelling of resonant MEMS inertial sensors

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Abstract: System-level Modelling of Resonant MEMS Inertial Sensors Koludarov P.Y. (Peter the Great St.Petersburg Polytechnic University, Institute of Applied Mathematics and Mechanics, “Mechanics and Control Processes” department), Lukin A.V. (Peter the Great St.Petersburg Polytechnic University, Institute of Applied Mathematics and Mechanics, “Mechanics and Control Processes” department), Popov I.A. (Peter the Great St.Petersburg Polytechnic University, Institute of Applied Mathematics and Mechanics, “Mechanics and Control Processes” department; IPME RAS) In this article a verified methodology of MEMS modelling is presented. The methodology is validated on micro resonator beam with comparison to analytical studies of its dynamics. Different resonant MEMS sensors can be created using this methodology. In this study dynamics of torsional micro-vibratory gyroscope is being investigated and system level model is being created. In this work Reduced Order Modelling approach to coupled nonlinear mechanical systems is utilized to consider complex geometry as well as multidomain physics for system level modelling. Finite element model is reduced to a system of differential equations of lower orders allowing model to be fast to simulate and effortless to implement in control schemes. An analytical model of reduced order gyroscope mechanical system is created and analyzed using asymptotic methods of nonlinear mechanics and numerical parameter continuation, which allows for performing parametric analyses obtaining essential mechanical characteristics such as frequency response.

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