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Analysis of Grazing Bifurcations in Impact Microactuators

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Impact microactuators rely on repeated collisions to generate large displacements of a microelectromechanical machine element without the need for large applied forces. Their design and control rely on an understanding of the critical transition between non-impacting and impacting long-term system dynamics and the associated changes in system behavior, known as grazing bifurcations. In this paper, we present three characteristically distinct transition scenarios associated with grazing conditions for a periodic response of an impact microactuator: a discontinuous jump to an impacting periodic response (associated with parameter hysteresis), a continuous transition to an impacting chaotic attractor, and a discontinuous jump to an impacting chaotic attractor. A theoretical normal-form analysis is presented that predicts the character of each transition from a set of conditions that are computable in terms of system properties at grazing. This analysis is validated against results from numerical simulations of a model impact microactuator.

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