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The Effect of Smoothing on Bifurcation and Chaos Computations in Non-Smooth Mechanics

John S. Hogan

University of Bristol, Bristol, UK

In rigid body mechanics involving impacts, backlash or friction, mathematical models of these phenomena involve functions that are discontinuous. Yet when numerical computations of the governing equations are carried out, especially when detection of bifurcation or chaos is important, a smoothed version of the dynamics is often used. In this paper we consider the effect of smoothing on the detection of border-collision or C-bifurcations, which occur when the system steady state intersects a boundary under parameter variation. Using a simple generic example, we show how smoothing always introduces spurious solutions into some part of parameter space. We also show how the location of the bifurcation point itself varies according the way in which the smoothing is carried out. In particular we show how to correct for this variation. We conclude by showing how different border-collision or C-bifurcations are different limits of smooth bifurcations.

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