Beyond the odd number limitation: Control matrix design for time delayed-feedback control algorithm

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Time-delayed feedback control (TDFC) algorithm [1] is an efficient tool for stabilization of unstable periodic orbits of nonlinear dynamical systems. The method has been successfully implemented in number of experimental systems [2]. However, Nakajima [3] proved the theorem, which states that the method is unable to stabilize unstable periodic orbits with the odd number of real Floquet multipliers greater than unity. This odd number limitation (ONL) theorem has been commonly accepted by scientific community, but ten years later after Nakajima's proof Fiedler et al. [4] have demonstrated by a simple example that the ONL theorem does not hold for autonomous systems. Recently, the corrected ONL criterion has been introduced by Hooton and Amann [5]. Here we show how this new criterion is related with the phase response curve of the periodic orbit [6] and propose a coupling matrix design algorithm that bypasses the corrected ONL theorem. We demonstrate our algorithm with specific examples of the Lorenz and Chua chaotic systems for which we construct non-diagonal time delayed feedback control matrices, which enable the stabilisation of their periodic orbits with the odd number of unstable positive Floguet multipliers.

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