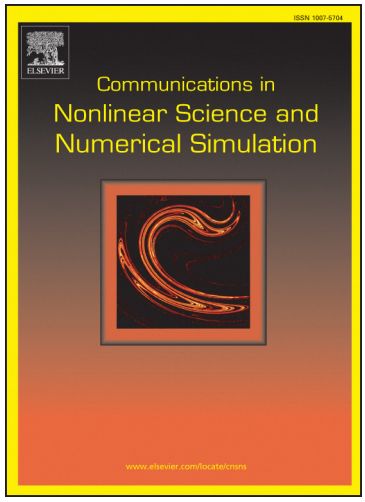

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Symmetric bifurcation analysis of synchronous states of time-delayed coupled Phase-Locked Loop oscillators

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Abstract

In recent years there has been an increasing interest in studying time-delayed coupled networks of oscillators since these occur in many real life applications. In many cases symmetry patterns can emerge in these networks, as a consequence a part of the system might repeat itself, and properties of this subsystem are representative of the dynamics on the whole phase space. In this paper an analysis of the second order N-node time-delay fully connected network is presented which is based on previous work: Synchronous states in time-delay coupled periodic oscillators: A stability criterion. Communications in Nonlinear Science and Numerical Simulation 18 (8) (2013) 2142 – 2152, by Correa and Piqueira, for a 2-node network. This study is carried out using symmetry groups. We show the existence of multiple eigenvalues forced by symmetry, as well as the existence of Hopf bifurcations. Three different models are used to analyze the network dynamics, namely, the full-phase, the phase, and the phase-difference model. We determine a finite set of frequencies ω, that might correspond to Hopf bifurcations in each case for critical values of the delay. The S_n map is used to actually find Hopf bifurcations along with numerical calculations using the Lambert W function. Numerical simulations are used in order to confirm

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