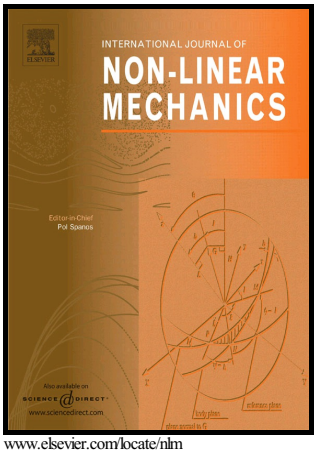

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Forecasting Supercritical and Subcritical Hopf Bifurcations in Aeroelastic Systems

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Abstract

A novel method of forecasting bifurcations based on only the observation of the pre-bifurcation regime is proposed. The method is an extension of previous approaches with a focus on oscillatory systems. The method also enables the use of much less measurement data. Numerical results are presented to demonstrate that this new approach predicts the post-bifurcation regime accurately and to explore the robustness of this method to process noise.

Keywords: forecasting, bifurcation, aeroelasticity, nonlinear systems, post-bifurcation regime, transient response

1. Introduction

Bifurcation phenomena are observed in a variety of systems such as engineered systems [1, 2], climate systems [3], global finance systems [4], ecological systems [5], and biological systems [6]. A few methods of predicting bifurcations by observing the recovery rate of the system from perturbations have been proposed [7-10]. For example, the effects of critical slowing down (such as the increase in the short term autocorrelation or the softening behavior) have been used for forecasting tipping points with application to climate dynamics [11-13] where the system is exposed to small but persistent noise (excitation). In those applications, the focus was on predicting the tipping point qualitatively by, for example, correlating approaching a tipping point with an increase in the autocorrelation of various measured signals. However, these techniques cannot be applied to cases where large perturbations are introduced to the system. A novel method to forecast bifurcations by monitoring the pre-bifurcation regime was suggested by Lim and Epureanu [14]. They proposed a method which can predict bifurcations of the system by