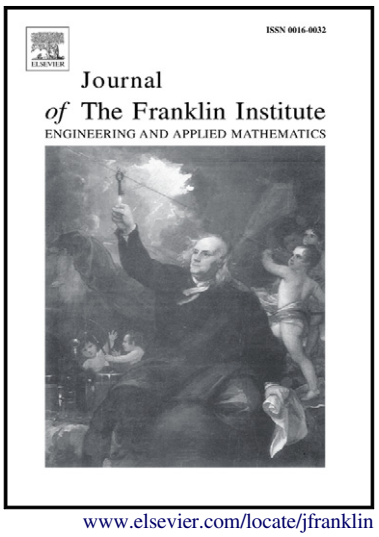

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Identification of Time Delay in Nonlinear Systems with Delayed Feedback Control

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Abstract

In the present paper, an algorithm is proposed to identify time delay parameters appearing in feedback loop of controlled systems in which the structural factors are prior known. The algorithm, connecting to the principle of least squires (LS) and the frequency-response function derived from harmonic balance method (HBM), provides a technique to fit the observed input-output data in frequency domain. Since the delay included in the exponential function can be of multi-values in frequency domain, the uniqueness of the identified results is also discussed so that the provided algorithm has completeness. As applications of the algorithm, a single degree of freedom and a two-degree of freedom systems are considered as two typical examples to display the validity of the algorithm. It is seen that the identified delay may be determined uniquely and may reach any desired accuracy by the present algorithm. It is also shown that the algorithm is simple but robust.

Keywords: Parameter identification; Time delay; Computing for data analysis; Feedback control; Signal processing

1. Introduction

Time delay appears in signal processing and transmitting. It can cause fundamental changes in dynamic characteristics to the system. Xu[1,2] certified the bifurcation and chaos phenomenon deduced by time delay. The results show that the delay can be used as a 'switch' to control motions of a system. With carefully designed strategies, Hu[3,4] and Murakami[5] used delay to stabilize a double pendulum into different equilibriums, and Olgac[6-8] introduced it into vibration absorbers. All of these controls require prior known structural and delay parameters. To this end, parameter identification is indispensable and supporting algorithms should be studied.

The delay identification methods to linear systems are mostly based on analytical principles. Orlov[9-11] studied the identifiability of time delays on linear system assumption and drew the conclusion that the system is identifiable when it is weakly controllable. He also defined an adaptive identifier[12] by assuming that the state and delay parameters are dependent variables of time. This identifier ensures the

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