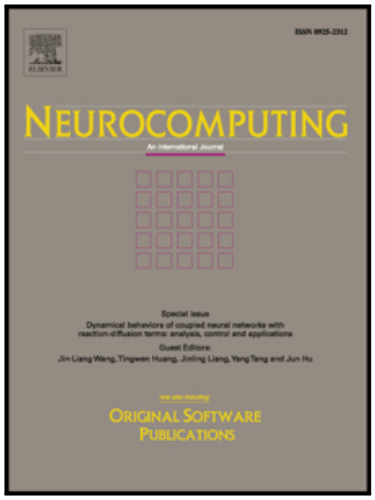
Communicated by Tao Li

Accepted Manuscript



Incipient fault detection of nonlinear dynamical systems via deterministic learning

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PII: S0925-2312(18)30723-9
DOI: 10.1016/j.neucom.2018.06.001
Reference: NEUCOM 19679

To appear in: *Neurocomputing*

Received date: 13 September 2017
Revised date: 12 March 2018
Accepted date: 4 June 2018

Please cite this article as: Qian Wang, Cong Wang, Incipient fault detection of nonlinear dynamical systems via deterministic learning, *Neurocomputing* (2018), doi: 10.1016/j.neucom.2018.06.001

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Incipient fault detection of nonlinear dynamical systems via deterministic learning

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Abstract

Detection of incipient faults is an important and challenging issue in the area of fault diagnosis and prognosis.This paper presents a new incipient fault detection approach for nonlinear dynamical systems via deterministic learning. Through defining and establishing the banks of health, sub-health and incipient fault modes, the incipient fault detectability condition is derived with the fault mismatch function. The system dynamics underlying three kinds of system modes are accurately approximated via deterministic learning firstly. Secondly, a bank of estimators is constructed using the learned modes. A set of residuals is achieved by comparing the bank of estimators with the monitored system. According to the smallest residual principle and the fault mismatch function, if the average L_1 norm of the residual, which is associated with one of the incipient fault modes, is smaller than the others at a time instant t_d, the system incipient fault is detected. Finally, the incipient fault detectability is analyzed rigorously. Numerical simulation is investigated to demonstrate the effectiveness of the approach. The significance of the paper lies in that the learned system modes are utilized to achieve rapid detection in the initial stage of incipient fault for nonlinear dynamical systems.

Keywords: Incipient Faults, Fault Detection, Dynamical Pattern Recognition, Deterministic Learning

2017 MSC: 00-01, 99-00

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