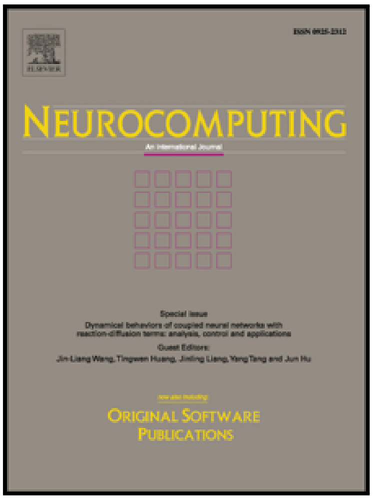
Communicated by Mou Chen

# Accepted Manuscript




## Modeling and Neural Network Control of a Flexible Beam with Unknown Spatiotemporally Varying Disturbance Using Assumed Mode Method

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PII: S0925-2312(18)30775-6
DOI: 10.1016/j.neucom.2018.06.039
Reference: NEUCOM 19717

To appear in: *Neurocomputing*

Received date: 6 February 2018
Revised date: 18 April 2018
Accepted date: 18 June 2018

Please cite this article as: Hejia Gao, Wei He, Yuhua Song, Shuang Zhang, Changyin Sun, Modeling and Neural Network Control of a Flexible Beam with Unknown Spatiotemporally Varying Disturbance Using Assumed Mode Method, *Neurocomputing* (2018), doi: 10.1016/j.neucom.2018.06.039

# Modeling and Neural Network Control of a Flexible Beam with Unknown Spatiotemporally Varying Disturbance Using Assumed Mode Method

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**Abstract**

In this paper, based on the Lagrange equation, and considering the $n$th order elastic mode, the dynamics of a flexible beam equation with unknown spatiotemporally varying disturbance are derived in tangent coordinates system using assumed mode method (AMM). Subsequently, a disturbance observer is developed to solve the unknown spatiotemporally varying disturbance. And neural network (NN) control with full-state feedback and output feedback is proposed to approximate the dynamic uncertainty of the flexible beam system and achieve vibration suppression. It is proved by Lyapunov's stability that the elastic vibration of the flexible beam system can be effectively suppressed. Extensive numerical simulation results verify the performance of the compounded disturbance observer-based adaptive neural network strategy from the perspective of practice.

*Keywords:* Flexible Beam, Neural Network, Vibration Control, Assume Mode Method.

## 1. Introduction

With the extensive application of flexible structures, its control theory and method has become a forward-looking research direction, which has attracted wide attention from academia and industry [1, 2, 3, 4]. At present, the problem of control theory and method for flexible structures has developed into a common scientific issue with extreme challenge, such as intelligent control problem of nonlinear systems in complex environment [5, 6, 7, 8], adaptive control problem of uncertain multiple-input multiple-output (MIMO) nonlinear systems [9, 10, 11, 12], tracking control problem for hypersonic flight vehicle or multiagent systems [13, 14, 15, 16], vibration control problem for flexible systems [17, 18].

For a control engineer, few areas of control theory are as physically motivated-but also as impenetrable-as control of partial differential equations (PDEs) [19, 20]. In control of PDEs, the challenge comes from the infinite dimensional dynamic model of the distributed parameter system. For the sake of the analysis of dynamic uncertainty and controller design, how to realize the transformation of PDE to ordinary differential equation (ODE) and design an intelligent control method with learning ability is the core issue.

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