Dynamic modelling of a flexible beam structure using feedforward neural networks for active vibration control

ABSTRACT

Active vibration control (AVC) techniques show promising results to reduce unwanted vibration level of flexible structures at any desired location. In this paper, the application of non-parametric identification method using feedforward neural networks (FNNs) to model a flexible beam structure for AVC system is presented. An experimental study was carried out to collect input-output dataset of a flexible beam system. The flexible beam was excited using a pseudo-random binary sequence (PRBS) force signal before acquiring the dynamic response of the system. A non-parametric modelling approach of the system was proposed based on feed-forward neural networks (FNNs) while its weight and bias parameters were optimised using chaotic-enhanced stochastic fractal search (SFS) algorithm. The performance of modified SFS algorithm to train a nonlinear auto-regressive exogenous model (NARX) structure FNNs-based model of the system was then compared with its predecessor and with several well-known metaheuristic algorithms. Correlation tests were used to validate the obtained model. Based on the proposed method, a small mean squared error value has been achieved in the validation phase. Considering both convergence rate and result accuracy simultaneously, the chaotic modified SFS algorithm performs significantly better than other training algorithms. In conclusion, the development of a non-parametric model of the flexible beam structure was conducted and validated for future investigations on active vibration control techniques.

Keyword: Active vibration control; Flexible structure; System identification; Stochastic fractal search