On-Line, Adaptive State Estimator for Active Noise Control

by

Prof. Tae W. Lim
Department of Aerospace Engineering
University of Kansas
Lawrence, KS 66045

Dynamic characteristics of airframe structures are expected to vary as aircraft flight conditions change. Accurate knowledge of the changing dynamic characteristics is crucial to enhancing the performance of the active noise control system using feedback control. This reseach investigates the development of an adaptive, on-line state estimator using a neural network concept to conduct active noise control.

In this research, an algorithm has been developed that can be used to estimate displacement and velocity responses at any locations on the structure from a limited number of acceleration measurements and input force information. The algorithm employs band-pass filters to extract from the measurement signal the frequency contents corresponding to a desired mode. The filtered signal is then used to train a neural network which consists of a linear neuron with three weights. The structure of the neural network is designed as simple as possible to increase the sampling frequency as much as possible. The weights obtained through neural network training are then used to construct the transfer function of a mode in z-domain and to identify modal properties of each mode. By using the identified transfer function and interpolating the mode shape obtained at sensor locations, the displacement and velocity responses are estimated with reasonable accuracy at any locations on the structure. The accuracy of the response estimates depends on the number of modes incorporated in the estimates and the number of sensors employed to conduct mode shape interpolation. Computer simulation demonstrates that the algorithm is capable of adapting to the varying dynamic characteristics of structural properties.

Experimental implementation of the algorithm on a DSP (digital signal processing) board for a plate structure is underway. The algorithm is expected to reach the sampling frequency range of about 10kHz to 20kHz which needs to be maintained for a typical active noise control application.