ABSTRACT

Problems involving the identification of damaged / unknown structural systems are widely encountered in the engineering field. Exact analytical solutions for these types of system are limited, due to the nature of nonlinearity and limited amount of informative data. Consequently, much effort have been devoted by numerous investigators to develop models based on their own priori knowledge.

In the late of 90's, the application of ANNs for identification of dynamical systems have been under interest by many researchers, e.g., (Narendra and Parthasarathy 1990), (Masri et al. 1993), (Chen et al. 1995), and (Yun et al. 2000). However, the application of ANNs for modeling unknown / hysteretic dynamical system with degradation characteristic is still available as a challenge topic. The realization of this concept is elucidated through numerical examples. A numerical methodology for dynamical analysis of discretized systems with the inclusion of ANNs-identified models (hybrid discrete-ANNs model) is also developed by the author.

The modeling of unknown hysteretic systems which is considered herein is meant and limited to the macro modeling of nonlinear restoring forces. More specifically, the artificial neural networks will model the relation between restoring forces and system states. The system states can be the displacement, velocity, and other related quantities of the hysteretic system of interest. The history or path-dependent behavior of the hysteretic system directs the whole architecture of the utilized artificial neural networks. The input variables to the artificial neural network comprise basically of independent kinematic state variables like displacement and velocity, whereas the output variable from the artificial neural network is the non-linear hysteretic force.

In this study, the realization of the proposed concept is elucidated by SDOF and MDOF systems with classes of nonlinearity are considered. These types of system are classified into two cases: conservative and non-conservative system. The duffing (hardening type) system is employed here as conservative nonlinearity type. The results show good mapping between the exact and predicting by ANNs.

Clough-Johnston hysteretic model and Extended Bouc-Wen-Barber-Noori (EBWBN) are used as non-conservative nonlinear systems with deteriorate characteristic. The results obtained from the emulating neural network are in good agreement with those from the exact solutions.