CHAPTER 5

CONCLUSIONS

The analysis of unknown / nonlinear dynamical systems with degradation characteristic using hybrid FE-ANNs model is studied. ANNs is employed for modeling unknown / nonlinear restoring force in mechanical elements which will include in the equilibrium equation and using implicit time domain integration scheme to calculated the responses of the systems. More specifically, the ANNs will model the relation between restoring forces and system states. The system states can be the displacement, velocity, and other related quantities of the system of interest. The model of an emulating network can be viewed as an incremental operator by which the differential / difference equations of the unknown behaviors are emulated.

The proposed method has been presented within the classes of nonlinearity, e.g. conservative and non-conservative systems. The detailing of choosing network architecture is derived based on each different nonlinear behavior.

The following is presented with notable conclusion form this present study.

1) A numerical methodology for analysis of dynamical systems represented by hybrid discrete-ANNs models is described here. By compacting the complicate chain function of ANNs into the form of a direct input-output function, the inclusion of the ANNs-based model into the discrete model is easily accomplished. The resulting hybrid discrete-ANNs model is then in the form of generalized discrete model to which any available numerical method is applicable. This virtue is demonstrated through numerical examples in which the Newmark method is utilized. The computation is performed without any difficulty and the results are obtained with high fidelity. Therefore, the dynamic analysis of complex systems with unknown subsystems that call for the use of ANNs in their modeling is realizable. As a result, the proposed methodology provides a viable means of analysis of complex systems (Ornthammarath and Harnpornchai 2002b).

2) A rationale methodology for modeling unknown / nonlinear restoring forces is presented herein. Other than typical response-related inputs like displacement and velocity, the past restoring forces are proposed as additional inputs for non-conservative, or hysteretic system. The restoring force intrinsically contains the information related to the hysteretic components, which may be related to physically measurable quantities but cannot be expressed in simple mathematical functions. It is also emphasized that the tail responses from the previous excitation are necessary to input as the initial conditions for the computation of the hysteretic force in the next excitation. By this means, the path-dependent behavior is continually preserved for any consecutive application of the trained ANNs (Ornthammarath and Harnpornchai 2002a).