Chapter XIV

Neural Network-Based Identification of Structural Parameters in Multistory Buildings

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Abstract

A detailed study of the capabilities and powerfullness of soft computing techniques such as artificial neural network with respect to the identification of structural parameters and structural responses are presented. This chapter includes the definition of neural architectures and system identification of multistory structure. An efficient identification algorithm for the multistory structure subject to initial condition and ground displacement is presented. Response identification subject to real earthquake data has also been discussed. Several example problems are incorporated to show the efficiency and reliability of the proposed algorithm.
Introduction

System identification methods in structural dynamics, in general are formulated as inverse vibration problems to identify properties of a structure from measured data. The dynamic behaviour of complicated systems often needs to be investigated by system identification, since it usually has to meet certain requirements. The use of computers and efficient mathematical tools allow an identification of the process dynamics by evaluating the input and output signals of the system. The result of such process identification is usually a mathematical model, by which the dynamic behaviour can be estimated or predicted.

As regards the publications by Natke (1982), Masri, Bekey, Sass, and Caughey (1982), Masri, Sass, and Caughey (1982), and Schoukens and Pintelon (1991) presented various methodologies for different type of problems in system identification. Ibanez (1979) has reviewed various techniques for improving structural dynamic models and Datta, Shrikhande, and Paul (1998) reviewed problems related to system identification of buildings done until that date. Some recent related publications may be mentioned as those of Loh and Tou (1995); Yuan, Wu, and Ma (1998); Quek (1999); Sanayei, McClain, Wadia-Fascetti, and Santini (1999); Lus, Betti, and Longman (1999); Huang (2001); Brownjohn (2003); Wroblieski and Yang (2003); Yang, Lei, Pan, & Huang (2003); and Chakraverty (2004a, 2005a).

It is known that the systems, which may be modeled as linear, the identification problem often turns into a nonlinear optimization problem. This requires an intelligent iterative scheme to get the required solution. There exist various online and off-line methods, namely the Gauss-Newton, Kalman filtering and probabilistic methods, such as maximum likelihood estimation. However, the following two basic difficulties are faced often for the identification problem with a large number of parameters:

1. The objective function surface may have multiple maxima and minima and the convergence to the correct parameters is possible only if the initial guess is considered as close to the parameters to be identified.
2. The inverse problem in general gives nonunique parameter estimates.

To overcome these difficulties, the present chapter introduces an identification methodology for the structural parameters and responses of multistory structures by the use of powerful technique of artificial neural network (ANN). However, recently number of studies viz. Masri et al. (2000); Chassiakos and Masri (1996); Narendra and Parthasarathy (1990); Bani-Han, Ghaboussi, and Schneider (1999); Huang, Hung, Wen, and Tu (2003); Chakraverty, Sharma, and Singh (2003); Chakraverty (2004b, 2005b); and the references mentioned there in used ANN for the structural identification problems.

Here, for given input to the system, rather than solving the inverse vibration problem, the forward problem for each time step has been solved as usual to generate the solution vector. First the initial (prior) values of the physical parameters (stiffness, etc.) of the system are randomized for the numerical experiment and then using these set of physical parameters the responses have been obtained. The responses and the corresponding parameters are used as the input/output in the neural net. An iterative scheme is proposed to train the neural network. When the iterative training of the network is done for an acceptable accuracy the
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