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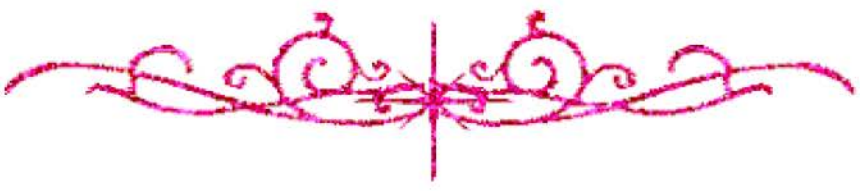

بالرسالة صفحات لم ترد بالأصل

Structural Health Monitoring of Plate Structures using Genetic Algorithms and Neural Networks

By

Tarek Moustafa Hatem

A Thesis Submitted to the
Faculty of Engineering, Cairo University
in Partial Fulfillment of the
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ABSTRACT

Structural Health Monitoring (SHM) is defined in the literature as the "acquisition, validation and analysis of technical data to facilitate structural inspection and maintenance decisions". The primary goal of SHM is to replace the periodical inspection system with a continuous monitoring system. This would reduce the downtime of vehicles and increase the probability of damage detection prior to catastrophic expensive failures.

Neural Networks (NN) and Genetic Algorithms (GA) have shown success in simulating and predicting the behavior of complex physical systems. Genetic Algorithms apply the Darwinian theory of natural selection to simulate complex physical systems, while Neural Networks apply the biological nervous system parallel communication concept. This thesis applies both techniques to two SHM case studies where damage of isotropic and composite plates is simulated and predicted. Five types of damage are considered in this thesis; namely, the circular hole damage, the stiffness reduction damage, the delamination damage, the linear surface crack damage and the linear through crack damage. Damage reduces the plate stiffness. As a result, natural frequencies of the damaged plate are different from those of the healthy one.
The shift in natural frequencies depends on the damage parameters, which are the type, magnitude, position and orientation of damage. This shift in natural frequencies is used by NN and GA techniques to predict damage parameters.

The natural frequency data used in the damage detection process were generated by applying I-DEAS structural modal analysis solver, for a wide range of damage parameters.

In the process of applying the NN and the GA to the SHM system, the representation of damage parameters as functions of natural frequencies of the plates under consideration is obtained by curve fitting where the Least Squares Method (LSM) with and without

applying GA is applied . Another approach to detect damage parameters as functions of natural frequencies is obtained by applying a Damage Location Assurance Criteria (DLAC).

Five NN types are used and presented in this these. They are the linear NN type, the back propagation NN type with and without regularization, the radial bases NN type, and the Generalized Regression NN.

In these studies, the "actual" and predicted damage parameters are presented for two case studies. A comparison between the results obtained by applying the NN and GA techniques is presented with a comparison of their accuracy and reliability.

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