Abstract

Structural health monitoring has become an important area of research in civil, mechanical and aerospace engineering community in recent years. Methods to detect, locate and assess damages in a structure and to evaluate their residual life are very important to assure the structural integrity for safe operating of plants and structures. The difficulties faced in implementing traditional procedures and the need to develop computer based automated evaluation process motivates the application of various types of soft computing tools. Swarm based optimization technique; especially the ant colony optimization (ACO) has been successfully implemented in travelling salesman problems, machine routine problems etc. in recent days.

Ant colony optimization algorithms are models inspired by the behavior of ant colonies. This method is basically a probabilistic technique for solving computational problems which can be reduced for finding optimal paths. ACO usually consists of two basic steps: first, constructing candidate solutions in a probabilistic way by using a probability distribution over the search space and second, modifying the probability distribution, using the candidate solutions in a way that is deemed to bias future sampling towards high quality solutions. An artificial ant in ACO is a stochastic constructive procedure that incrementally builds a solution under construction. Therefore, the ACO can be applied to any combinatorial optimization problem for which a constructive heuristic can be defined.

The present work focuses on the use of ant colony optimization technique for damage assessment of structures using different vibration parameters such as frequency, modal assurance criteria, curvature damage factor and their combinations. The structural damage has been introduced by introducing a stiffness reduction factor. The inverse problem in the damage assessment technique is formulated as an optimization problem. A computer code has been developed in MATLAB environment for the damage assessment of structures with the presence of noise free and noisy set of data. Experimental validation has been carried out to understand the accuracy and robustness of the developed algorithm for damage assessment purpose. Extensive study has been carried out considering various vibration parameters with two kinds of ACO, namely discrete and continuous ACO. The developed code has been implemented on various types of skeletal structures for single as well as multiple damage cases. The results obtained from both discrete and continuous ACO has been compared using various damage indicators. The outcomes of the results are quite encouraging.

Keywords: Structural damage, Inverse problem, Ant colony optimization, Stiffness reduction factor, Curvature damage factor, Flexibility, Modal assurance criteria, Sensor placement optimization.