Damage Classification in Space Frame Structures Using a New Artificial Immune System Algorithm

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Abstract

Steel jacket-type platforms are the common kind of the space frame structures and health monitoring is an important issue in their safety assessment. In this study, a new damage detection method is adapted for this kind of structures and inspected experimentally using a laboratory model. The method has been investigated for developing the robust damage detection technique which is less sensitive to both measurement and analytical model uncertainties. For this purpose, incorporation of the artificial immune system with weighted attributes (AISWA) method into finite element (FE) model updating has been proposed. It has been shown that the method offers important advantages. Therefore, it is proposed as a suitable method for the detection of the failures in the large civil engineering structures with more complicated structural geometry.

Keywords: Space Frame, Fault Diagnosis, AIS Method, Noise Modeling, Physical Models.

1. INTRODUCTION

The industry of space frame structures has been growing at a fast rate during recent six decades. Steel jacket-type platforms are by far the most common kind of space frame structures and they have been widely utilized for various purposes including offshore drilling, processing and support of space frame operations. Elshafey et al [1] indicated to some references in this field. Monitoring of the structures is essential for ensuring the safety during the service life of a structure. The process assumes greater significance in the case of space frame structures, since these structures are in direct contact with the sea waters and any unexpected failure can be calamitous in nature. Nichols [2] has discussed about structural health monitoring (SHM) methods for space frame structure and described a fault detection algorithm using phase space methods.

Li et al [3] studied a new nondestructive damage identification method based on flexibility matrix which can be used to detect and locate structural damage and evaluate the severity of damage in legs of jacket platforms by modal parameters of structure.

Reynders et al [4] used an operational modal analysis with exogenous forces approach and conducting a case study on three real span bridges. Chen and Zang [5] presented an algorithm based on the Artificial Immune Pattern Recognition (AIPR) approach for the damage classification in some case studies. They developed an AIPR-based structure damage classifier which incorporates several characteristics of the natural immune system to find the faults by an algorithm based on their own points of view on immune system. They investigated the validity of the method using a benchmark structure proposed by the IASC–ASCE and showed that the AIPR based pattern recognition is suitable for structure damage classification. But, there are not any reports about application of the AIS based algorithms for structural damage detection purposes in space frame platforms. In this study to establish a more capable AIS based method with higher accuracy in fault classification than the prior works, various developments have been applied on the proposed algorithm. For this purpose, in new algorithm which has been named AISWA, both clonal selection and negative selection have been used simultaneously to benefit of the advantages of a combined procedure. Furthermore, the attributes of the features have been weighted by AIS in order to increase the effect of proper attributes and