Unsupervised Structure Damage Classification Based on the Data Clustering and Artificial Immune Pattern Recognition

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Abstract. This paper presents an unsupervised structure damage classification algorithm based on the data clustering technique and the artificial immune pattern recognition. The presented method uses time series measurement of a structure's dynamic response to extract damage-sensitive features for the structure damage classification. The Data Clustering (DC) technique is employed to cluster training data to a specified number of clusters and generate the initial memory cell set. The Artificial Immune Pattern Recognition (AIPR) algorithms are integrated with the data clustering algorithms to provide a mechanism for the evolution of memory cells. The combined DC-AIPR method has been tested using a benchmark structure. The test results show the feasibility of using the DC-AIPR method for the unsupervised structure damage classification.

Keywords: structural health monitoring, unsupervised structure damage classification, data clustering, artificial immune pattern recognition.

1 Introduction

Damage diagnosis is one of the major tasks of the structural health monitoring (SHM) systems. The SHM process involves the observation of a structure's dynamic response measurements from a group of sensors, the extraction of damage-sensitive features from these measurements, and analysis of these features to determine the current state of the structure [1]. Traditional SHM systems are wired data acquisition systems to collect distributed sensor data to a central data processing station. The practical use of wired SHM systems is limited due to high instrument and installation costs [2]. The wireless sensor network approach is emerging for the effective SHM since it allows dense sensing through many in-expensive sensor nodes and is easy for deployment and maintenance. While sensor network approach presents a number of advantages, SHM sensor network systems currently face many challenges. Major challenges in SHM are: 1) How can we provide sustainable long-term monitoring and

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