A Statistical Pattern Recognition Approach to Structural Health Monitoring

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Abstract: The process of implementing a damage detection strategy for aerospace, civil and mechanical engineering infrastructure is referred to as structural health monitoring (SHM). Here damage is defined as changes to the material and/or geometric properties of these systems, including changes to the boundary conditions and system connectivity, which adversely affect the system’s performance. The SHM process involves the observation of a system over time using periodically sampled dynamic response measurements from an array of sensors, the extraction of damage-sensitive features from these measurements, and the statistical analysis of these features to determine the current state of system health. For long term SHM, the output of this process is periodically updated information regarding the ability of the structure to perform its intended function in light of the inevitable aging and degradation resulting from operational environments. After extreme events, such as earthquakes or blast loading, SHM is used for rapid condition screening and aims to provide, in near real time, reliable information regarding the integrity of the structure.

Our approach is to address the SHM problem in the context of a statistical pattern recognition paradigm. In this paradigm, the process can be broken down into four parts: (1) Operational Evaluation, (2) Data Acquisition and Cleansing, (3) Feature Extraction and Data Compression, and (4) Statistical Model Development for Feature Discrimination.

Biography: Dr. Charles Farrar is currently the Engineering Institute leader at LANL. His career at LANL began in 1983 as a graduate research assistant. While at Los Alamos, he earned a Ph. D. in civil engineering from the University of New Mexico in 1988. The first ten years of his career at LANL focused on performing experimental and analytical structural dynamics studies for a wide variety of systems including nuclear power plant structures subject to seismic loading, and weapons components subject to various portions of their stockpile-to-target loading environments. Currently, his research interests focus on developing integrated hardware and software solutions to structural health monitoring problems and the development of damage prognosis technology. The results of this research have been documented in more than 280 publications as well as numerous keynote lectures at international conferences. His work has been recognized at Los Alamos through his reception of the inaugural Los Alamos Fellows Prize for Technical Leadership and by the Structural Health Monitoring community through the reception of the inaugural Lifetime Achievement Award in Structural Health Monitoring. He is a Fellow of ASME.

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