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Time series based robust damage and fault diagnosis for engineering structures and systems under uncertainty

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Abstract: The problem of damage and fault diagnosis for structures and engineering systems operating under uncertainty is addressed via statistical time series based methods. A critical overview of the main principles, underlying assumptions, and available approaches is presented. The issue of robustness, arising from the need for counteracting the effects of uncertainty, including that due to varying Environmental and Operational Conditions (EOCs) and populations of similar structures and systems, is demonstrated. The main approaches for achieving robustness are presented, with emphasis on conceptual and practical simplicity, ease of use, operation with a low number of sensors and limited numbers of training signals, physical interpretability, and the achievement of high-performance even for early faults. The novel holistic Functional Model (FM) based method, within which the subproblems of damage/fault detection, precise localization, and level estimation may be seamlessly integrated, is then introduced and its various forms are discussed. Application case studies, pertaining to damage diagnosis for engineering structures and systems under uncertainty are presented, with diagnostic performance systematically assessed. The presentation concludes with remarks on the status of the technology and future perspectives.

Biographical Sketch: Spilios Fassois is Professor and Founding Director of the Stochastic Mechanical Systems and Automation (SMSA) Laboratory at the University of Patras, Greece. He previously served on the faculty of the University of Michigan – Ann Arbor. His research interests include stochastic mechanical and aeronautical systems, statistical time series methods, data-based modeling, diagnostics, Structural Health Monitoring, and Machine Learning with applications on structural, vehicular, aeronautical, and other engineering systems. He is the recipient of the 2023 `Evangelos Papanoutsos Excellence in Teaching Award' at the University of Patras, the 1990 `Excellence in Teaching Award of the College of Engineering' at the University of Michigan, and various other awards and distinctions. He is Editor-in-Chief for the Journal of Mechanical Systems and Signal Processing (MSSP), Board Member for additional international journals, and Scientific Committee member for numerous international conferences. He has given numerous Keynote and other invited presentations, has organized 5 Thematic Issues for esteemed international journals, and published over 320 articles in technical journals, conference proceedings, and encyclopedias, with his work being supported by industry and national/international funding agencies.

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