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DYNAMIC DATA DRIVEN STRATEGIES AND RESOURCE ALLOCATION FOR SYSTEM HEALTH MONITORING

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System health monitoring and management strategies play a key role in enabling safe and cost effective operations of next generation autonomous, self-aware aerospace vehicles. Among the possible applications, relevant examples are the real-time structural health monitoring and on-board system diagnostics. This way, control strategies can be dynamically adapted to meet the current system capabilities, and maintenance can be optimally scheduled accounting for the estimated Remaining Useful Life (RUL) of components. The on-board computational power and available data storage, along with the physical feasibility of the installation of multiple sensors, represent the main limitations to run system identification algorithms in real-time. In particular, measured quantities can lead to large volumes of data which are very expensive to store, manage, and process.

This work proposes and discusses a dynamic data driven framework to identify sets of informative sites for critical quantities to measure, store and process online in support of operational decisions. High-fidelity physics-based models of the systems under test are executed offline to obtain sets of accurate data. Then, reduced-order modeling (Proper Orthogonal Decomposition [1, 2, 3]) and machine learning (Self-Organizing Maps [4]) techniques are combined to obtain compressed representations of the quantities to monitor. Sampling points to query and store online are chosen to capture the information content of measured quantities at best. Hence, low-dimensional mappings are exploited to reduce the computational effort associated with real-time assessment of system state and capabilities. The approach is demonstrated for two engineering problems requiring optimal resource allocation. In particular we discuss real-time structural assessment of unmanned air vehicle wing panel and fault identification for aircraft actuation systems. This work was supported by the U.S. Air Force Office of Scientific Research Grant FA9550-16-1-0108 under the Dynamic Data Driven Application System (DDDAS) Program, Program Manager Dr. Eric Blasch, and by the Visiting Professor Program at Politecnico di Torino.

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