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DIAGNOSTICS OF ACTUATION SYSTEM FAULTS FROM DYNAMIC DATA

Pier Carlo Berri[1], **Matteo D. L. Dalla Vedova**[1] **and Laura Mainini**[1,2]

[1] Department of Mechanical and Aerospace Engineering, Politecnico di Torino,
{pier.berri,matteo.dallavedova,laura.mainini}@polito.it
[2] Department of Aeronautics and Astronautics, MIT

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The availability of an accurate online diagnostic procedure for aircraft systems is getting a growing importance in order to adapt the mission profile to the current system health status and enable the prognostic estimation of Remaining Useful Life (RUL) of components, therefore optimizing the maintenance schedule, reducing the operating costs and at the same time improving safety. In this context, the implementation of diagnostic strategies for actuation systems is very critical for the increasing diffusion of Electro Mechanical Actuators (EMAs). In particular, due to the relatively recent introduction of these technologies for aircraft applications, field data are rarely available to support the study of system reliability. On the other hand, EMAs are a convenient application field for diagnostic and prognostic strategies, since useful signals are already measured by the control electronics for closing the feedback loop of the actuator.

This work proposes a multifidelity strategy to combine information provided by different physical models of the system dynamics for the online estimation of its health status. A High Fidelity model (HF) is executed offline to characterize the system behavior, while a Low Fidelity model (LF) [1] is employed online as a reference signal to compare to the measured variables of the physical system. The method leverages low dimensional representations of the quantity to monitor using a resource allocation method [2] based on Proper Orthogonal Decomposition (POD) [3, 4, 5] and Self Organizing Maps (SOM) [6] to reduce the computing time needed for the solution of the parameter identification problem, which otherwise would feature a very high dimensionality due to the time-dependent nature of the monitored signals.

We demonstrate the approach for the specific case of the fault identification of an EMA for aircraft secondary flight controls. In particular, two models of the monitored system are used for this purpose: a computationally heavy HF model is used in the offline phase to optimize the location of the signal sampling points, while a faster LF model is executed online to solve the parameter identification problem. The HF model is a very detailed physical representation of the actuation system enabling the simulation of different failure modes. The LF model is a simplified physics-based representation the system and is intended to emulate its behavior in different operating condition with reduced computational effort.

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