ACTUATOR FAILURE DETECTION USING INPUT-OUTPUT MEASUREMENTS

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An actuator failure is considered to occur when it produces an input to the structure that is different from the commanded input. In this study, a new method is developed to isolate and detect the failures of multiple actuators connected to a system in real time using interaction matrix formulation and input-output measurements. The interaction matrix technique allows discretion to eliminate the state variables in certain input-output equations, and the influence of all other inputs except the one being examined. These input-output equations serve as an effective tool to monitor the integrity of each actuator regardless of the status of the other actuators. Although the procedure requires the knowledge of analytical model of the system being tested, the analytical redundancy can be predetermined through standard input-output-based system identification algorithms such as Observer/Kalman filter Identification (OKID) and Eigensystem Realization Algorithm (ERA). This method is capable of real-time actuator failure detection and isolation under any type of input excitation.

In this new formulation, one error function is built for each examined actuator. The error function for each actuator provides an indication for the examined actuator by producing non-zero value in the error function when the examined actuator fails to follow the commanded input (for measurement noise case). The coefficients of the error function are directly calculated from the healthy input, from the examined actuator, and all measured outputs without having to identify the state-space model of the system. Thus the need to know the state-space model of the plant can be bypassed. This strategy turns out to be particularly advantageous in practice because it bypasses the intermediate system identification step and error incurred during such identification. Numerical simulation and experimental results prove the capability of the proposed algorithm in detecting and isolating multiple actuator failure.

Keywords: Actuator Failure, Input-Output, Interaction Matrix Formulation, Error Function, Direct Method