Model reduction for turbofan health monitoring

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This paper tackles the issue of monitoring the health of a turbofan engine using a reduced order model. Turbofan are complex mechanical systems composed of shafts, turbines and compressors.
Monitoring the health of engines is a critical industrial problem which focusses on a large number of performance indicators such as aerodynamic parameters (Fuel Flow, Exhaust Gas Temperature, Engine Pressure Ratio, angular velocity of shafts, ...) and mechanical parameters (oil consumption, vibration amplitudes, ...) whose dynamic behavior can be approximately modelled [4] and linearized. Reduced-order models can then be derived thanks to classical approximation theory [5].
In this article we examine to which extent classical model-based Fault Detection (FD) and Health Management procedures [2] benefit from model reduction.
To do so, we recall the principles of FD when a state estimator is available, before comparing turbofan state estimators available in the litterature [1]. Then we compare the performance of classical FD schemes in various conditions including full-scale model and reduced-order model. Special emphasis is put on including the specific error generated by model order reduction, following the work of Huttunen et al. [3], and to compare the performance of the obtained FD scheme with previous ones.
This work can be extended to vibration health monitoring in turbofan engines, building both on the large number of works that deal with reduced order modelling of continous mechanical systems; and on FD in vibrating structures.

References

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