New Practical Approaches for Modern PHM

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Abstract

Prognostic health monitoring (PHM) by vibration signal analysis for rotating machinery is widely used for condition-based maintenance. Currently, machine learning, physical-based and signal processing algorithms cannot be implemented successfully for severity estimation and remaining useful life (RUL) estimation of rotating components of airspace vehicles (like airplane, helicopters etc.), where very few if any examples of faults can be used during the development phase of the algorithms.

PHM by vibration signals can be implemented in four stages: fault detection, fault location estimation, fault severity estimation, and RUL estimation. In the first stage, the algorithm tries to detect if there is a fault in the rotating components. In the second stage, it tries to localize the origin of the fault, for example, whether it is in the inner or outer race of the bearing. In the third stage, the algorithm estimates the fault severity, for example, by estimating its geometries. In the last stage, it estimates the RUL of the rotating components.

Several physical and signal processing algorithms have been developed over the last decades and can currently be used to address the two first stages. However, these approaches are very limited for fault severity estimation and, hence, also for RUL estimation.

In the presentation new approaches to overcome these difficulties will be presented:

a. New algorithms based on validated physics-based models
b. Hybrid AI modeling approaches
c. New sensing approaches based on FBGs and small embedded cameras
d. Digital twin used for CBM

In the presentation practical examples from the aeronautical and transportation industries will be presented.