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Integrated Gas Turbine Performance Diagnostics and Condition Monitoring Using Adaptive GPA

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Abstract : Gas turbine performance degrades over time, and the degradation is greatly affected by environmental, ambient, and operating conditions. The engines may degrade slowly under favorable conditions and result in a waste of engine life if a scheduled maintenance scheme is followed. They may also degrade fast and fail before a scheduled overhaul if the conditions are unfavorable, resulting in serious secondary damage, loss of engine availability, and increased maintenance costs. To overcome these problems, gas turbine owners are gradually moving from scheduled maintenance to condition-based maintenance, where condition monitoring is one of the key supporting technologies. This paper presents an integrated adaptive GPA diagnostics and performance monitoring system developed at Cranfield University for gas turbine gas path condition monitoring. It has the capability to predict the performance degradation of major gas path components of gas turbine engines, such as compressors, combustors, and turbines, using gas path measurement data. It is also able to predict engine key performance parameters for condition monitoring, such as turbine entry temperature that cannot be directly measured. The developed technology has been implemented into digital twin computer Software, Pythia, to support the condition monitoring of gas turbine engines. The capabilities of the integrated GPA condition monitoring system are demonstrated in three test cases using a model gas turbine engine similar to the GE aero-derivative LM2500 engine widely used in power generation and marine propulsion. It shows that when the compressor of the model engine degrades, the Adaptive GPA is able to predict the degradation and the changing engine performance accurately using gas path measurements. Such a presented technology and software are generic, can be applied to different types of gas turbine engines, and provide crucial engine health and performance parameters to support condition monitoring and condition-based maintenance.

Keywords : gas turbine, adaptive GPA, performance, diagnostics, condition monitoring
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