Real-time Health monitoring of Gas Turbine Components Using Online Learning and High-dimensional Data

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Introduction

Big Data analytics holds enormous potential for enabling reliable operation of power generating gas turbines and combined cycle plants. The objective of this research is to develop a Big Data analytics framework for critical gas turbine components through systematic experimentation that leverages unique industry-class turbine test rigs. The Big Data analytics methodology consists of four key components shown in Figure 4.

- Develop Data Curation Procedures that tackle data storage, data quality assessments, and integrity checks.
- Develop Feature Engineering Tools using physics-based models to guide data transformations and develop high-fidelity fault features.
- Develop Prognostic Models for predicting and continuously updating remaining operational life of critical gas turbine components.

Big Data Analytics for Gas Turbines

The proposed Big Data analytics methodology consists of four key components shown in Figure 4.

- Experimental Data Curation
- Feature Engineering
- Fault Detection & Diagnostics
- Prognostics & Predictive Analytics

Experimental Plan

The Big Data analytics framework will provide the tools for synthesizing large volumes of data, extracting key fault features, and performing robust fault detection and life predictions. This will be supported by an extensive design-of-experiments that utilizes unique industry-class testing facilities at Georgia Tech and Penn State University, which target critical combustor and turbine faults.

Cloud-Based System Architecture

A cloud-based architecture will be utilized for storing, sharing, and performing computations on Big Data.

- In collaboration with our industry partners, the project is intended to generate public domain, industrially relevant data sets that the broader community can explore.
- Please contact us if you are interested in generating proprietary data sets and/or testing proprietary hardware that leverages the approaches developed in this program.

Turbine Faults

Inlet Temperature Transients
Spatially-resolved and time-resolved blade temperatures

Blade Coolant Loss
Spatially-resolved and time-resolved heat flux

Inter-stage Sealing Loss
Sampling of CO₂ tracer gas

Blade Tip Clearance
Clearances adjusted by shaft placement; clearance probes

Acknowledgments

The proposal team would like to acknowledge the University Turbine Systems Research (UTSR) program at NETL and our industry partners who supported and helped shape our proposed research agenda.

References