Turbofan Engine Surrogate model for use in Data Analytics at KLM ES

MSc Assignment for …., Propulsion & Power (FPP), Faculty of Aerospace Engineering

Introduction

KLM Engine Services (ES) is part of Air France Industries KLM Engineering & Maintenance Group, overhauling approximately 200 aircraft engines annually. The overhaul shop visit ends with a standardized performance test, to assess compliance to certification rules and customer contracts, before it is released for operation on-wing. At two different locations, the following turbofan engine types are tested:

- CFM56-7B KLM E&M Testcell / Schiphol-Oost
- CF6-80E1 KLM E&M Testcell / Schiphol-Oost
- CF6-80C2 KLM E&M Testcell / Schiphol-Oost
- GEnx-1B Zephyr Testcell / Charles de Gaulle Airport, Paris
- CFMI LEAP-1A & -1B (in gradual introduction)

Over the years KLM ES Engineering has used GSP (Gas turbine Simulation Program) as a supporting tool to analyze and evaluate engine performance data. Gas Path Analysis (GPA) techniques are used to translate engine performance data into component condition information. For optimal performance analysis accuracy, parameter inputs from all gas path sensors at the various engine stations are required. With new engine types such as the GEnx and the LEAP, the OEM does no longer provide the ability to install the additional sensors at the various engine stations, hence data input is limited, resulting in reduced potential to accurately analyze performance. However, the missing information can be compensated for by using accurate and detailed system performance models, which provide relationships between measured and unmeasured parameters.

The other feature that distinguishes next-generation turbofan engines from their older counterparts is the introduction of Continuous Engine Operating Data (CEOD), collected in-flight. Currently, it is difficult to couple a GSP performance model to this data pipeline, and therefore KLM ES is looking for an alternative in the form of a surrogate model. An added benefit is a much faster runtime.

Key objectives

- To develop a surrogate model that utilizes on-wing sensor data from the GEnx-1B.
- Assess the potential of using a surrogate model for on-wing performance analysis and condition monitoring.
- Develop a concept on how to integrate the tool into the maintenance process for work scope decision support.

Assignment

Your work will include the following elements:

1) A literature study on current trends in using surrogate models for gas turbine performance modelling.
2) Introduction to current KLM performance and condition monitoring practice and relation to the maintenance concept.
3) Introduction to GSP (test analysis and gas path analysis models) and KLM Big Data projects.
4) Assessment of how to best capture engine performance (failure/deterioration modes) with a small set of calculated parameter curves using the available sensor data.
5) Verify the model results using existing GSP models and simulated data.
6) Validate the model results using on-wing data and engine maintenance events.

Report

Results of the work must be reported in English, with a copy of this assignment and an executive summary.

Coaching

The work will be performed in close collaboration with KLM Engine Services (Juan Regueiro, Tim Rootliep)

Date 23 July 2021

Professor,	Delft University supervisor,	Supervisors at KLM
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