Professur für Thermofluiddynamik

IFTA

TUM

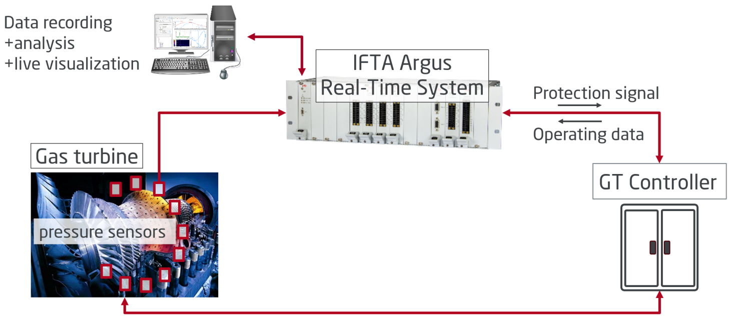
Master's Thesis

Start: from now on

☒ Theoretical
☒ Numerical
☐ Experimental
☐ Constructional

Date of announcement: May 2024

Online Characterization of Combustion Dynamics Using System Identification Based on Sensor Data



Control of an industrial gas turbine using online monitoring.

Combustion systems exhibit feedback between heat release fluctuations and chamber acoustics, which generates system-specific characteristic sound emissions – a subject commonly categorized under the umbrella of "combustion dynamics". At a priori unknown conditions, this feedback can become unstable leading to high-amplitude self-sustained pressure oscillations and highly unsteady combustion. In extreme cases, the flame can go extinct, or the combustion chamber can be damaged – situations that must absolutely be avoided. Since the detailed stability margins in which these high-amplitude oscillations occur are unknown and can shift during operation (fuel flexibility, machine aging, ambient temperature, etc.), continuous monitoring based on dynamic pressure measurements is often carried out. Usually, the resulting measurement data is inspected in the frequency domain, which has the advantage that (sinusoidal) periodic oscillations collapse to single amplitudes at characteristic frequencies. Although this provides more insights than looking at the raw time series data, it is still challenging for operators to assess trends or stability margins. Therefore, within this research project, new methods shall be explored that fit linear dynamical systems to the measurement data using output-only identification methods. The eigenvalues of the resulting system then potentially allow for reliable and useful conclusions on stability margins or combustor condition. This research project shall pave the way for the development of new tools for early warning of combustion instabilities, machine tuning and AI-based condition monitoring. The project is a collaboration between TUM and IFTA, a company located in Puchheim near Munich that develops and sells machine monitoring and protection systems in the energy sector.

Requirements:

Python (or similar)
System Identification
State space modeling
Signal processing

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