Local rational approximation with prescribed poles for improved frequency response function identification

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Local Rational Approximation with Prescribed Poles for Improved Frequency Response Function Identification

Industrial Challenge [1,2]
- Accuracy deteriorated by thermally induced deformations
- Towards active thermo-mechanical control

High Fidelity Thermo-Dynamical Modeling:
- Error compensation
- Active control

Challenge in Thermal System Identification:
\[ Y(k) = G(e^{j\omega k})U(k) + T(e^{j\omega k}) + V(k) \]

Time Constants
- Mechanical: \( \mathcal{O}(1 \text{ s}) \) \times 1000
- Thermal: \( \mathcal{O}(1000 \text{ s}) \)

Time constant of transient \( \times 1000! \)

Local Method with Pre-Scribed Poles [4]

Local Parametric Modeling:
- Local Polynomial Method (LPM)
- Local Rational Method (LRM) [3]

Local Rational Method with Prescribed Poles (LRMP)
\[
G(\Omega_\omega) = \sum_{b=0}^{N_b} \theta G(b, k) \Psi(b, \omega)
\]
\[
T(\Omega_\omega) = \sum_{b=0}^{N_b} \theta T(b, k) \Psi(b, \omega)
\]

Key Mechanism: Include poles in \( \Psi \) to remain linear in the parameters

How to incorporate prior knowledge in local \( \omega \) domain?

Experimental results

- Set 1 includes initial step response to offset
- Set 2 validation set, low transient after 20 hour

Fast and accurate FRF identification for advanced thermal modeling & control

References


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