

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

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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:

$$Y(k) = G(e^{i\omega_k})U(k) + \underbrace{T(e^{i\omega_k})}_{\text{transient}} + V(k)$$

Time Constants

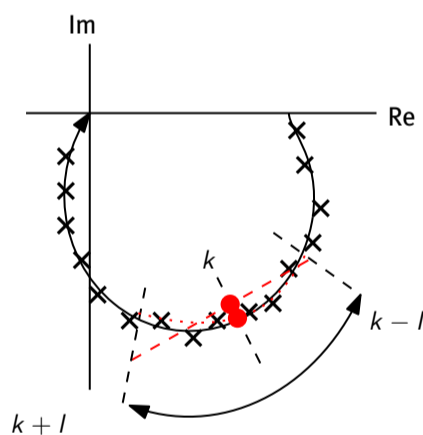
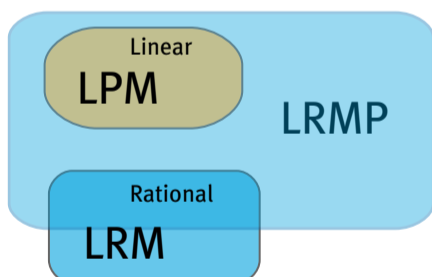
- Mechanical: $\mathcal{O}(1 \text{ s})$ $\times 1000$
- Thermal: $\mathcal{O}(1000 \text{ s})$

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]



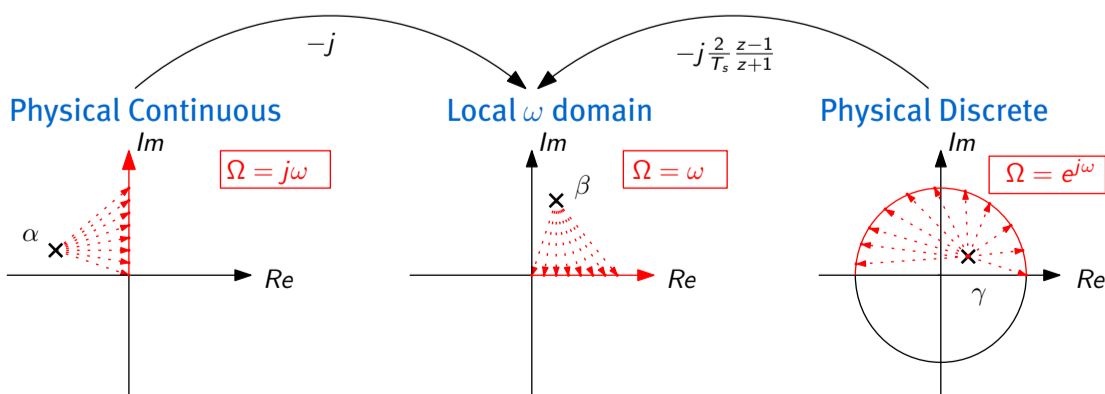
Local Rational Method with Prescribed Poles (LRMP)

$$G(\Omega_\omega) = \sum_{b=0}^{N_b} \theta_G(b, k) \Psi(b, \omega)$$

$$T(\Omega_\omega) = \sum_{b=0}^{N_b} \theta_T(b, k) \Psi(b, \omega)$$

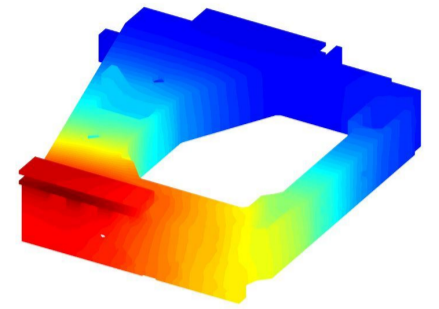
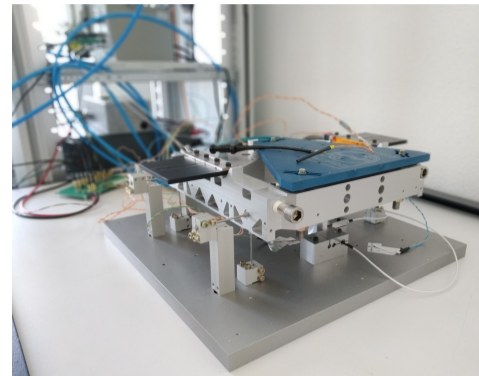
Key Mechanism: Include poles in Ψ to remain linear in the parameters

How to incorporate prior knowledge in local ω domain?

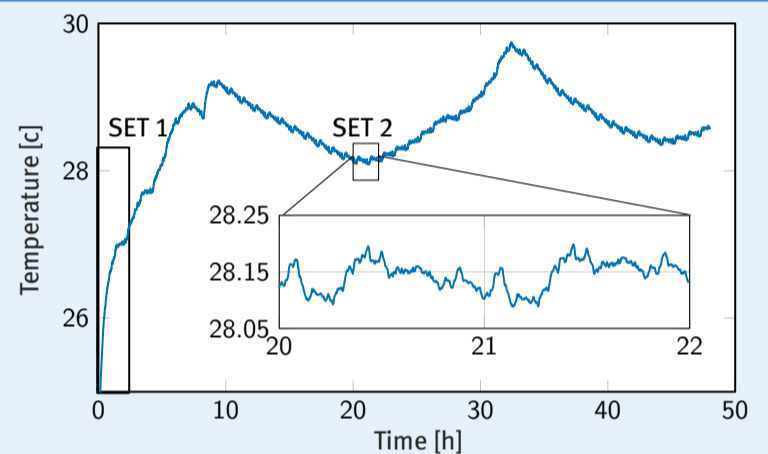


Precision stage application (PSA)

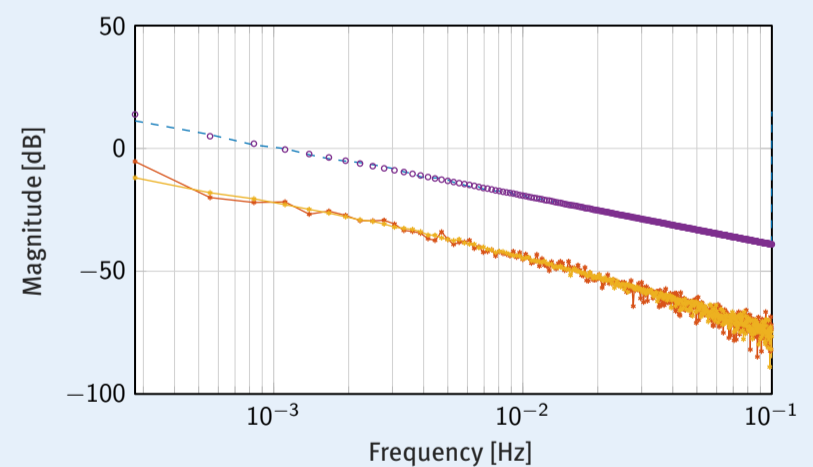
- Linear motor coil as heat source
- Multisine excitation with period of 1 hour
- Offset required, heater is positive input only



Experimental results



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



- ETE Set 1
- o Transient Set 1
- * LRMP Set 1
- * LRMP Set 2

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References

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