AI assisted high-tech systems

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Motivation

Growing challenges

Role of AI:
- Go beyond the capabilities of current engineering methods
- Efficient use of priors
- Model completion and compensatory control
- Physical explainability & guarantees

Towards hysteresis compensation

Piezo actuators based motion platform

Challenges:
- Complex hysteresis behavior
- Frequency and temperature dependency

Test results

State-space neural network

Modelling large-scale structures

Challenges:
- High-order dynamics
- Highly resonant system
- Clearance & friction nonlinearity

Test results

6-DOF high-precision motion control

Objective: Achieve nm-accurate motion of a magnetically levitated stage with high-velocity and acceleration.

Moving-magnet configuration (prototype developed with EPE)

Challenges:
- MIMO: 9 × 40
- rigid-body & commutation model (NL with position dependency)
- uncertain EM-dynamics (coil pitch, eddy currents, etc.)
- uncertain ME-dynamics (flexible modes, air damping)

Capturing complex behaviour from data

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Gaussian process based model learning:

Challenges:
- Complex nonlinear behavior during transients (op change)
- Need for model adaptation (plant changes)