Identification and Control for High Tech Motion Systems

Identification in high tech

**Man on the moon:** Automated identification and control for complex multivariable motion systems.

*From Experimental Data:* ... 
≥ 8 outputs, ≥ 6 inputs, 
≥ 10,000 freq. points

*Develop novel techniques for accurate FRF estimation*

... to a **Parametric Model:** ...
≥ 50 modes, McMillan degree

\[
\min_{\hat{P}} \left\| W(e^{j\Omega}) \left( P(e^{j\Omega}) - \hat{P}(e^{j\Omega}) \right) \right\|^2
\]

*Develop novel parametric identification tools*

... relevant for control
Robust, high-performance controller

\[
\min_{\mathbf{C}} \left\| \frac{P}{I} (I + C \hat{P})^{-1} \mathbf{C} (I + \hat{P}) \right\|_{\infty}
\]

*Use novel control relevant identification criterion*

Modelling for robust control

Control-relevant model set:
Tight bound on worst-case performance

\[
\mathcal{J}_{\text{WC}}(P, C^{\text{exp}}) < \mathcal{J}(\hat{P}, C^{\text{exp}}) + \gamma
\]

*Experimental validation on an industrial motion system*

**Inferential: predicting performance**

Performance variable \( z \) ≠ measured variable \( y \)

Accurate models for \( P_1 \) and \( P_2 \) used in controller synthesis

Inferential control in motion systems:

*Experimental study on flexible beam setup*

Actual performance \( z \)    Measured performance \( y \)

![Rede magnitude diagram, nonparametric estimate (dot), Nominal model (solid), model sets (yellow, cyan)](image)

Next-generation mechatronic design

**Vision:** Lightweight motion systems for very fast and ultra accurate positioning

**Potential problem:** Structural deformations

**Our approach:** Modelling and control of structural modes by exploiting additional actuators and sensors

**Acknowledgments**
We thank our advisors Tom Oomen and Maarten Steinbuch. Furthermore we acknowledge the contributions of Robbert van Herpen, Egon Geerardyn, many MSc. students and our colleagues from industry.