Modelling and System Identification for Model Based Control

VO 325.107 (lecture, 2.0h, 3.0EC), summer term 2024.   [info sheet as of 28th Feb. 2024]

Schedule

Unit	Calendar week	Topic
1	15	Course introduction, regression, least squares, curve fitting, introduction to neural networks, optimisation, learning.
2	16	Linear dynamic systems, systems identification of linear systems, adaptive control, introduction to nonlinear dynamic systems.
3	17	Systems identification of nonlinear systems, local model networks, blended multi-model systems, examples of utilisation of such models for control.
4	18 and 21	Nonlinear systems identification with Gaussian process models, model inversion, examples of utilisation of GP models for control.
5	21	Application of modelling techniques presented in course for industrial model-based control, course conclusions, preparation for exam.

Course Contents

The course will cover **advanced model design** and **system identification techniques** for modelling of dynamic systems in engineering practice.

The paradigms presented are tailored in such a way to **obtain models which can then be employed in model-based control strategies**. Different model-based control methodologies such as **model predictive control**, **internal model control**, **adaptive control**, etc. embody different classes of models with various types of structures and parametrisations. Since the efficiency and quality of a model-based control is strongly related to the accuracy of the internal model, it is therefore important to select a modelling technique which will generate the best possible model for particular application.
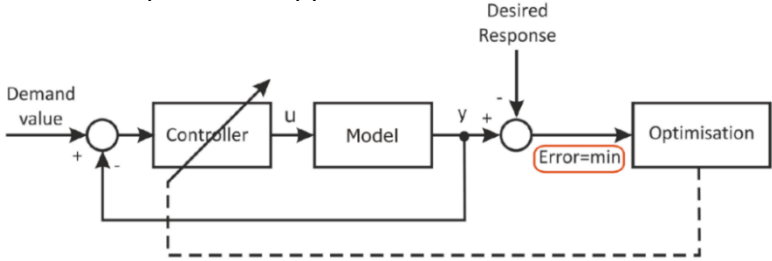
Modelling approaches such as local model networks, Takagi-Sugeno fuzzy models, neural networks and support vector machines, as well as probabilistic models like Gaussian processes will be presented. Pros and cons of each of them will be highlighted. Machine learning and adaptive algorithms for structure identification and parametrisation will be presented in detail. Difficulties related to curse of dimensionality, rank deficiency, overfitting, bias-variance trade-off and off-equilibrium dynamic will be pointed out and practical guidelines how to

overcome them will be given. Model properties such as transparency and inevitability will also be discussed.

The presented modelling techniques for model-based control will be demonstrated on **industrial examples** taken from **automotive applications and process control**.
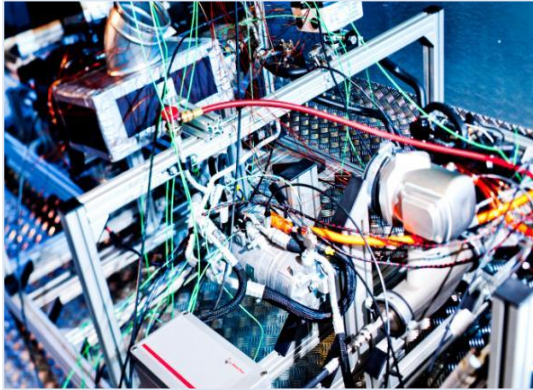
Scientific computing, simulation and animation software will extensively be used in order to provide efficient and attractive presentation of course material.

Lectures will be held in English.

Venue and Time

Lectures will be given at TU Wien, building BA, above the AudiMax, Getreidemarkt 9, 1060 Vienna, as well as online distance lectures on following dates:

Unit	Date			Time	Venue
1	CW 15	Fri	Apr 12th 2024	10:00 – 12:00	Seminar room BA08B (8th floor)
1	CW 15	Fri	Apr 12th 2024	13:30 – 15:30	Seminar room BA08B (8th floor)
2	CW 16	Tue	Apr 16th 2024	10:00 – 12:00	Online
2	CW 16	Thu	Apr 18th 2024	15:00 – 17:00	Online
3	CW 17	Tue	Apr 23rd 2024	10:00 – 12:00	Online
3	CW 17	Thu	Apr 25th 2024	15:00 – 17:00	Online
4	CW 18	Fri	May 3rd 2024	10:00 – 12:00	Seminar room BA08B (8th floor)
4	CW 18	Fri	May 3rd 2024	13:30 – 15:30	Seminar room BA08B (8th floor)
4	CW 21	Fri	May 24th 2024	10:00 – 12:00	Lecture hall GM3 Vortmann (2nd floor)
5	CW 21	Fri	May 24th 2024	13:30 – 15:30	Seminar room BA10B (10th floor)

Exam

The preferred examination mode is an **oral exam**, planned to be held in June 2024. The date and time are yet to be announced.

Lecturers

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If there are any questions, please ask in the lecture or contact us at the institute:
building BA, 5th / 6th floor above the AudiMax, Getreidemarkt 9.

- In lectures many examples are demonstrated by MATLAB/Simulink
- A special student-version of MATLAB/Simulink is available online through TU.it
- Additional MATLAB/Simulink stuff:
  - Mathworks-HP
  - „Getting Started" Book (pdf)
  - MATLAB-Einführung (Technikum Wien)