This paper was last edited on 13th April 2022

Current list of **diploma thesis** topics:

Issued	**Topic**	**Contact**	**Size**	**Preliminaries**
2021/07	An intraventricular balloon system to control the pressure-volume relationship in small animal hearts	Jakubek 32501	MSc or PA+SE	MATLAB and programming skills, Identifikation-VO
2021/07	Development of a Hardware-In-the-Loop (HIL) system to test implantable blood pumps	Jakubek 32501	MSc or PA+SE	MATLAB and programming skills, Identifikation-VO
2021/09	Geradeauslaufverhalten von Elektrofahrzeugen	Edelmann 32501	MSc	MATLAB und Programmierung, Identifikation-VO, Fahrzeugdynamik
2021/11	Predictive thermal and energy management of heavy-duty fuel cell electric vehicles: modelling and control	Ferrara 325517	MSc	MATLAB/Simulink, English, basic knowledge of automotive components
2021/12	Lithium-ion cell modelling for automotive applications	Oliveira 325524	MSc	MATLAB/Simulink, English, basic programming skills
2022/02	Optimal charging strategies for Lithium-ion cells	Oliveira 325524	MSc	MATLAB/Simulink, English, basic programming skills

Current list of **project works** and **seminar thesis** topics:

Issued	**Topic**	**Contact**	**Size**	**Preliminaries**
2021/09	Coupling and Simulation of MATLAB controllers with SUMO traffic simulator	Gratzer 325541	SE+Lab	MATLAB, Python and programming skills, fundamentals of control
2021/10	Literature research: Methods/algorithms for motion/behavior prediction of road users (vehicles, cyclists, pedestrians, ...)	Gratzer 325541	SE	basics in mechanics
2021/11	Speed and Power Prediction in a multiple model approach	Poks 325511	PA or SE+Lab	MATLAB and at least two control engineering courses
2021/12	Simulation studies of the Single Particle Model for Lithium-ion cells*	Oliveira 325524	PA or SE+Lab	MATLAB and strongly motivated, Identifikation VO is a plus
2022-03	Data-Driven MPC: Literature Research and Case Study	Stanger 325542	PA+SE	MATLAB, opt. Adaptive and Predictive Control (VO 325.036)
2022-03	Sensor-Fault-Detection: Literature Research + Development and Implementation of fault detection algorithmus for flue gas measurements	Stanger 325542	PA+SE	MATLAB
2022/03	Literature research Rotor models for a helicopter and methods for active vibration damping	Poks 325511	PA/SE+ LU	MATLAB/Simulink, State-Space formulation, modelling
2022/03	Modeling of a rotor model for a helicopter for active vibration damping	Poks 325511	PA/SE+ LU	MATLAB/Simulink, State-Space formulation, modelling

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INSTITUT FÜR MECHANIK UND MECHATRONIK
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Diploma Thesis

An intraventricular balloon system to control the pressure-volume relationship in small animal hearts

Content of the proposed diploma thesis in coorperation with The Medical University of Vienna:

The adverse remodeling of the failing heart (increase in volume) is primarily triggered by left ventricular pressure- or volume-overload. Recent studies suggest that ventricular unloading with ventricular assist devices (VADs) is one of the main stimuli that stops adverse remodeling, while partially reversing the pathologic changes. However, the exact mechanisms are not well understood, which may be attributable to the lack of appropriate animal models: On the one hand, in large animal models the VAD can be implanted, however, such experiments are expensive and cumbersome. On the other hand, small animal experiments are less costly, however, the effect of VADs on the cardiac pressure-volume relationship cannot be replicated.

The aim of this master thesis is to optimize and test a system which accurately controls the pressure-volume relationship in small animal hearts (Figure 1 left). To reduce the number of animal experiments, first an experimental system which mimics the small animal heart based on an available voice coil system (Figure 2 right) will be developed. In a next step, strategies to control the pressure-volume relationship will be designed, implemented, and tested in-vitro. Finally, the typical pressure-volume relationships during VAD support will be replicated in an isolated small animal heart and its cardiac mechano-energetics (workload and oxygen consumption) assessed.

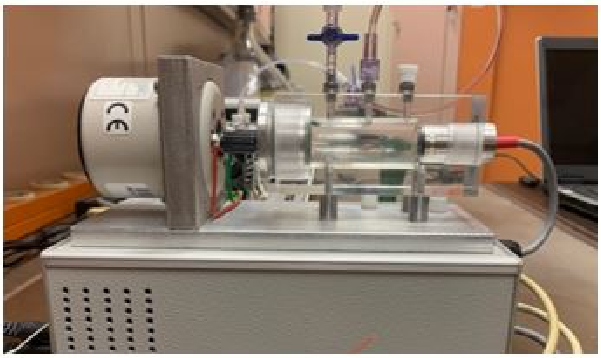

Figure 1 Left: Isolated small animal heart. Figure 2 Right: The experimental voice coil setup to mimic a small animal heart and control its pressure-volume relationship.

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In the thesis the following workpackages have to be tackled:

- Establish a numerical model of a small animal heart
- Develop an experimental model of a small animal heart based on an existing in-vitro setup
- Design, implement and evaluate strategies to control the pressure-volume relationship in-vitro
- Evaluate the most promising approach in an available isolated small animal heart

Requirements:

- Knowledge of MATLAB and programming skills
- Knowledge of modelling and system identifikation
- Sound English communication

Contact (TU Vienna):

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Vienna, April 13, 2022

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INSTITUT FÜR MECHANIK UND MECHATRONIK
Mechanics & Mechatronics

Diploma Thesis

Development of a Hardware-In-the-Loop (HIL) system to test implantable blood pumps

Content of the proposed diploma thesis in coorperation with The Medical University of Vienna:

In the past decades, the field of durable ventricular assist devices (VADs) witnessed enormous progress from large pulsatile devices towards small and durable implantable rotodynamic blood pumps (RBP). Despite this success, the market potential of VADs is far from exhausted, which may be attributable to the limited understanding and optimization of the patient-device interaction. To date, investigations of the patient-device interaction are limited to either simplified numerical simulations or animal experiments (Figure 1 left). The aim of this master thesis is (i) to develop a HIL system to test physical VADs under typical pressure/flow conditions in-vitro and (ii) to investigate the interaction between different VADs and the cardiovascular system of simulated heart failure patients.

A schematic diagram of the HIL concept is shown in Figure 1b. The HIL system simulates the hemodynamic condition within an existing numerical model of the cardiovascular system. The simulated pressures at the in- and outlet of the pump will be applied to two fluid-filled reservoirs by controlling a numerical-hydraulic interface. The measured flow rate delivered by the VAD is fed-back into the numerical model. Additionally, the fluid volume in the two reservoirs will be balanced by controlling the fluid levels with an additional pump.

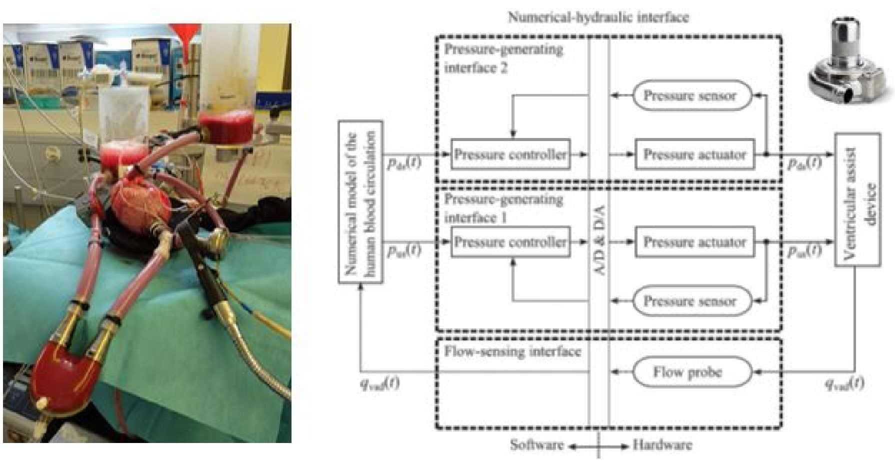

Figure 1 Left: Isolated large animal heart connected to an in-vitro circuit mimicking the human cardiovascular system. Right: A schematic diagram of the proposed HIL system to evaluate the interaction between the VAD and simulated heart failure patients.

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In the thesis the following workpackages have to be tackled:

- Assembling the pneumatic and hydraulic interface with existing hardware components
- Identify the open loop response of the hydraulic-pneumatic interface
- Design closed loop controls for (i) pressures, (ii) fluid levels, and (iii) temperature in Matlab/Simulink
- Integrating an existing numerical model of the cardiovascular system into the HIL setup
- Compare the effects of different VAD systems in simulated heart failure patients

Requirements:

- Knowledge of MATLAB and programming skills
- Knowledge of modelling and system identifikation
- Sound English communication

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Diplomarbeit

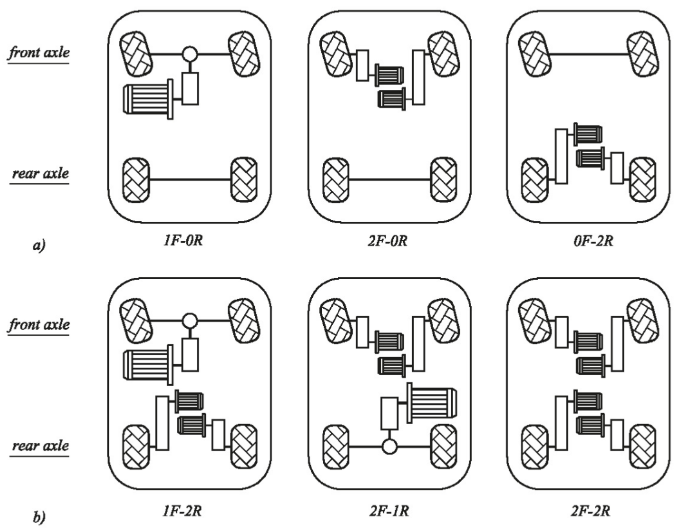
Geradeauslaufverhalten von Elektrofahrzeugen

Recherche und Implementation von ausgewählten Ursachen für mangelhaftes Geradeauslaufverhalten von Fahrzeugen mit radindividuellem Antrieb.

Inhalt und Ziel der Diplomarbeit:

Neuartige Antriebstopologien bei Elektrofahrzeugen (siehe Abbildung) ermöglichen die aktive Beeinflussung des Fahrverhaltens, der Fahrstabilität sowie der Energieeffizienz. So ermöglicht etwa torque-vectoring Fahrtrajektorien zur Unfallvermeidung, die mit konventionellem Antriebskonzepten nicht erreichbar sind. Weiters lässt sich das Fahrverhalten effizient an die (aktuellen) Wünsche und Erwartungen des Autofahrers anpassen, ohne mechanische Veränderungen am Fahrzeug vornehmen zu müssen. Zukünftig werden deshalb Fahrzeuge öfters mit radindividuellen Antriebsmotoren ausgestattet sein. Der radindividuelle Antrieb führt jedoch auch dazu, dass kleinste Abweichungen der Antriebsmomente zwischen den Antriebsmotoren den Geradeauslauf des Fahrzeuges negativ beeinflussen und das Fahrzeug bei der Geradeausfahrt „zur Seite zieht“. Um diesem störenden Verhalten beizukommen können sowohl passive (mechanisch-konstruktive) als auch aktive (regelungstechnische) Maßnahmen nützlich bzw. ausreichend sein.

Ziel dieser Diplomarbeit ist es, den state-of-the-art zu möglichen Ursachen für mangelhaftes Geradeauslaufverhalten von Fahrzeugen mit radindividuellem Antrieb zu recherchieren und ausgewählte Ursachen in einem Fahrzeug-/Antriebsstrangmodell zu implementieren. Darauf aufbauend soll eine (Regelungs)Strategie entwickelt werden, die den Geradeauslauf solcher Fahrzeuge etwa auch auf geneigten Fahrbahnen oder bei wechselnden Kraftschlussverhältnissen zwischen Reifen und Fahrbahn verbessert. Schließlich soll die Effektivität und Robustheit des Ansatzes in der Simulation und gegebenenfalls mit einem realen Testfahrzeug gezeigt werden.



Arbeitspakete der Diplomarbeit:

- Recherche von möglichen Ursachen für mangelhaftes Geradeauslaufverhaltens
- Entwicklung einer (Regelungs)Strategie
- Test und Simulation der Effektivität und Robustheit des Strategieansatzes

Voraussetzungen:

- Kenntnisse in MATLAB und Programmierung
- Modell- und Systemidentifikations Kenntnisse
- Grundkenntnisse und -verständnisse in Fahrzeugdynamik

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Wien, April 13, 2022

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INSTITUT FÜR MECHANIK UND MECHATRONIK
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Diploma Thesis

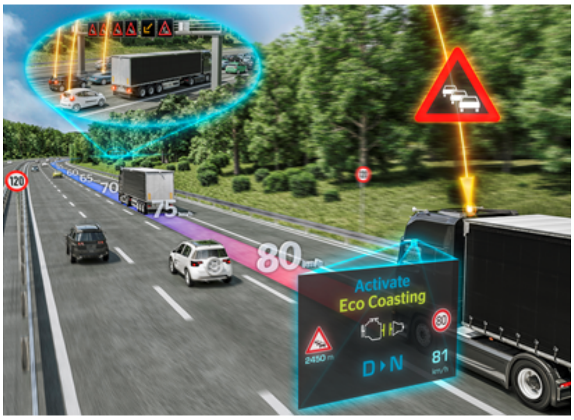
Predictive thermal and energy management of heavy-duty fuel cell electric vehicles: modelling and control

AVL

Content of the proposed diploma thesis:

Thermal and energy management are critical tasks for the advancement and commercialization of heavy-duty fuel cell vehicles. The development of predictive control strategies is under investigation to improve the vehicles' performance regarding the hydrogen economy and system lifetime.

This research topic is developed within the framework of the project HyTruck and FC4HD in collaboration with AVL.



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General tasks:

- Definition of a thesis plan (work packages, milestones, and timeline)
- Literature study of the state of the art
- Modelling in Matlab/Simulink
- Design and validation of control algorithms
- Documentation

Requirements:

- Knowledge of MATLAB
- Knowledge of model predictive control (preferred)
- Good writing/speaking skills in English
- High motivation

Contact:

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Vienna, April 13, 2022

Technische Universität Wien — Vienna University of Technology

Institut für Mechanik und Mechatronik — Mechanics & Mechatronics

Master Thesis

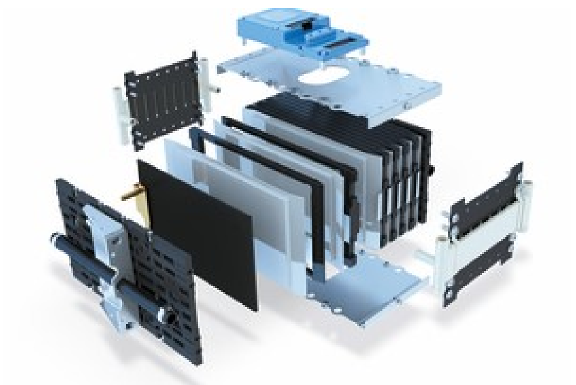
Lithium-ion cell modelling for automotive application

Content of the proposed master thesis:

Efficient and intelligent electric vehicle operation rely on the capability of estimating battery power, ageing and charge states over the vehicle lifetime. This is relevant for predictive maintenance, safety, range and being compliant with existing regulations. In order to achieve these goals, an accurate model, which is able to predict the battery behaviour under realistic current loads and operating conditions is required.

In Battery Management Systems (BMS), these cells are often modelled by simple equivalent circuits, which work well for most, but not all, existing use cases. To overcome that, more accurate and computationally expensive cell models exist.

The goal of this master thesis is to implement one of these cell models in MATLAB, namely a pseudo-2D lithium-ion cell model ("Doyle-Fuller Newman Model"), identify the model parameters and validate the results against real battery data. This will be done by investigating the sensitivity of the model parameters to check what is possible to identify from testing data and what needs to be determined a priori. Finally, the identified model will be validated against experimental data from a Battery Testbed belonging to our project partners. See picture of a depiction of a battery pack below.



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General tasks:

- Familiarize yourself with relevant literature regarding lithium-ion cell modelling
- Implement the aforementioned model in MATLAB
- Check which parameters can be identified from real driving data
- Validate and compare the identified model performance against other commonly used approaches/drive cycles

Requirements:

- Basic programming skills
- Previous knowledge on electrochemistry, system identification and finite element methods are a plus
- High motivation

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Master Thesis

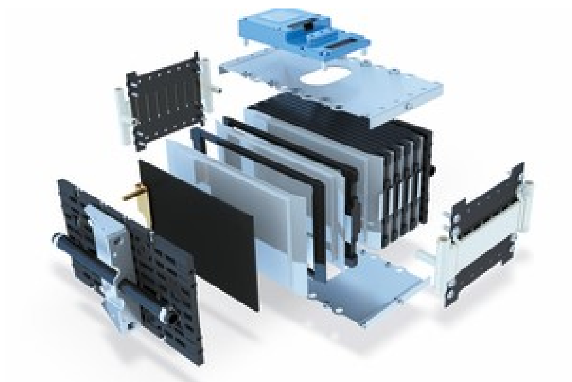
Optimal charging strategies for Lithium-ion cells

AVL

Content of the proposed master thesis:

One of the challenges involved in achieving an efficient and intelligent electric vehicle operation is to minimize vehicle downtime due to battery charging. Fast charging strategies play a crucial role in minimizing this downtime, while at the same time maintaining the operational constraints, which ensures a safe operation while keeping battery degradation in check.

This Master Thesis will investigate optimal charging strategies for Li-ion batteries, both from a time and degradation point of view. The student is expected to perform a thorough literature review and then implement a minimum-time charging optimization strategy in MATLAB, based on previously developed models and compare them to state of the art charging cycles.



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General tasks:

- Familiarize yourself with relevant literature regarding lithium-ion cell charging strategies and basics of optimal control
- Implement the charging optimization in MATLAB
- Compare the results with state-of-the-art charging strategies

Requirements:

- Basic programming (MATLAB) skills
- Previous knowledge on optimal control is a plus
- High motivation

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