TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

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.

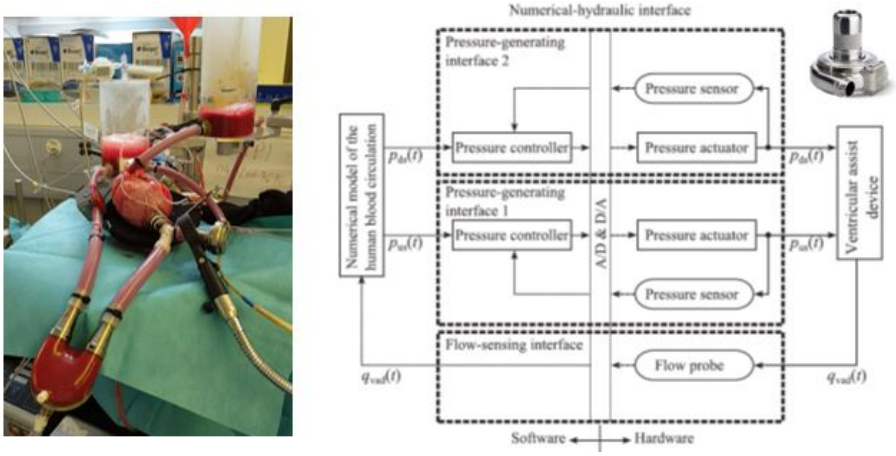

Figure 1 Left: Isolated large animal heart connected to an in-vitro circuit mimicking the human cardiovascular system. Right: A schematic diagram of the proposed HIL system to evaluate the interaction between the VAD and simulated heart failure patients.

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

Contact (TU Vienna):

Univ.Prof. Dr. Stefan Jakubek
Institute of Mechanics and Mechatronics
Division of Control and Process Automation
Technische Universität Wien
Getreidemarkt 9 / BA / 6th floor, E325-04
1060 Vienna
Email: stefan.jakubek@tuwien.ac.at

Contact (Medical University of Vienna):

Dr. Marcus Granegger
Medical University of Vienna
Department for Cardiac Surgery
Spitalgasse 23
1090 Vienna
Tel.: +43 1 40400 69490
Email: marcus.granegger@meduniwien.ac.at

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