Closed-loop Bio-Dispensing

Degree programme: BSc in Micro- and Medical Technology | Specialisation: Medical technology
Thesis advisor: Prof. Dr. Jörn Justiz, Roman Amrein
Expert: Marc Thurner (MimiX biotherapeutics Ltd)
Industrial partner: MimiX biotherapeutics Ltd., Wavre

Bio-printing is an emerging method to dispense biological cells in such a way that a desired structure can be achieved with a precise arrangement of the cells. The goal of this bachelor thesis is to implement a control loop on a prototype of a novel bio-dispensing unit of the company MimiX, so that a precise amount of biomaterial can be dispensed with an exact flow rate.

Introduction

The company MimiX together with the Bern University of Applied Sciences has developed an Advanced Dispensing System (ADS). The whole ADS is a prototype and is still in development. In bio-printing it is essential to know the exact dispensing flow rate so that the desired structure and arrangement of the cells can be achieved. The implemented control loop developed within the framework of this bachelor thesis enables thus the control of the flow rate and the dispensed amount, which is crucial in the case of bio-printing.

Concept

A thermal flow rate sensor measures and sends the actual flow rate to a microcontroller. The same microcontroller contains the control loop which computes the drive signal of the ADS. In addition, the measured flow rate is transmitted to a PC and displayed graphically in real time. A second microcontroller receives the drive signal, computes the drive timings to finally drive the ADS. Furthermore, a display shows the user the different flow rates and dispensing quantity settings. A schematic representation of the ADS is depicted in figure 1.

Control

The necessary feedback to close the control loop is obtained by a thermal flow rate sensor. To determine the most suitable controller type and control parameters, the phase and amplitude response of the ADS must be determined mathematically or experimentally. However, the ADS is a complex non-linear and dynamic system. Therefore, it is very difficult to describe it mathematically or experimentally and it is not possible to realize it within the scope of this bachelor thesis. For this reason, an iterative trial and error method is used to determine the best controller type and parameters. First a simple P-controller and in iterative steps up to a PID controller with anti-windup is implemented.

Results

Good control of the flow rate with fast response time and good disturbance suppression could be realized using different controller types yielding best results for a PID controller with anti-windup. The resulting flow rates of silicone oil with a viscosity of 50 cst controlled by a PID controller with anti-windup are shown in figure 2.

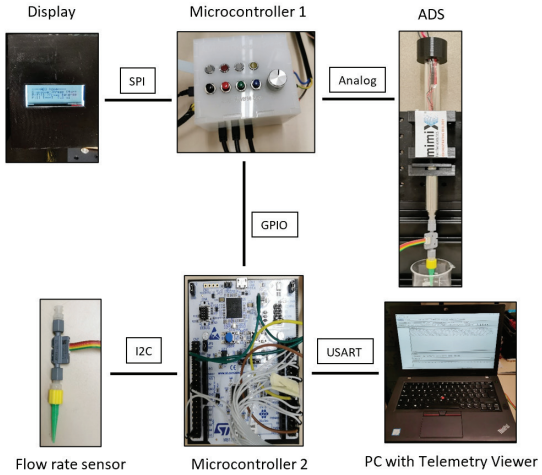

Figure 1: Schematic representation of the ADS.

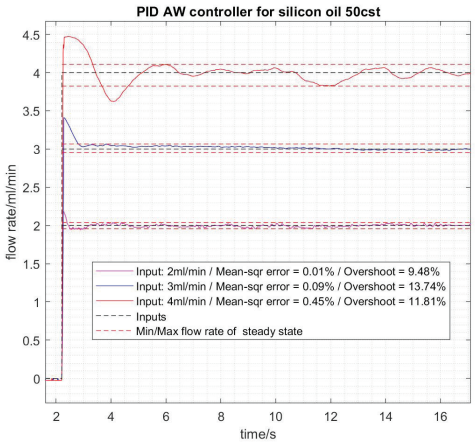

Figure 2: PID anti-windup controlled flow rates.

Julian Markus Lehmann
079 579 70 46
julian.lehmann@bluewin.ch