University of Basel
Department of Biomedical Engineering

BIROMED-Lab
Medical Robotics and Mechatronics

Master Thesis: Feasibility and effectiveness of Micro-Particle-Image-Velocimetry as a feedback for plate tilting angle control to mimic the in vivo organ blood flow rate profile for perfused Organ-on-a-Chip

Context: Organs-on-a-Chip (OoaC) are in vitro miniaturized and simplified model systems of organs. Since 2009, the OoaC approach to synthesising viable non-perfused small in vitro organs progressed significantly and is currently the most commonly used approach. The method of choice is to grow an OoaC in a gel. Most OoaC engineering in academic research is carried out manually and is, therefore, labour-intensive. The perfusion is critical to nourish cells with nutrients and transport drugs. Methods to generate perfused OoaC e.g. using a tilting station, have been developed but the perfusion flow rate profile does not mimic human organ in vivo blood flow rate profile. We aim at allowing a controlled flow rate by using feedback on the current flow rate to control the angle of the tilting stage so that the static pressure difference between two reservoirs placed at opposing sides of the stage can be adapted to drive the flow as desired. The question whether Micro-Particle-Image-Velocimetry (mPIV) is feasible and effective to measure the current culture medium flow rate in an OoaC automation context is your opportunity to work on an exciting project, which has an impact on research as well as the pharmaceutical industry.

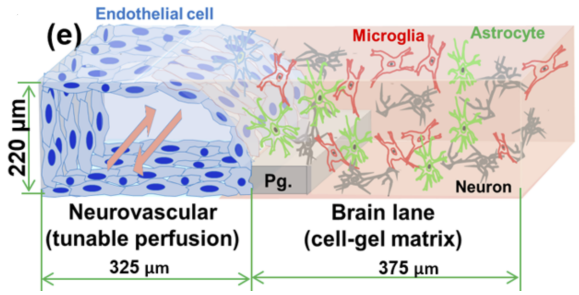

Figure 1: Schematic design of Mimetas OrganoPlate® perfusion. The culture medium flow is represented by the orange arrows.

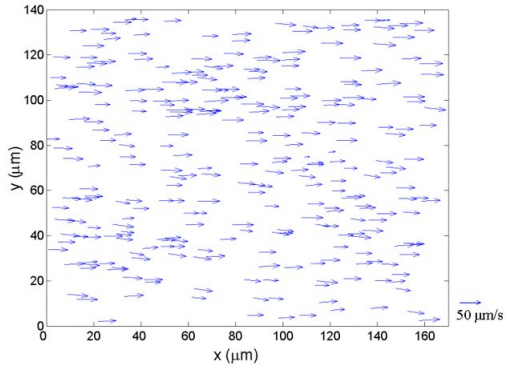

Figure 2: Example of mPIV vectors that display individual particle displacements between images taken at different times.

Task description:

You will be responsible for setup a mPIV (fig. 2) measurement that delivers the current perfusion channel culture medium flow rate to the control system of the tilting system.

Workpackages:

- review of the relevant literature on mPIV and in vivo blood flow rate profile for the liver and gut
- design mPIV algorithm(s) and assess their feasibility for OoaC with respect to the existing device (microscope, tilting stage, and software platform)
- implement and test your mPIV algorithm(s)
- integrates your developed algorithm(s) into the current control system as feedback for the tilting stage
- validate that your algorithm allows controlling the culture medium flow rate using the tilting stage

Start: FS 2023 or upon agreement with the student
Duration: 6 months

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fig. 1: Liu L, Koo Y, Akwitti C, Russell T, Gay E,Laskowitz DT, et al. (2019) Three-dimensional (3D) brain microphysiological system for organophosphates and neurochemical agent toxicity screening.
fig. 2: Devasenathipathy, S., Santiago, J. (2005). Electrokinetic Flow Diagnostics. In: Breuer, K.S. (eds) Microscale Diagnostic Techniques. Springer, Berlin, Heidelberg.