Open-source microfluidic flow regulation hardware

1 CONTEXT

Actuation (pumping) and regulation (valves, flow rate sensors etc.) are essential components to any microfluidic flow chemistry setup. The goal of this project is to develop a portable (battery-powered), user-friendly, remote-controlled (wireless communication) valve & flow sensor box that can control up to 8 solenoid valves. The developed flow regulation box must be compatible with the existing microfluidic infrastructure at the Department of Electronics (pumping, chips etc.). The project includes electronics, software and enclosure design, 3D printing mechanical parts, as well as simulated (CFD) and/or experimental flow characterization. The thesis topic can be taken by both BSc and MSc students, objectives for an MSc thesis are separately marked. Upon successful completion of all MSc thesis objectives, results will be used in project PRG620 and will be published on GitHub as open-source hardware.

2 OBJECTIVES

- Research existing literature on microfluidic flow regulation (valves, sensors etc.), understand the basics of microfluidics
- Getting familiar with existing pumping equipment, chips, as well as previous results on flow regulation at the Department of Electronics
- Evaluate existing technological solutions to the problem of microfluidic flow control, assess and compare performance
- Building on previous results, develop breadboard valve controller prototype and demonstrate applicability to the existing microfluidic infrastructure
- [MSc thesis] Develop breadboard flow sensor prototype and demonstrate applicability to the existing microfluidic infrastructure
- [MSc thesis] Combine parts on a single PCB, design and implement 3D printed device enclosure
- [MSc thesis] Develop user interfaces, battery management, wireless communication
- [MSc thesis] Demonstrate the valve controller as part of a droplet microfluidic setup (related to project PRG620)

3 PREREQUISITES

- PCB design and microcontroller programming (embedded C preferably)
- Prior knowledge of CAD is an advantage
- Interest in microfluidics and Lab-on-a-Chip research
- Self-motivation and the ability to work independently

4 REFERENCES

1. Y. Liu and X. Jiang, “Why microfluidics? Merits and trends in chemical synthesis,” Lab Chip, vol. 17, no. 23, pp. 3960–3978, 2017.
2. T. S. Kaminski, O. Scheler, and P. Garstecki, “Droplet microfluidics for microbiology: Techniques, applications and challenges,” Lab Chip, vol. 16, no. 12, pp. 2168–2187, 2016.
3. Pardy, T.; Sink, H.; Koel, A.; Rang, T. Development of a Low-Cost, Wireless Smart Thermostat for Isothermal DNA Amplification in Lab-On-A-Chip Devices. Micromachines 2019, 10, 437.

5 CONTACTS

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Thomas Johann Seebeck Department of Electronics supports equal opportunities; female students are particularly encouraged to contact us.