Development of a new, cost effective, point-of-care diagnostic (evaluation) system

Research / Thesis project

Computational Systems Biology group, D-BSSE, ETHZ

Anticipated start date: 2023

Background and Objective

Quantification of a diagnostic test result and its digitalization is crucial in modern medical diagnostics. A plethora of dedicated readers, that often can only be used with a single specific test have been developed[1–4]. Generalization, modularization and the usage of wide spread, cost effective resources for such readers would lower the costs (during development and final usage) and increase the throughput in (point-of-care) diagnostics. However, such readers require high standards in terms of the sensitivity, accuracy and reproducibility of a test result under various circumstances. In this project we consider a in-house developed modular camera calibration system (MCCS) in combination with a test system as a starting point to test several different camera sensors (mobile industry processor interface (MIPI) cameras) for their applicability for such readers. With a focus on pixel size, gain, ISO and shutter speed for controlling the sensor, different optics and sample to camera distances. To validate the various combinations, we consider systematic evaluation using standardised LEDs and calibrated light intensity meters. Additionally suitable lateral flow systems will be evaluated and characterized for suitability. Finally the best performing prototype (Software-Hardware interface) will be applied to an immunoassay detecting a protein biomarker in blood.

Project tasks

1. Familiarization with the in-house developed MCCS hardware and lateral flow systems.
2. Implementation of a software library for the automatic control and readout of the camera sensors.
3. Optimization of the software-hardware interface (software, camera, microfluidic system).
4. Creation of an experimental design plan for systematic evaluation of the required parameters.
5. Run experiments with appropriate statistical analysis of the results.
6. Evaluation of the best performing system using an established immunoassay. Determine an initial LOD and CV.

General:

The project or thesis will include a written report (in English language, with critical assessment of the work) and an oral presentation of the work in our group. Additionally, we expect comprehensible written, test driven code development using version control. The delivered code and hardware will be tested for the expected functionality and the aforementioned criteria prior to the project/thesis evaluation. The project/thesis is part of a collaboration with an industry partner and other research institutes. A suitable candidate will have to sign a confidentiality agreement and keep the work confidential.

Required skills:

Good rapid prototyping skills (3D design & printing); Good programming skills (OOP), preferentially experience with Java and Python (C++); basic knowledge in Optics, camera sensors, image generation and processing and electronics; basic knowledge in microfluidics; basic knowledge in diagnostics; basic knowledge in statistics and experimental design.

Contact

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References:

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3. Wood, C. S. *et al.* Taking connected mobile-health diagnostics of infectious diseases to the field. *Nature* **566,** 467–474. ISSN: 14764687. http://dx.doi.org/10.1038/s41586-019-0956-2 (2019).
4. Cuny, A. P., Rudolf, F. & Ponti, A. pyPOCQuant — A tool to automatically quantify Point-Of-Care Tests from images. *SoftwareX* **15,** 100710. ISSN: 23527110. https://doi.org/10.1016/j.softx.2021.100710 (2021).