Developing an impedance sensor in microfluidic channels for smart biosensor lab-on-a-chips

Master thesis project | Neuromorphic Engineering

Introduction | smart lab-on-a-chip

Microfluidic lab-on-a-chip devices can be used to **analyse locally** and on a small scale biological markers such as cells, but also ions, proteins or other molecules. The need for such rapid **point–of-care** devices originates from need to be able to test conveniently and immediately at the patients desire. However, some properties of these biomarkers can be ambiguous which result in unclear testing.

Brain-inspired (**neuromorphic**) computing has recently demonstrated major advancements in pattern and image recognition as well as classification of unstructured (big) data [1]. These **neural networks** are ideal for classifying difficult ambiguous data such as biomarkers or cells.

Despite a number of notable examples in which neural networks are implemented in **healthcare**, such as recognising skin cancer from images, the unprecedented efficiency and wide applicability of **machine-learning** has not been demonstrated to date, and can open up a new multi-disciplinary field of research with numerous pioneering point-of-care applications.

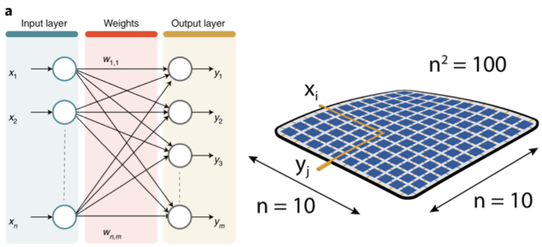

Fig. 1. Schematic of the crossbar array of the smart lab on a chip to be developed.

Project | impedance sensor in microfluidic channel

We want to exploit the remarkable efficiency of these neural networks [1] in a dedicated lab-on-a-chip to **recognise and classify** circulating tumour cells (CTC) in blood (Fig 2). For that multiple sensor inputs to the neuromorphic array on the lab-on-a-chip are necessary. Here, one of those sensors will be developed. The **impedance sensor** will be fabricated close to a microfluidic channel. The project will consist of the fabrication of microfluidic channels as well as the sensor. An example of an inline impedance sensor can be found in Fig 3.

Electrical measurement using LabView and relevant hardware is required. Simple polystyrene beads will be assessed and classified according to size before moving to **biological cells**.

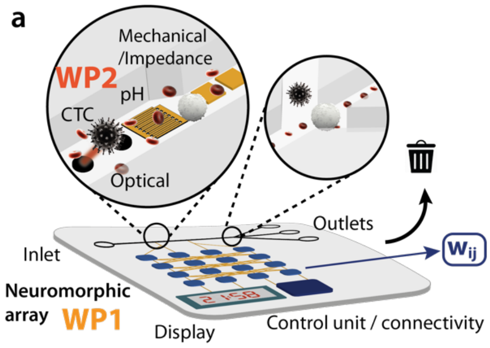

Fig. 2. Complete smart Lab-on-a-chip including integrated sensors

Goal | milestones and achievements

The goals of this project are:

1. To develop a microfluidic chip with integrated impedance sensor.
2. Test the sensor with microbeads/cells

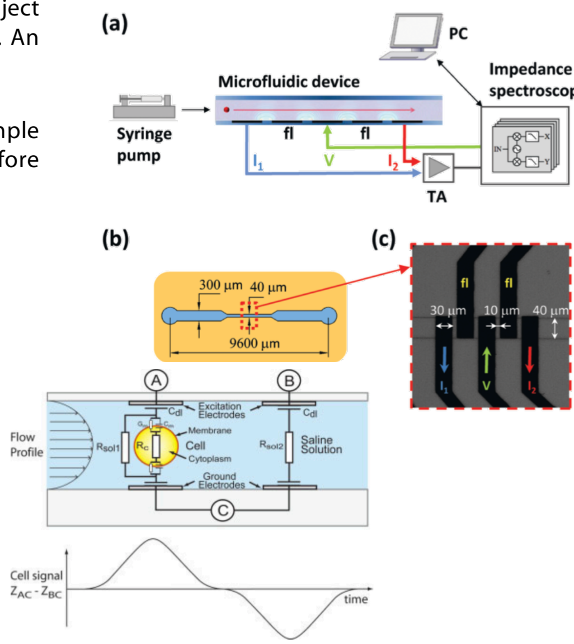

Fig. 3. Example of microfluidic impedance sensors and signals [2,3]

References

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2) Coplanar electrode microfluidic chip enabling accurate sheathless impedance cytometry, Ninno et al. **Lab on a Chip** 2017.
3) Impedance Spectroscopy Flow Cytometry: On-Chip Label-Free Cell Differentiation, **Cytometry Part A**, 2005
4) Organic electrochemical transistors for cell-based impedance sensing, Rivnay et al. **Applied Physics Letters** 2015

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