micro systems

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Optical cell detecting in microfluidics for smart biosensor lab-on-a-chips

Master thesis project | Neuromorphic Engineering

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 convenientely 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.

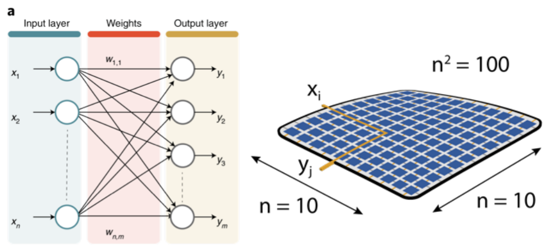

Fig. 1. Schematic of the crossbar array of the smart lab on a chip to be developed.

Project | optical photodetector 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 **optical sensor** will be fabricated close to a micro-fluidic channel. The project will consist of the fabrication of microfluidic channels as well as optical sensor (Fig 3).

Electrical measurement using LabView and hardware is required. Simple polystyrene beads will be assessed and classified according to size before moving to **biological cells**. Using laser light through a waveguide in combination with an optical 4-quadrant sensor, our group previously demonstrated it is possible to combine this sensor output with neural networks to classify different types of algae, see ref [3].

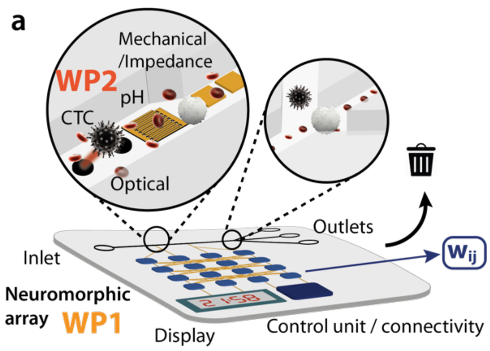

Fig. 2. Complete smart Lab-on-a-chip including integrated sensors

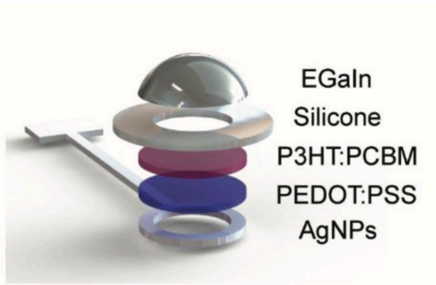

Fig. 3. Example of printable photodetector [2]

Goal | milestones and achievements

The goals of this project are:

1. To develop a microfluidic chip with integrated optical sensor.
2. Test the sensor with light pulses and microbeads/cells.
3. Integrate an OLED as *in situ* light source.

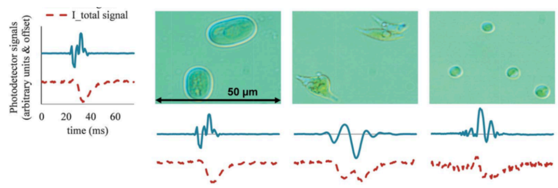

Fig. 4. Algae detected by a 4-quadrant photodetector [4]

References

1) Organic Electronics for Neuromorphic Computing, Y van de Burgt, et al. **Nature Electronics**, 2018
2) 3D Printed polymer photodetectors, **Advanced Materials**, 2018
3) Optical classification of algae species with a glass lab-on-a-chip, **Lab on a chip**, 2012

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