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HARDWARE PLATFORM FOR MACHINE LEARNING:

All-Optical neuromorphic computing circuits for cell sorting and ultrafast BITstream processing

NB-photonics, a consortium of research laboratories of Ghent University, is seeking partners interested in Photonic Reservoir Computing, a novel neuromorphic computing paradigm with applications in high-speed low-power processing of telecom signals, as well as cell type identification in holographic imaging.

Introduction

Reservoir computing is a neuromorphic technique to efficiently classify digital (e.g. bitstreams) and analog data (e.g. images). Whereas most implementations of reservoir computing are based on software, we present a hardware platform based on photonics. Our so-called "photonic reservoir" processes optical signals. These can carry extremely high amounts of data, more than any electrical signal can convey. The photonic reservoir is **unique** in its processing **speed** and can work with **very little power**. We have the IP and know-how to build an **affordable photonic reservoir** and are actively looking for **partners for industrialization**.

Technology

Researchers at Ghent University have developed a hardware platform based on **Silicon Photonics technology** for reservoir computing. Silicon Photonics technology emerged as the go-to technology for optical data processing in large datacenters of internet giants such as google and facebook. We exploit this technology platform to build affordable and scalable photonic reservoirs. The photonic reservoir mimics the operation of the brain for solving complex tasks and is essentially a small, flat semiconductor chip known as a photonic integrated circuit (PIC). The photonic reservoir is **flexible to design** and can be **trained for a variety of tasks**.

Applications

A photonic reservoir can work as a low-power high-speed **classifier** of objects (e.g. for cell sorting. The technology is also particularly well suited to **process light signals** containing high-speed (e.g. >200 GB/s) data in advanced coherent modulation formats (e.g. header recognition or non-linear dispersion compensation).

Advantages

The photonic reservoir itself does **not consume any power** and can do data processing at **high bit rates** far beyond what is currently possible in software. The proposed hardware implementation is **reliable** and can readily connect to standard tele- and datacom equipment. In a life-science context, it can entangle very complex datasets. Given that the photonic reservoirs are made cost-effectively, **parallel processing** of multiple sensor data streams is also possible. All of this can be done in the optical domain, without the need for electro-optic conversions which are costly in terms of latency, power consumption and chip real estate.

State of development

The technology has been validated experimentally in the lab for basic speech and header recognition and in simulation with real-life data from cell sorting experiments.

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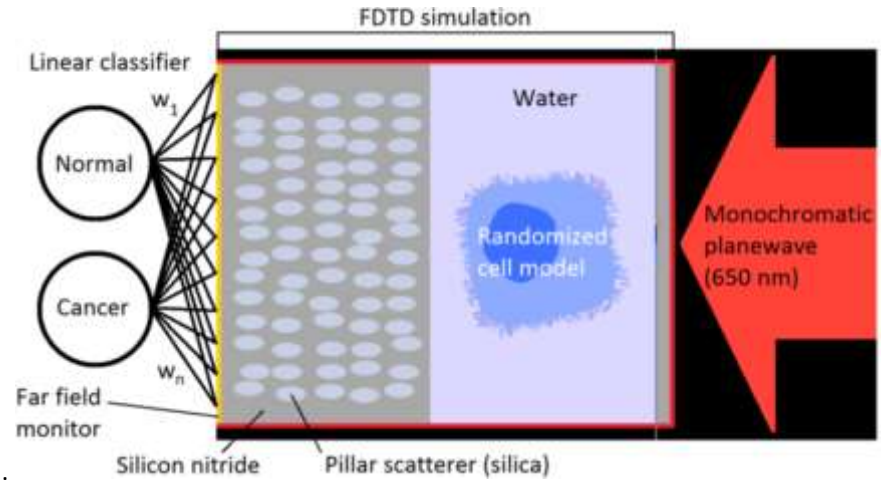
Partnership

We are seeking companies interested in commercializing our photonic reservoirs through a patent license or a collaborative research project.

Intellectual property

Patent title: Reservoir Computing Using Passive Optical Systems. European patent application EP2821942 and granted US patent US9477136 covering the basic concept of an integrated photonic reservoir.
In addition we filed for three additional patents that are key to make the invention work in practice, especially with respect to scalability and for applications like cell sorting.

Figure



Example of a Photonic reservoir to detect cancerous cells (patent pending)

References

K.T Vandoorne et al., **Experimental demonstration of a reservoir computing on a silicon photonics chip**, Nature Communications, 5, p.1-6 (2014)
Alessio Lugnan et al., **Integrated pillar scatterers for speeding up classification of cell holograms,** Opt. Express 25, 30526-30538 (2017)

Keywords

Photonic reservoir, Silicon Photonics, optical neural systems, neuromorphic computing

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