HORIZON 2020

Functionally scaled computing technology: From novel devices to non-von Neumann architectures and algorithms for a connected intelligent world

Results in Brief

Defining the future of information processing and memory technology

With the support of EU funding, researchers developed new forms of computer hardware ready to answer the demands of big data and artificial intelligence.

DIGITAL ECONOMY

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The future of information processing and memory technology is being shaped by the internet of things and big data.

"The ever increasing demands of ubiquitous computing requires small, flexible, power-efficient connected devices," says C. David Wright, a professor of Electronic and Computer Engineering at the University of Exeter.

"While the rise of big data is pushing us to develop faster, less power-hungry, and more intelligent hardware and software processing that will let us extract and utilise relevant information from this abundant data."

Answering both demands is the EU-funded Fun-COMP project.

Computing in the age of AI

The goal of the project was to develop new forms of computer hardware suited to the age of big data and artificial intelligence (AI). “Our aim was to develop a new wave of industry-relevant technologies capable of extending the limits facing mainstream processing and storage approaches,” explains Wright, who served as the project coordinator.

To accomplish this, researchers focused on nanophotonics, or the use of devices and systems for manipulating light at the nanoscale.

According to Wright, the innovative nanophotonic devices and systems developed during the Fun-COMP project fuse together the core information processing tasks of computing and memory. They also incorporate in hardware the ability to learn, adapt and evolve.

“By designing solutions from the bottom up, we were able to take advantage of the huge benefits, in terms of increases in speed and bandwidth and reduction in power consumption, promised by the emergence of silicon photonic systems,” adds Wright.

Processing at the speed of light

One of those solutions is an entirely new form of photonic co-processor, also known as a tensor processor unit, or TPU. “This TPU can carry out the matrix-vector multiplications used by AI at speeds orders of magnitude faster than today’s state-of-the-art special purpose electronic processors,” notes Harish Bhaskaran, a professor at the University of Oxford, a key Fun-COMP partner.

Researchers also successfully developed the first-ever, all-optical phase-change spiking neurosynaptic photonic processing chip. By incorporating interconnected hardware photonic neurons and synapses, the chip can conduct both supervised and unsupervised learning.

Another important outcome was a novel photonic correlation processor that can be used for unsupervised correlation detection on real-world data streams.

“This processor could prove very useful for such tasks as social media analysis, financial forecasting, and detecting anomalies in data centres,” remarks Abu Sebastian, a researcher at IBM Zurich, one of the project’s main industrial partners.

World-leading innovation

Together, these outcomes have firmly placed integrated phase-change photonics as a ‘hot’ research field for the development of future computing and communication technologies.

“Thanks in part to the exciting results coming out of the Fun-COMP project, leading research groups from around the world are now working in this field,” concludes Wright.

Governments are also investing in the field. In fact, Wright and other researchers involved in the Fun-COMP project are now further developing the photonic TPU hardware via the EU-funded Phoenics project, which is led by Wolfram Pernice, a professor at Heidelberg University.

Other Fun-COMP partners and researchers have established the Oxford-based spin-off company Salience Labs, which is working to commercialise some of the project’s ideas.

Fun-COMP’s results have also been presented at 38 conferences and published in 41 journal papers, including such prestigious titles as ‘Nature’, ‘Nature Nanotechnology’, ‘Science Advances’, and ‘Optica’.

Keywords

Fun-COMP | technologies | information processing | memory technology | computer hardware | big data | artificial intelligence | AI | internet of things | connected devices | software | nanophotonics | tensor processor unit

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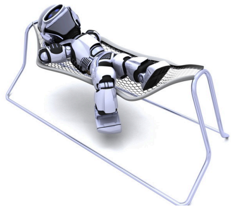

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Project Information

Fun-COMP

Funded under

Grant agreement ID: 780848

Project website

DOI
10.3030/780848

Project closed

EC signature date
23 November 2017

Start date
1 March 2018

End date
31 August 2022

INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies - Information and Communication Technologies (ICT)

Total cost
€ 3 996 951,25

EU contribution
€ 3 996 951,25

Coordinated by
THE UNIVERSITY OF EXETER
United Kingdom

Last update: 20 January 2023

Permalink: https://cordis.europa.eu/article/id/442778-defining-the-future-of-information-processing-and-memory-technology