Photo-Chemical Adaptive 3D Systems for Next Generation Neuromorphic Computing

Initiative: NEXT

Ausschreibung: Neuromorphic Computing

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Twenty-first century society is fundamentally data-hungry and the demand for energy efficient and scalable information processing solutions is under exponential growth. Neuromorphic hardware is inspired by the brain structure and functionality to overcome this major challenge to conventional computing. In this project we propose a novel hardware platform for neuromorphic computing based on photochemical systems that offers unique advantages in terms of scalability, plasticity (i.e., adaptation for learning) and integrability. Photonics provides energy-efficient and scalable solutions with potential for on-chip integration, while soft matter biochemistry enables optical plasticity by controlling light with light. For the first time, our interdisciplinary approach interconnects three solid research lines carried out at our respective laboratories in Mainz, Trento, and Glasgow. We propose the following clear work plan: First we will develop micropatterned photosensitive hydrogels capable of complex reversible changes in their physical and chemical properties when subject to light patterns. Next, we will use the mm-size bulk hydrogel unit to implement large-scale optical networks with synaptic plasticity, where the local connectivity preserves memory of the past optical inputs. In parallel but with a more applied mindset, we will develop photonic devices with enhanced functionalities provided by the hybrid microscale integration with hydrogels for future scalable photonic neural networks. Finally, we will explore chemical information transfer mechanisms in hydrogels based on uncaging chemicals upon light irradiation, with the objective to understand and exploit the complex spatiotemporal dynamics in hydrogels for future multisensory applications.

Projektbeteiligte

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