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Restoring Vision Through Electrical Stimulation

In a project under Horizon 2020, researchers from seven European organizations will examine how the vision of visually impaired people can be restored using electrical stimulation of the brain. The project is being coordinated by the University of Zurich and supported by the European Union with funding of 4 million euros.

If a project receives funding from the European Union, it must involve excellent science in innovative and promising interdisciplinary research fields that provide new and relevant ideas for industry and society. The international Neural Active Visual Prosthetics for Restoring Function project meets all these criteria and has been awarded an EU research grant totaling 4 million euros over four years. The project will kick off on 1 September 2020 and is being coordinated by Prof. Shih-Chii Liu at the Institute of Neuroinformatics of the University of Zurich.

Working in interdisciplinary teams from seven European universities and institutions with complementary expertise in computational, systems and clinical neuroscience, materials engineering, microsystems design and deep learning, the project will develop technology to restore vision of blind people through electrical stimulation of the brain.

Close interdisciplinary cooperation

The aim of the project is to develop a neuroprosthesis with thousands of electrodes driven by adaptive machine learning algorithms for a new brain-computer interfacing technology. “We want to create a novel neuroprosthesis system that is lightweight, robust and portable, and which will remain effective for decades,” explains Shih-Chii Liu. Current systems only stimulate a small set of neurons in the brain, and interfaces have a longevity of only a few months.

Liu is convinced that the project will succeed in its goals: “All the partners have long-time experience in their respective fields, so the required background knowledge is already in place. The breakthroughs will come with the planned larger scale efforts and partner interactions in this project.” The challenge will be coordinating the expected breakthroughs across multiple disciplines.

Establishing innovation

These breakthroughs include innovative approaches for stimulation with high-electrode-count interfacing with the visual cortex. For this, thin flexible probes are needed that cause minimal tissue damage as well as new electrode coatings and novel microchip methods. The researchers will also channel the stimulation currents to many thousands of electrodes and monitor neuronal activity in higher cortical areas.

Breakthroughs are also expected when it comes to artificial neural networks trained by deep learning, which will only extract the most relevant visual information from a camera input to enable blind individuals to recognize objects and facial expressions and navigate through unfamiliar environments. These networks will transform the camera footage into stimulation patterns that drive the neurons in a way that the blind person can interpret. This is the only way that the signals can be processed and passed on. At the same time, eye tracking will be used to improve perception in a closed-loop approach.

Algorithm translates stimulation patterns

In addition to coordinating the project, the University of Zurich is also contributing through its technological expertise. The neuroinformatics team of Shih-Chii Liu and Tobi Delbruck will be working with consortium partners to develop power-efficient neuromorphic deep learning hardware and algorithms. The network implemented on the neuromorphic hardware will translate camera input into stimulation patterns to drive the stimulation electrodes.

“This research project is important because it lays ground-breaking work for constructing a new brain neuroprosthesis and brings added benefits to other neuroprosthesis research,” says Liu. The involved researchers hope that the project will raise Europe’s still relatively low profile in this research field.

The project’s seven partners

The international Neural Active Visual Prosthetics for Restoring Function (NeuraViPeR) project brings together scientists from the University of Zurich, the University of Freiburg (Germany), the Royal Netherlands Academy of Arts and Sciences, Stichting Katholieke Universiteit (Netherlands) and the Miguel Hernández University of Elche (Spain). The Flemish research institute IMEC/IMINDS and the Dutch business Phosphoenix are also involved in the project, which has an overall budget of 3,999,681 euros.

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