



University of Pavia

Ph.D. School of Microelectronics
Ph.D. School of Electrical and Electronics Engineering
and Computer Science
Ph.D. School of Bioengineering, Bioinformatics and Health Technologies

Seminar

Circuit challenges and opportunities in Brain-Machine Interfaces

Dr. Dante MURATORE
Delft University, Assistant Professor

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Abstract

Brain-machine interfaces (BMIs) of the future will be used to treat diverse neurological disorders and augment human capabilities. However, realizing this futuristic promise will require a major leap forward in how electronic devices interact with the nervous system. Current BMIs provide coarse communication with the target neural circuitry because they lack the required resolution and bandwidth. But, what exactly are the requirements for spatial resolution and bandwidth? Systems that communicate with a larger number of neurons do not achieve single-cell resolution; while high-resolution systems can only record from a limited number of neurons. Time and amplitude resolution in the electrical recording also comes at a cost in the system's bandwidth. These considerations result in a striking dichotomy in how present and future BMIs are designed that has to be considered in the context of the specific system being examined. On the one hand, works on intracortical motor BMIs show that, for current devices, spike sorting (and single-cell resolution) does not introduce a substantial increase in performance. On the other hand, as a better understanding of the neural circuitry in the motor cortex develops and new recording devices become available, different tradeoffs could apply. This is the case already in the retina, where the ability to sort spikes coming from different cells, and further sorting these cells into different cell types, is a crucial step towards high-resolution artificial retinas.

In this talk, BMIs will be introduced from a circuit designer's point of view and it will be shown how system-level aspects (e.g. to spike sort or not) drive the circuits we need to design.

Dr. Muratore will also share how he got started in this field after his Ph.D. in Microelectronics at the University of Pavia and his thoughts on what IC designers can contribute to this field.

Biography

Dante Muratore received the B.Sc. and M.Sc. degrees from Politecnico of Turin in 2012 and 2013, respectively. He received the Ph.D. degree from the University of Pavia, Italy in 2017 working on integrated sensor interfaces. From 2015 to 2016 he was a Visiting Scholar at the Massachusetts Institute of Technology. From 2016 to 2020 he was a Postdoctoral Fellow at Stanford University, USA. As of October 2020, he is an assistant professor at Delft University of Technology. His research focuses on investigating hardware and system solutions for high-bandwidth brain-machine interfaces that can interact with the nervous system at natural resolution. Currently, he is developing an artificial retina to treat macular degeneration and retinitis pigmentosa in collaboration with researchers at Stanford University. He is an excellent baker, a terrible singer, and a passionate teacher.

Organizer

Dr. Elisabetta Moisello

Seminar in English

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