Beyond CMOS technologies for enabling integrating Artificial Intelligence at the Edge

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Abstract

(1,500 – 3,000 characters)

With the increase of Artificial Intelligence (AI) in everyday life, developing AI-specific hardware based on brain-inspired computing is of utmost importance for efficient, adaptative and low-power systems. Neuro-inspired computing systems emulate the human brain's neuronal functions to efficiently solve problems that are easy to humans, such as pattern recognition. In this context, the EU H2020 NeurONN project explores a new energy-efficient computing paradigm based on phase-computing Oscillatory Neural Networks (ONN) [1,2]. It aims to create a neurocomputing chip that can be deployed on edge devices for AI [3,4,5,6].
In this talk, a novel and alternative neuromorphic computing paradigm based on oscillating neural networks (ONN) will be presented. Energy efficient relaxation oscillators based on phase-change VO_2 material for oscillating neurons and tunable 2D TMD MoS_2 memristors for synapses are the building blocks of ONN architecture. Inspired by neural oscillations or brain waves, in ONN, the information is encoded in the phase of coupled oscillators. The talk will cover aspects from materials, devices, circuits to ONN architecture design and hardware implementation and demonstration on AI tasks. To demonstrate the ONN operation, we create a robotic application using two ONNs serially (ONN 1 feeds ONN 2), configured for pattern recognition to perform obstacle avoidance. We use a robot (see Figure 1) equipped in the front with eight infrared proximity sensors.

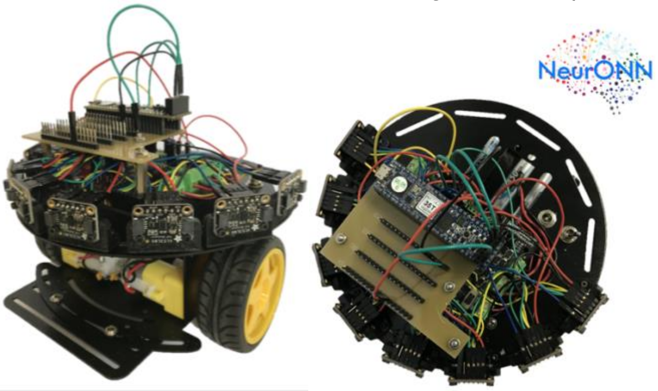

Figure 1. A mobile robot with proximity sensors controlled by an Oscillatory Neural Network (ONN) to avoid obstacles.

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[1] E. M. Izhikevich, Computing with Oscillators, Neural Networks, 2000.
[2] F. C. Hoppensteadt and E. M. Izhikevich, Pattern recognition via synchronization in phase-locked loop neural networks, in *IEEE Transactions on Neural Networks*, 2000.

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Short CV	**Aida Todri-Sanial** received the B.S. degree in electrical engineering from Bradley University, IL in 2001, M.S. degree in electrical engineering from Long Beach State University, CA, in 2003 and a Ph.D. degree in electrical and computer engineering from the University of California, Santa Barbara, in 2009. She is currently a Director of Research for the French National Council of Scientific Research (CNRS) attached to Laboratoire d'Informatique de Robotique et de Microélectronique de Montpellier (LIRMM). Dr. Todri-Sanial was a visiting fellow at the Cambridge Graphene Center and Wolfson College at the University of Cambridge, UK during 2016-2017. Previously, she was an R&D Engineer for Fermi National Accelerator Laboratory, IL. She has also held visiting research positions at Mentor Graphics, Cadence Design Systems, STMicroelectronics and IBM TJ Watson Research Center. Her research interests focus on emerging technologies and novel computing paradigms such as neuromorphic and quantum computing.
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