MIM WEBINARS

AN IN-MEMORY COMPUTING SERIES

Next Talk: 19/July/2021, 4-5:30pm CET

COMPUTING USING VOLTAGE-CONTROLLED STOCHASTICITY IN MRAM

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The adoption of magnetoresistive random access memory (MRAM) by major semiconductor manufacturers not only presents the potential to replace existing embedded memory types (e.g., initially embedded Flash and eventually, embedded SRAM) with MRAM, but also provides an unprecedented opportunity to develop unconventional computing architectures that utilize the physics of these newly available MRAM devices (i.e., magnetic tunnel junctions, MTJs) within mainstream semiconductor manufacturing platforms. In this talk we will first discuss the challenges facing existing embedded spin-transfer torque (STT-) MRAM in terms of scaling to higher bit densities while achieving speed and endurance that make it competitive against SRAM. We will then discuss how voltage-controlled (as opposed to current-controlled) MRAM cells can potentially overcome these challenges, and present our recent results in the development of voltage-controlled MRAM (VCM) cells. We then discuss how appropriately designed modified MRAM cells with low retention time can be used to fulfill unconventional roles within a computing system, notably as electrically controlled stochastic bitstream (SBS) generators. We then discuss the application of such MRAM-based SBS generators to true random number generation and to stochastic computing (SC), and present our recent results on the implementation of an SC-based artificial neural network using a series of stochastic MRAM cells [1]. Finally, we extend some of the presented ideas to more exploratory MRAM materials based on antiferromagnets, which provide immunity to large external magnetic fields, eliminate bit-to-bit magnetic interactions, and provide significantly faster dynamics, which are expected to be beneficial for both high-speed memory and stochastic computing applications [2-4].

[1] Y. Shao et al., IEEE Magnetics Letters 12, 4501005 (2021)

[2] S. Arpaci et al., Nature Communications 12, 3828 (2021)

[3] J. Shi et al., Nature Electronics 3, 92 (2020)

[4] V. Lopez-Dominguez et al., Physical Review Applied 11, 024019 (2019)

More information about the event and the speaker:
https://www.ict.tuwien.ac.at/staff/taherinejad/MiM/next.html

Mondays in Memory (MIM) is a free biweekly webinar series open to everyone around the world and dedicated to all aspects and technologies related to in-memory computing (including, in a broader sense, near-memory computing too). MIM will be held on the first and third Monday of each month (starting in May 2021) at 4pm CET (7am Pacific time, and 10pm Beijing time).
Each webinar starts with a 40mins talk by a speaker, followed up with a 40mins questions and discussions with the speaker and two panel members. Dr. Nima Taherinejad hosts the webinars, and together with his team they organize the MiM series.

Website: http://www.ict.tuwien.ac.at/ staff/ aherinejad/MiM/
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Pedram Khalili Amiri is Associate Professor of Electrical and Computer Engineering at Northwestern University, and Director of the Physical Electronics Research Laboratory (PERL). Prior to joining Northwestern, he was at the University of California, Los Angeles (UCLA). He focuses on development of spin-transfer-torque MRAM, voltage-controlled MRAM, antiferromagnetic MRAM, and unconventional computing architectures based on magnetic devices. Pedram has published more than 110 papers in peer-reviewed academic journals, and is an inventor on 15 issued patents. He and his team placed top-6 out of 3,000 entries worldwide in the Cisco Innovation Grand Challenge in 2015. He received the Northwestern University ECE department's Best Teacher Award in 2020. He has served on the technical program committees and organizing committees of numerous conferences, and is a member of the Flash Memory Summit conference advisory board. Pedram is Chair of the Chicago Chapter of the IEEE Magnetics Society, and represents the IEEE Magnetics Society on the IEEE Task Force for Rebooting Computing (TFRC) Executive Committee. He is a Senior Member of the IEEE.