MNEMOSENE
computation-in-memory architecture
based on resistive devices

Newsletter No. 1
Jan 2018 - Dec 2018
www.mnemosene.eu

MNEMOSENE at a glance

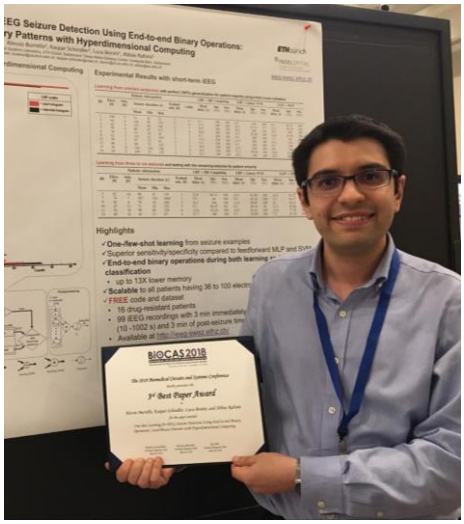
MNEMOSENE is an ambitious research and innovation action addressing the theme "*Development of new approaches to scale functional performance of information processing and storage substantially beyond the state-of-the-art technologies with a focus on ultra-low power and high performance*" of the EU's Horizon 2020 ICT research and innovation programme. The project will last 3 years and has been funded with a total of 4M €. Coordinated by Said Hamdioui at Delft Technical University (NL), the MNEMOSENE Consortium include Eindhoven University of Technology and IMEC (NL), ETH Zurich and IBM Research – Zurich (CH), Arm (UK), RWTH Aachen University (DE), INRIA (FR) and Intelligentsia Consultants (LU).

In order to meet the requirements of future electronic applications, MNEMOSENE will focus on the development, design and demonstration of a Computation-In-Memory (CIM) architecture based on extending arrays of non-volatile resistive switching devices (memristors) with logic functionality inside or around the cell array.

MNEMOSENE officially started in January 2018 and has now successfully concluded its first year of activities according to the work plan, resulting in several publications and participations to conferences and other dissemination events

News

31.10.2018 - Abbas Rahimi received best paper award at BioCAS. Dr. Abbas Rahimi, an ETH postdoctoral fellow at the Integrated Systems Lab (IIS) and member of the MNEMOSENE project, has received the best paper award at the IEEE Biomedical Circuits and Systems Conference (BioCAS) held in Cleveland (OH, USA) on 17-19 October 2018. The paper, entitled "*One-shot Learning for iEEG Seizure Detection Using End-to-end Binary Operations: Local Binary Patterns with Hyperdimensional Computing*" and partially funded by H2020 MNEMOSENE, is the result of a collaboration between the Integrated Systems Laboratory at the ETH Zurich and the Sleep-Wake-Epilepsy-Center (SWEC) of the University Department of Neurology at the Inselspital Bern.



Abbas Rahimi (ETHZ) in Cleveland (OH, US)

The paper describes the design and development of a fast learning algorithm based on hyperdimensional computing (enabling full in-memory computing) for seizure detection in epileptic patients. The algorithm learns from few seizure examples and generalizes well for unseen seizures surpassing the state-of-the-art machine learning methods. All the codes and datasets used in this work are freely available.

European Commission

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Project Meetings

MNEMOSENE officially started on Jan 1st, 2018. The Consortium organised the project kick-off meeting on Jan 25th, 2018 in Manchester (UK). Project meetings have been organised throughout the first year according to the work plan, including a project review which took place in Bruxelles (BE) at the presence of the EC Project Officer Panagiotis Tsarchopoulos and the two Monitors assisting in the project assessment (Juan Antonio Maestro de la Cuerda and Riccardo Cattaneo).

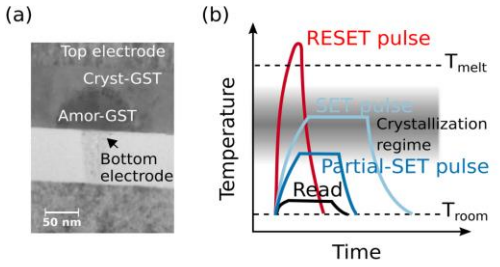
- [25.01.18] Kick-off meeting (Manchester, UK)
- [26.06.18] M6 Project meeting (Eindhoven, NL)
- [27.09.18] Technical workshop (Delft, NL)
- [11.10.18] M9 Project review (Bruxelles, BE)

Upcoming meetings

- [31.01.19] M12 Project meeting (Zürich, CH)

MNEMOSENE kick-off meeting in Manchester

MNEMOSENE technical workshop in Delft



(a) TEM image of a mushroom-type PCM device; (b) Pictorial representation of the programming pulses and the resulting relative temperature for operations in PCM (from [2]).

Publications

Less than 1 year from the project start, research supported by MNEMOSENE has already resulted in publications in peer-reviewed journals and conference proceedings. All publications have been made open access through self-archiving. Additionally, the code and datasets used for publication [3] are freely available for download on http://ieeg-swez.ethz.ch/ .

[1] *Compressed Sensing With Approximate Message Passing Using In-Memory Computing*. M. Le Gallo, A. Sebastian, G. Cherubini, H. Giefers, E. Eleftheriou. IEEE Transactions on Electron Devices 65(10), 4304 (2018).

[2] *A phase-change memory model for neuromorphic computing*. S. R. Nandakumar, M. Le Gallo, I. Boybat, B. Rajendran, A. Sebastian, and E. Eleftheriou. Journal of Applied Physics 124, 152135 (2018).

[3] *One-shot Learning for iEEG Seizure Detection Using End-to-end Binary Operations: Local Binary Patterns with Hyperdimensional Computing*, A. Burrello, K. Schindler, L. Benini, A. Rahimi. 2018 IEEE Biomedical Circuits and Systems Conference (BioCAS), Cleveland, OH (Oct 17-19, 2018).

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Dirk Wouters (RWTH) in Stanford (CA, US)

Dissemination Events

The majority of dissemination and communication activities for MNEMOSENE is expected to begin at M13 (Jan 19). Nonetheless, the Project Coordinator and other Consortium members have already started to promote MNEMOSENE during international conferences and workshops. A full list of events where MNEMOSENE was promoted is reported below.

- [22-24.01.18] Workshop on *'Memristor Technology, Design, Automation and Computing' (mDAC),* S. Hamdioui, 13th HiPEAC (High-Performance Embedded Architecture and Compilation) Conference 2018 (Manchester, UK)
- [19-23.03.18] Workshop on *'Emerging Memory Solutions & Applications: Technology, Manufacturing, Architectures, Design, Automation and Test'*, S. Hamdioui, DATE (Design, automation and test in Europe) Conference 2018 (Dresden, DE)
- [20.09.18] Invited Talk: *'Computation-in-Memory: Hope or Hype?'*, S. Hamdioui, TalTechDigital Vision Conference (Tallinn, EE)
- [20-21.09.18] Invited Talk: *'Memristive devices for Emerging Computing Paradigms'*, S. Hamdioui, 8th MemoCIS Workshop (Dresden, DE)
- [24-26.09.18] Invited Talk: '*Memristive devices for Computation-in-Memory: Dream or Reality*?', S. Hamdioui, 12th European Workshop on Microelectronics Education (Braunschweig, DE)
- [04-05.10.18] MNEMOSENE Poster presentation, D. Wouters, 8th International Workshop on Resistive Memories (Stanford, CA, US)
- [08-10.10.18] Panel Session: *'Computation-in-Memory: Hope or Hype?'*, S. Hamdioui, 26th IFIP/IEEE International Conference on Very Large Scale Integration (Verona, IT)
- [17-19.10.18] Poster Session: *'One-shot Learning for iEEG Seizure Detection Using End-to-end Binary Operations: Local Binary Patterns with Hyperdimensional Computing'*, A. Rahimi, 2018 IEEE Biomedical Circuits and Systems Conference (Cleveland, OH, US)

Upcoming Events:

- [21-23.01.19] Workshop on *'Memristor Technology, Design, Automation and Computing' (mDAC),* S. Hamdioui, 14th HiPEAC (High-Performance Embedded Architecture and Compilation) Conference 2018 (Valencia, ES)
- [25-29.03.19] *Paper (in preparation)*, S. Hamdioui et al., DATE (Design, automation and test in Europe) Conference 2018 (Florence, IT)

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