Politecnico di Torino

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ELECTRICAL, ELECTRONICS AND COMMUNICATIONS ENGINEERING

PNRR - Memristor Dynamic Neural Networks for Additive Manufacturing

Funded By	MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Politecnico di TORINO [P.iva/CF:00518460019]
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Context of the research activity	In the last decade, the embedment of networking technology and sensors within advanced networked services for smart city and Additive Manifacturing (AM) applications has generated a massive explosion of data. The retrieve of relevant information from massive amount of data will soon be impossible with conventional computers due to physical limitations. Radically novel platforms of intelligent electronic systems will be developed with potential use in: (a) Energy analytics for zero-waste; (b) monitoring and adaptive control of AM processes. PNRR M4C2, Investimento 1.3 - Avviso n. 341 del 15/03/2022 - PE0000004 3A-ITALY Made in Italy circolare e sostenibile - E13C22001900001 (Spoke 6)
	In the last decade, the embedment of networking technology and sensors within advanced networked services for smart city and Additive Manfactuitng (AM) applications (e.g. environmental and weather monitoring, in-situ and in-line monitoring of AM processes) has generated a massive explosion of data. The retrieve of relevant information from massive amount of data will soon be impossible with conventional computers due to physical limitations. Memristor Dynamic Neural Networks for Additive Manufacturing represent innovative cognitive computing platforms exploiting the disruptive memristor technology for the treatment of massive amount of data making use of dynamic neural networks and machine learning algorithms. The proposed platform shows a number of considerable benefits in terms of processing time, area consumption and power dissipation in comparison to conventional high-performance computing platforms. The research activity in Memristor Dynamic Neural Networks for Additive Manufacturing is based on two pillars: - crossbar arrays of memristor devices;

Objectives	- machine algorithms for dynamic neural networks. The project work-plan is articulated into two temporal phases interrelated with the main pillars: (1) Specification and Fundamental Developments; (2) Technology Refinement and Proof-of-Concept. In particular, Phase 1 (Year 1) deliverables are cast as: - Development of analytical and numerical techniques for design and analysis of memristor crossbar arrays; - Development of architectures for dynamics neural networks exploiting memristor arrays. Phase 2 (Year 2 and Year 3) deliverables are classified as: - Integration and fabrication of the design modules into a miniaturized platform prototype; - Evaluation of the performance metrics of the prototype platform in selected AM applications. The milestones of the reasearch activity are: Milestone 1: we expect to estimate the efficiency (in terms of computing capability, power consumption and near real time processing feature) of the platform in pattern recognition tasks (advanced damage detection and damage reconstruction algorithms). Milestone 2: the proof-of-concept demonstrator will be crucial to show that feasibility in real application of highly-sensorized AM procesess. The results of this project can have a tremendous social and economic impact for future electronic devices devoted to intelligent AM techniques exploiting a massive amount of data in near real time. Transmitting data to the cloud is a power-hungry operation. Local data processing is preferred as it reduces the frequency of data transmission to the cloud. By eliminating the need for expensive controllers or complex memory management, Memristor Dynamic Neural Networks provide a radically new innovation through zero-waste power and high-density integration.

Skills and competencies for the development of the activity	Analog Electronics and Neural Networks Memristor Technology Micro and Nano Electronic Devices Characterization and Modeling of memristor devices Technology and Fabrication processes