POLITECNICO DI MILANO

PhD in INGEGNERIA ELETTRICA / ELECTRICAL ENGINEERING - 40th cycle

THEMATIC Research Field: METHODOLOGIES AND ALGORITHMS FOR ADVANCED MODELING OF ELECTRICAL SYSTEMS THROUGH FPGA AND REAL-TIME SIMULATORS

Monthly net income of PhDscholarship (max 36 months)
€ 1500.0
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	This research aims to develop novel methodologies and algorithms for the simulation of electrical systems, with a specific focus on real-time and FPGA-based simulation platforms. The research will encompass the following key areas: •**Development of high-fidelity simulation models:** This will involve the creation of accurate and efficient models for various electrical systems, including power systems (transmission and distribution grids, renewable energy integration), power electronics converters (AC/DC, DC/DC, motor drives), and coupled multiphysics systems (e.g., electromechanical, thermoelectric). •**Real-time simulation techniques:** Exploration and implementation of real-time simulation algorithms, such as numerical methods (e.g., explicit and implicit solvers) and parallel computing techniques (e.g., multithreading, distributed computing), to achieve real-time performance for hardware-in-the-loop (HIL) testing and control system development. •**FPGA-based acceleration:** Design and implementation of high-performance simulation algorithms on FPGAs (Field-Programmable Gate Arrays) to leverage their inherent parallelism and achieve significant speedup

	compared to traditional CPU-based simulations. •**Application-specific architectures:** Investigation and development of customized hardware architectures (e.g., using specialized processing elements, memory hierarchies) to optimize FPGA implementations for specific simulation tasks and improve resource utilization.
Methods and techniques that will be developed and used to carry out the research	1. Modeling Techniques: •Object-Oriented Programming. •Equation-Based Modeling. •Data-Driven Modeling. 2. Simulation Methods: •Numerical Integration Methods. •Event-Driven Simulation. 3. FPGA-Based Acceleration: •Hardware Description Languages (HDLs). 4. Real-Time Simulation Considerations: •Time Synchronization: Ensure alignment between the simulation and real-time clock. •I/O Handling: Manage signals from external devices for integration into the simulation. •Hardware-in-the-Loop (HIL) Testing: Connect the simulator with physical hardware for realistic testing. The research work will be carried out at the Simlab 4.0 laboratory of Politecnico di Milano and at RSE.
Educational objectives	The educational objectives are: 1. To learn about new algorithm and methodology for the realtime simulaition 2. Define challenging scenario and design how to model

	2. Define challenging scenario and design how to model and simulate the previously defined scenarios. 3. Learn how to find kpi and techniques for hybrid simulations.
Job opportunities	Employment opportunities are: 1. Research centers and universities 2. companies in the area of power systems and electric vehicles
Composition of the research group	0 Full Professors 2 Associated Professors 1 Assistant Professors 4 PhD Students
Name of the research directors	Prof. Giambattista Gruosso

Contacts
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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	750.0 €
By number of months	0

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Educational activities:
Financial aid per PhD student is available for purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences, instrumentations and computer, etc. This amount is equal to 10% of the annual gross amount, for 3 years.

Teaching assistantship:
Availability of funding in recognition of supporting teaching activities by the PhD student. There

are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

Computer availability: individual use.
Desk availability: individual use.