POLITECNICO DI MILANO

PhD in INGEGNERIA ELETTRICA / ELECTRICAL ENGINEERING - 41st cycle

THEMATIC Research Field: MEASUREMENT AND INSTRUMENTATION

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 field is divided into two main categories: the first focuses on electronic measurement applications, while the second concerns optical systems and their characterization and simulation. Regarding the first category, digital twins in electronic systems are poised to revolutionize the entire lifecycle of electronic devices—from design to deployment and maintenance. By creating high-fidelity virtual replicas of circuits, embedded systems, and power electronics, engineers can simulate system behavior, predict failures, and optimize designs in real time. These digital counterparts enable predictive maintenance, reducing downtime and extending the lifespan of critical systems in sectors such as aerospace, automotive, and healthcare. Integration with artificial intelligence will drive automated design processes, facilitating intelligent component selection, thermal management, and layout optimization. In manufacturing, digital twins will support smart factories by monitoring production lines, detecting anomalies, and improving yield. For IoT and cyber-physical systems, they will provide real-time monitoring, firmware updates, and enhanced security. Additionally, in power electronics, digital twins will optimize energy flow and grid integration, while in FPGA and SoC development, they will enable hardware-in-the-loop testing and co-simulation. Overall, digital twins will become essential tools for innovation, reliability, and operational efficiency in the electronics industry. As for the second category, digital twins are increasingly enabling real-time, high-fidelity simulations of

	optical systems—such as lenses, sensors, and fiber optics—allowing for virtual prototyping of complex optical setups, optimization of parameters like alignment, aberration correction, and thermal effects, and a significant reduction in physical iterations during R&D. Notable applications include LiDAR and camera systems, where digital twins can simulate sensor behavior in diverse environments, improving sensor fusion, calibration, and fault detection. In this context, the main objectives of the research activities include: (i) modelling of electronic systems and instruments; (ii) modelling of electro-optical devices (e.g., vibrometers, telemeters); (iii) design of innovative methods for measuring, controlling and identifying parameters that influence system behaviour and performance; and (iv) development of hardware-in-the-loop systems to enhance overall system efficiency.
Methods and techniques that will be developed and used to carry out the research	The research activities will be carried out using well established tools from mathematics, physics, circuit theory, and control theory, integrated with advanced techniques such as stochastic programming, neural networks and Artificial Intelligence. The main objective is the development of algorithms for the modeling and design of electromagnetic, electromechanical, electronic, and electro-optical components, with a particular focus on integration within complex optical systems. Digital twins will be defined to simulate and optimize the dynamic behavior of these systems, both during the design phase and operational stages. The activities will include: Definition of advanced control techniques to optimize the performance of electrical drives and optoelectronic devices. Development and experimental validation of models through parameter identification and prototype testing. Design, realization, and testing of physical prototypes. · Programming of microcontrollers and FPGAs for the interfacing and control of electro-optical components. Design and implementation of optimization algorithms for the coordinated (optimal) management of converter-interfaced power sources (including energy storage

	systems), with respect to various objective functions (e.g., provision of ancillary services, maximization of economic benefits).
Educational objectives	Refinements of skills in simulation and design of optical systems . Assistance in the development of models of complex electro-optical and electronic systems. Training in actively contributing to the project team, both in academic research and in activities with industrial partners.
Job opportunities	R&D Italian Firms, University career.
Composition of the research group	5 Full Professors 5 Associated Professors 1 Assistant Professors 0 PhD Students
Name of the research directors	Alessandro Pesatori,Christian Laurano,Michele Norg

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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents	--

Scholarship Increase for a period abroad	
Amount monthly	750.0 €
By number of months	6

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.