POLITECNICO DI MILANO

PhD in INGEGNERIA STRUTTURALE, SISMICA, GEOTECNICA / STRUCTURAL SEISMIC AND GEOTECHNICAL ENGINEERING - 39th cycle

THEMATIC Research Field: SIMULATION OF MULTI-PHYSICS MECHANICAL SYSTEMS FROM THE MICROSCALE TO THE MACROSCALE BY DEEP LEARNING & REDUCED ORDER MODELS

Monthly net income of PhDscholarship (max 36 months)
€ 1250.0
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	HAVING REGARD to the D.D. 104 of 02/02/2022 (call PRIN 2022), within the framework of the National Recovery and Resilience Plan, Mission 4 Education and research – Component 2 From research to business – Investment 1.1, funded by the European Union – NextGenerationEU. Partial financing through project funds PRIN 2022 will take place in the first months of activation of the doctoral scholarship, until the expected PRIN 2022 amount is disbursed. PRIN 2022 Project: DIgital twins of nonlinear MIcrostructures with iNnovative model-order-reduction strategies (DIMIN) Project code: 2022XATLT2 - CUP: D53D23004270006. Relying on reduced order models (ROMs) is nowadays essential to perform repeated numerical simulations required, e.g., in optimal design or uncertainty quantification problems, as well as real-time simulations in multiple virtual scenarios.

	Applications **Design of Micro-Electro-Mechanical Systems** High-fidelity models of Micro-Electro-Mechanical Systems (MEMS) are extremely expensive. Because of several uncertainties hampering such systems, relying on reduced order modeling also including the effect of uncertainty is therefore essential. **Bio-Inspired Flying and Swimming Devices** A second, relevant context in which the developed DL-ROMs will be employed is the efficient simulation of complex multi-physics problems related to archetypal types of flyers and swimmers found in nature, ranging from the microscale (bacteria) to the macroscale level (birds and fishes), together with deep reinforcement learning for use in robotic applications.
Methods and techniques that will be developed and used to carry out the research	Current strategies to build ROMs require a huge amount of data from high-fidelity, full-order solvers to train (offline) the ROMs and enable their deployment during the testing (online) stage. However, data from sensors as well as high-dimensional noisy images acquired over time are very often available, thus providing an alternative, cheaper source of data to train a ROM for a low-dimensional representation of the current asset. DL-ROMs will be first designed to perform the learning task using also experimentally acquired data, rather than only from numerically generated data, and then combined with strategies for fusion of multi-fidelity data.
Educational objectives	Since the proposed research project is highly multi-disciplinary, the candidate will have the opportunity to collaborate with a number of laboratories and research groups either in the Department of Civil and Environmental Engineering or in other Departments of the Politecnico di Milano, in industries and in international research centers. He/she will acquire specialized knowledge on fluid structure interaction and on coupled numerical techniques.
Job opportunities	Direct employment in MEMS industries or research centers.

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Composition of the research group	1 Full Professors 0 Associated Professors 1 Assistant Professors 1 PhD Students
Name of the research directors	Attilio FRANGI

Contacts
attilio.frangi@polimi.it http://frangi.faculty.polimi.it/

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	625.0 €
By number of months	6

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

Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research:

•Universitat Politecnica de Catalunya - CIMNE
•Université Paris-Saclay - LMT
•University Washington, Seattle

Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): The Ph.D. course supports the educational activities of its Ph.D. students with an additional funding equal to 10% of the scholarship, starting from the first year.

Teaching assistanship (availability of funding in recognition of support to teaching activities by the PhD student): Ph.D. students are encouraged to apply, upon prior authorization, to the calls to support teaching activities at the undegraduate and Master levels at Politecnico, being paid for that. The teaching assistantship will be limited up to about 80 hours, maximum half of them devoted to teaching and classroom activities and the rest to support classworks and exams.

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Computer availability and desk availability: Each Ph.D. student has his/her own computer for individual use.Each Ph.D. student has his/her own desk, cabinet and locker.