



# PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 40th cycle

**PNRR 630 Research Field: LEARNING-BASED MODEL PREDICTIVE  
IMPEDANCE/ADMITTANCE CONTROL FOR THE EXECUTION OF CHALLENGING  
MANIPULATION TASKS**

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

<b>Context of the research activity</b>	
<p><b>Motivation and objectives of the research in this field</b></p>	<p>The research is motivated by the pressing need for advanced control strategies in robotics to enable the execution of complex manipulation tasks in dynamic and uncertain environments. Traditional control methods often struggle to handle challenging scenarios involving contact interactions and variable object properties. By integrating model predictive control (MPC) with impedance/admittance control techniques, this research aims to develop a novel learning-based control framework. Leveraging machine learning algorithms such as reinforcement learning or deep learning, the goal is to enable robots to learn the dynamics of manipulation tasks and adapt control parameters in real-time. Through simulations and experiments on robotic platforms, the effectiveness of the proposed control approach will be validated, assessing its performance in executing challenging manipulation tasks under varying environmental conditions and object properties. Potential applications are in industries requiring high-precision manipulation, such as assembly, pick-and-place operations, and object manipulation in cluttered environments.</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>The PhD student will develop and apply several methods and techniques which include:</p> <ul style="list-style-type: none"> <li>•MPC algorithms to predict and optimize the robot's future</li> </ul>



	<p>states and control actions;</p> <ul style="list-style-type: none"> <li>•design and implement impedance and admittance control strategies to regulate the interaction forces between the robot and its environment;</li> <li>•RL algorithms to enable the robot to learn optimal control policies through trial and error;</li> <li>•DL techniques to process and interpret complex sensory data, such as visual inputs from cameras or force measurements from sensors;</li> <li>•simulation environments and digital twins of the robotic system to test and validate control algorithms;</li> <li>•experiments to validate the developed control strategies on physical robotic platforms.</li> </ul>
<p><b>Educational objectives</b></p>	<p>The educational objectives are to equip students with an in-depth understanding of advanced control methodologies, enhance their problem-solving skills in complex engineering scenarios, and provide hands-on experience in designing and testing control strategies on robotic platforms. Additionally, the research aims to foster interdisciplinary integration, encouraging the synthesis of concepts from mechanical engineering, computer science, and artificial intelligence.</p>
<p><b>Job opportunities</b></p>	<p>Our last survey on MeccPhD Doctorates highlighted a 100% employment rate within the first year and a 35% higher salary compared MSc holders in the same field. These job opportunities span various disciplines such as engineering, sustainability, material science, and project management, offering diverse career paths for individuals interested in advancing sustainable practices in the field of electric vehicle technology. The research is carried out in collaboration with Leonardo LABS.</p>
<p><b>Composition of the research group</b></p>	<p>1 Full Professors 0 Associated Professors 1 Assistant Professors 2 PhD Students</p>
<p><b>Name of the research directors</b></p>	<p>Prof. Francesco Braghin</p>



Contacts	
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<p>Phone: 02 2399 8306 Email: francesco.braghin@polimi.it, marta.gandolla@polimi.it For questions about scholarship/support please contact phd-dmec@polimi.it</p>
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Additional support - Financial aid per PhD student per year (gross amount)	
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Housing - Foreign Students	--
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Housing - Out-of-town residents (more than 80Km out of Milano)	--
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Scholarship Increase for a period abroad	
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Amount monthly	750.0 €
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By number of months	6
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National Operational Program for Research and Innovation	
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Company where the candidate will attend the stage (name and brief description)	Leonardo S.p.A.
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By number of months at the company	6
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Institution or company where the candidate will spend the period abroad (name and brief description)	to be defined
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By number of months abroad	6
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Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
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<p>Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops and conferences) for a total amount of euro 6.114,50.</p>
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<p>Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. 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.</p>
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