POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 39th cycle

THEMATIC Research Field: PDE OPTIMIZATION OF ROBOT SWARMS FOR ACOUSTIC INVISIBILITY CLOAK

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0
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	Cloaking refers to the possibility to achieve perfect concealment of objects with respect to probing incident radiation. Acoustic cloaking can be obtained allowing the speed of sound around an object to be highly anisotropic to steer waves around and not into the object itself. Such anisotropy is not available in nature and must be obtained by the engineering of a microstructure. Currently, most approaches rely upon passive or active layers of (meta) materials covering the object to protect. However, the latter usually suffer from limitations due to the size and weight of the cloak itself and due to the loss of performances when exposed to different incidence angles. The aim of this project is to overcome these issues following a new paradigm: steering the incident waves using a field of controllable agents, that is a robot swarm. Using a PDE-optimization approach, the swarm can indeed be controlled and reconfigured to adjust the stiffness/density distribution around the object to conceal. Besides of the theoretical aspects of this research project, the candidate will have the opportunity to build and test the developed control logics on an underwater swarm in the instrumented pool of our laboratory.
Methods and techniques that will be developed and used to carry out the research	As anticipated above, the candidate will use and develop its own PDE optimization tools and routines (as necessary) to implement the control logics to be deployed on the robot swarm. In this second part, the basics of robotics and microcontrollers for embedded systems will

	robotics and microcontrollers for embedded systems will be required to design the robots and the experiments.
Educational objectives	This research topic involves both cutting-edge technology development and the use of some refined state-of-the-art techniques which are becoming ever more relevant in the industry, with applications going from search and rescue operations to underwater pipelines inspection. As such, this PhD project is perfect for candidates pursuing either an academic or an industrial career.
Job opportunities	Our last survey on MeccPhD Doctorates highlighted a **100% employment rate** within the first year and a **35% higher salary,** compared to Master of Science holders in the same field.
Composition of the research group	1 Full Professors 1 Associated Professors 0 Assistant Professors 2 PhD Students
Name of the research directors	Prof. Francesco Braghin

Contacts
Phone: 02 2399 8306 *Email:* francesco.braghin@polimi.it For questions about scholarship/support phd-dmec@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	700.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
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 5.707,13.

Our candidates are strongly encouraged to spend a research period abroad, joining high-level research groups in the specific PhD research topic, selected in agreement with the Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approx. 700 euro/month - net amount).

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.