



PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 37th cycle

**THEMATIC Research Field: ON ORBIT SERVICING CLOSE PROXIMITY ROBOTICS
NAVIGATION AND CONTROL FOR NEAR EARTH ECOSYSTEM PRESERVATION**

Monthly net income of PhDscholarship (max 36 months)

€ 1325.0

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**

Strong attention is given in Space to the near-Earth ecosystem and environment preservation, dangerously attacked by the enormous amount of dead satellites, fragments, launchers parts left orbiting around forever. Satellites are a crucial source of big data for the Earth ecosystem and biosphere Observation, Communication, and Navigation services provision and those orbiting debris are threats in terms of potential collisions to kill active spacecraft jeopardizing the services, pollution through degraded materials still on board (e.g. hydrazine, chemical cells, composites, refractory materials) which might re-enter in the atmosphere, block for new useful space assets to safely launch. More, satellites come to the end of life and flip into debris, just because of fuel depletion or single fault event, even if still healthy to service Earth. The capability to either remove orbital debris or to refurbish space assets to prolong their operational life is fundamental to contribute to both Space and Earth ecosystems preservation: Active Debris Removal would keep clean the operational orbits, On-Orbit Servicing would contribute to sustainable development, limiting the on Earth resources waste to support the whole supply chain for new, replacing satellites production; just refurbishing already available space assets supposed to be turned off because out of on-board resources. On-orbit unmanned proximity operations are a frontier and dedicated SW/HW needs to be studied, developed and tested. The research aims at



	investigating, implementing, and verifying, through numerical and experimental activities, techniques and architectures for the very close autonomous navigation and control of robotic appendages devoted to finalizing the physical contact between an orbiting uncooperative target and the servicer satellite, under different use cases in the basin of the Clean Space and On-Orbit servicing domain.
Methods and techniques that will be developed and used to carry out the research	The whole PhD will see a strict collaboration with the LDO industrial partner worldwide recognized as a leader in Space Robotics and optical payloads for space application; the candidate, under the joint supervision of the academic and the industrial tutor, will work on designing and implementing new approaches for relative accurate navigation to perform very close proximity operations with robotics in close loop control. Attention will be given to settling and running experimental tests to assess the benefits and criticalities of the technology in preparation for the next IOS missions. The PhD research will be the opportunity to strengthen a profitable bidirectional exchange between the worlds of research and industry.
Educational objectives	The specific objective of this PhD is to develop skills in Space Debris and On-orbit Servicing related engineering, with attention to autonomous very close proximity navigation and safe control, and capture/contact mechanisms design. Through this project, the candidates will develop skills not only in mathematical modelling, numerical analysis, experiments setup, and runs but also an attitude open to innovation and exchange between the research and industrial worlds, with a general focus on the preservation of the terrestrial and near-Earth ecosystem, biodiversity, reduction of the impact of climate change through technological innovation and promotion of sustainable development. In this sense, education will be complemented by a broad variety of soft skills, including presentation of the research, report writing, outreach, dissemination, and preparation of industrial progress meetings.



Job opportunities	The job opportunities that this project opens up are in the field of space systems engineering HW/SW design, development and testing, GNC design and testing, robotics for space, Clean Space and Debris management, On-Orbit Servicing.
Composition of the research group	1 Full Professors 0 Associated Professors 2 Assistant Professors 13 PhD Students
Name of the research directors	Prof. Michelle Lavagna

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	564.01 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
The PhD candidate will receive a desk, a personal computer. Apart from the compulsory ones, the PhD candidate will have the opportunity to follow additional courses, to receive economic support to attend summer schools and participate in conferences. There will be the possibility of paid teaching assistantship.