POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 39th cycle

THEMATIC Research Field: AUTONOMOUS NAVIGATION FOR CLOSE PROXIMITY OPERATIONS IN SPACE

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	The proposed research involves multi-measurements based navigation to occur on board during close proximity operations in space with relevance to on-orbit servicing. The capability to properly reconstruct the shape and the dynamics of objects is fundamental before starting close proximity and contact operations as those related to On-Orbit Servicing and assembling. Vision-based navigation, currently investigated has room for improvement whenever environmental conditions are detrimental and accuracy requirements are highly demanding. Moreover, image processing could be still computationally demanding to run onboard to answer for autonomous navigation. The research wants to investigate techniques to lighten image processing preserving the expected accuracy by looking at data fusion from other sources of measurements, according to different environmental conditions, potential failure and malfunctioning included; the goal is to assess their effectiveness in the space asset 6dof dynamics reconstruction with representative processor in the loop. That entails the development of new data management and data filtering approaches to be numerically and experimentally assessed and validated. The reference application is multiple space artefacts interaction in close proximity/contact operations.
Methods and techniques that will be developed and used to carry out the research	The research will take advantage of the state of the art in the research group for image processing as a starting point to investigate both robustness to a subset of

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	point to investigate both robustness to a subset of anomalies (environmental or failure driven) and techniques to reduce the computational burden and complement the loss of accuracy with other sensors fusion. The measurement sources definition and processing step will serve as input to develop the data fusion/management and filtering approach to ensure the correct level of accuracy for the different proximity scenarios with nominal/non-nominal conditions. A key index in building the architecture for the full state reconstruction will be the robustness to anomalies, to preserve safety whenever operating in very close proximity. To this end, the potential improvement AI techniques could give will be taken into account during the design and assessment phases. The research will take advantage of a numerical phase first and an experimental phase focused on porting and testing at least processor-in-the-loop the implemented fusion-based navigation.
Educational objectives	The specific objective of this PhD is to develop skills in autonomous robust navigation in close proximity operations performed by unmanned spacecraft, exploiting heterogeneous measurement sources, images included. The candidate will refine his/her competencies in mathematical\numerical modelling, and experimental campaign settling and running. Moreover, he/she would enhance his/her knowledge in the area of AI techniques for data management; during his/her research period he/she will get in contact with external entities, public and private being the topic quite in line with many ongoing activities in the group. Technical education will be complemented by a broad variety of soft skills, including presentation of the research, report writing, outreach, dissemination, and preparation of progress meetings.
Job opportunities	The job opportunities that this project opens up are in the fields of autonomous navigation, sensor modelling and measurements management, space GNC engineering, and system engineering not limited to the space industrial parterre.
Composition of the research group	1 Full Professors 0 Associated Professors

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	2 Assistant Professors 10 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	700.0 €
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, possibly through a hot-desking procedure, and a personal computer, if needed. Apart from the compulsory ones, the PhD candidate will have the opportunity to follow additional courses and receive economic support to attend summer schools and participate in conferences. There will be the possibility of paid teaching assistantship.