

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 40th cycle

THEMATIC Research Field: PROGETTO SPACE IT UP CONTRATTO DI FINANZIAMENTO ASI N. 2024-5-E.0 CUP MASTER I53D24000060005 CUP POLIMI D43C24000350006 -MULTISPECTRAL IMAGING FOR SPACECRAFT ON-BOARD GUIDANCE SYNTHESIS

Monthly net income of PhDscholarship (max 36 months)	
€ 1600.0	
In case of a change of the welfare rates during the three-year period, the amount could be modified.	
Context of the research activity	

	Pondo di finanziamento ASI degrato z. 687/2022
	Bando di linanziamento ASI decreto n. 687/2022 -
	Deliberazione n. 71/2022 – Ternatica 15 Attivita spaziali,
	di cui all'avviso MUR n. 341/2022 per Partenariati estesi.
	Progetto di ricerca "SPACE IT UP!" approvato con
	decreto ASI n. 53/2024. Contratto di finanziamento ASI n.
	2024-5-E.0 (COP Master 153D24000060005; COP
Motivation and objectives of the research in this field	POLIMI D43C24000350006).
	ASI Funding Notice Decree No. 687/2022 - Resolution
	No. 71/2022 - Topic 15 Space Activities, referred to MUR
	Notice No. 341/2022 for Extended Partnerships. Research
	project "SPACE IT UP!" approved by ASI Decree No.
	53/2024. ASI Funding Agreement No. 2024-5-E.0 (CUP
	Master I53D24000060005; CUP POLIMI
	D43C24000350006).
	The proposed research investigate multi-measurements
	coupled with innovative data management techniques to
	support operations in space merging the navigation and
	guidance tasks. Particular attention is given to multi-band
	imaging sensors and Artificial Intelligence techniques to
	synthetize from the image acquisition effective guidance
	strategies. The need to increase the decision making
	capabilities on board space vehicles is the more dictated
	by the new emerging scenarios dealing on one side with
	proximity operations in fast dynamics such as formations,
	servicing on orbit, landing and on the other side with high



	precision requirements in terms of localization and control. The multi-band imaging unlocks the measurements acquisition from lighting conditions and offers broader signal sources from natural objects in space too as stars and small bodies. Image based navigation and control are largely studied in the vision domain even if still young in its on-orbit real applications; room for improvement exists in many areas: the research wants to contribute to: larger signal band exploitation, processing burden reduction, measurements into direct control strategy synthesis settlement. Robustness to sw\hw failure and malfunctioning will be considered as well, being relevant aspects which can jeopardize the effectiveness of the image processing in highly radiation environment. The research aims assessing the performance of the architectures identified along the study first numerically and then experimentally to get to a TRL4 taking advantage of the facilities the research group developed along time.
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 VIS-IR image processing and synthetic sets generation as benchmark and input to focus on the investigation of possible approaches to fuse the navigation and guidance tasks by images manipulation. To this end, different techniques in the basin of the data mining and deep learning algorithms will be considered to assess the feasibility of a guidance profile synthesis directly from imaging sensors inputs. Increasing complexity scenarios will be considered to develop and test a numerical framework then followed by hardware in the loop; the complexity will entail scenarios out of nominal either because of injected failures or because of scenes out of the training database, as well as tighter requirements in the guidance synthesis such as high reactivity, large authority on the free dynamics. To get to a valuable assessment against the expected bottlenecks, an experimental phase is also foreseen to check for the computational feasibility of the implemented tool with flight-like processors in the loop.



Educational objectives	The specific objective of this PhD is to develop skills in advanced guidance and navigation for a new generation of more demanding unmanned spacecraft, which might benefit of some AI techniques in data processing with particulat attention to imaging data sources. The candidate will refine his/her competences 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 on going 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 field of space system engineering, modelling and PII\HIL testing, with focus on GNC skills for increased autonomous assets, not limited to the space industrial parterre.
Composition of the research group	1 Full Professors 0 Associated Professors 2 Assistant Professors 9 PhD Students
Name of the research directors	Prof. Michelle Lavagna

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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	800.0 €		
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.