POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

THEMATIC Research Field: ON BOARD GUIDANCE AND CONTROL STRATEGIES FOR HIGHLY RECONFIGURABLE SPACE ASSETS IN PERTURBED ENVIRONMENT

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	Space assets are becoming more infrastructures for services on-call more than vehicles targeted to a predefined, frozen utilization plan. Therefore their maneuverability and reactivity according to the environment and any impromptu request are becoming drivers. The research wants to investigate from design to testing, from the algorithms to the hardware the most promising architecture to get to a solution that makes the guidance and control of space vehicles 6 dof dynamics highly recalculable on board to autonomously cope with sudden pointing plans change, new and fast re-positioning and any other adjustment in the robotic vehicle dynamics. Applicability will be tested on highly perturbed environments, such as very low orbits in the atmosphere, non-keplerian dynamics regimes, and non-uniform gravity fields, both on single and distributed space architectures (i.e. formations and fleets). A comprehensive analysis of applicability will occur to identify strengths and limitations of the final architecture proposed, to be a valid tool to support a new generation of flexible and on-orbit reconfigurable satellites
Methods and techniques that will be developed and used to carry out the research	Attention will be focused on semi-analytical modeling for the dynamics to speed it up as well as on potential integration with AI techniques for model identification, driven by keeping light the computational burden on board. An important reference and a starting point for the guidance and control synthesis will be represented by

	guidance and control synthesis will be represented by taking advantage of convexification and finite horizon techniques such as the MPC might. An incremental approach is expected to be adopted, focusing first on the implementation of the analytical formulation, as far as feasible for the most relevant perturbations still treated numerically in literature, so that to enlight at the most the represented dynamics on board. Then, attention will focus first on the CoM adaptive control design and testing, adding the attitude control flexibility as a second step. A large sensitivity campaign assessment will occur focusing both on different perturbed scenarios and on potentially uncertain parameters which would affect the robustness of the control itself. Time will be devoted to including in the architecture, expected to be the output of the research proper robustness performance, according to the scenario dealt with. The expected results are the implementation and verification of the guidance and control technique evaluated, through the research, to be the fittest for answering the largest flexibility in dynamics fast reconfigurability space assets dynamics. Depending on the research evolution, tests with processors in the loop are expected to be included to finally comment on the algorithm's on-board real applicability and the presence of any technological shortstopper.
Educational objectives	Through this project, the candidate will develop skills in mathematical modelling, numerical analysis, and advanced guidance and control techniques. The candidate will have also the chance to complement his/her training with experiments set up and testing algorithms with HW\processor in the loop. Education will be complemented by a broad variety of soft skills, including presentation of the research, report writing, outreach, dissemination, and interaction with industry and agencies working on ongoing studies the research team is conducting.
Job opportunities	The job opportunities that this project opens up are expert engineers in guidance and control for complex vehicles, flight dynamics engineers, jobs in the area of simulators, onboard software development, verification, and testing at

	different stages in the product chain, not limited to the aerospace domain.
Composition of the research group	1 Full Professors 0 Associated Professors 2 Assistant Professors 12 PhD Students
Name of the research directors	Prof. Michelle Lavagna

Contacts
Dipartimento di Scienze e Tecnologie Aerospaziali - Politecnico di Milano - via La Masa 34, 20156 Milano - Italy - tel. +390223998323 - fax +390223998334 - email: phd-daer@polimi.it - web site: www.aero.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	2100.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
The Ph.D. candidate will receive a desk and a personal computer. Apart from the compulsory ones, the Ph.D. candidate will have the opportunity to follow additional courses, receive economic support to attend summer schools, and participate in conferences. There will be the possibility of paid teaching assistantship. none