POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 38th cycle

PNRR_351_PUBBL_AMMIN Research Field: ENHANCED AND EXTENDED SPACE TRAFFIC MONITORING CAPABILITIES

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	Funded by PNRR M4C1 (potenziamento dell¿offerta dei servizi di istruzione: dagli asili nido alle università) Contributes to M1C1 (digitalizzazione, innovazione e sicurezza nella PA) The space sector is a symbol of international cooperation and a meeting point of multiple disciplines. Space is an environment shared by all humanity and it needs the collaboration of governmental entities and private companies to guarantee its sustainable use. In this context, Space Situational Awareness (SSA) and Space Traffic Management (STM) are two key fields to enable safe space operations, which are strictly related to the provision of services to users on ground. STM is a rapidly growing concern for the space community, due to the increase in the space population. Conjunction events are increasingly likely and less predictable due to insufficient quality of available data and processing algorithms. With the expansion of space activities in the cislunar space, these problems arise again in regions far away from the near-Earth realm, increasing commercial, exploratory, and defence interests. The objective of this research is to enhance national SSA services for both near-Earth region and cislunar environment through the development of innovative observation strategies and processing algorithms. These

	include the use of multiple sensors and the fusion of measurements to improve the quality of available data and derived quantities. For cislunar SSA, innovative solutions involving on-orbit sensors will be investigated considering the need to significantly adapt models and methods to be successful in the cislunar realm. This research work aims therefore to identify effective solutions to help national public administrations involved in SSA/STM, mainly Italian Air Force (ItAF) as current national public provider of SSA services, to manage more efficiently the problems related to this sector, also through the development of techniques and tools that guarantee simplified use for users. Analysis of performance and costs also aims to promote collaborations between public agencies and private companies to achieve higher quality operations, higher efficiency in resource allocation and potential business opportunities for private companies. Finally, in the context of cislunar SSA, the identification of valid solutions would anticipate what will soon become a current problem for the international community because of the growing interest in lunar missions thanks to the Artemis program.
Methods and techniques that will be developed and used to carry out the research	Period abroad: 6 months, Department of Aerospace and Mechanical Engineering, University of Arizona, AZ, USA Internship: 6 months, Aeronautica Militare Italiana This research aims at improving the state of the art on surveillance/tracking services for both catalogued and newly detected objects. The candidate will develop and implement strategies to identify an efficient configuration of observation points, investigating both ground-based and space-based solutions. A multi-objective optimization process, based on the definition of a score for each configuration can be pursued considering all the relevant factors, such as the number of facilities, the number and the type of sensors, and the uncertainties resulting from the specific computations. Fusion of measurements and the use of multiple observation points are exploited to drive processing algorithms towards more precise solutions.

	A series of operations will be defined, starting with the development of a simulator tool and ending with evaluating the performance of the considered configuration. In the process, many methods and techniques are used, such as orbit determination algorithms and estimation techniques to get a refined version of the orbital knowledge. This research may be enriched with further analysis on how to implement this capability by sharing it among public and private players, investigating any potential resource optimizations on the public side, and any potential business opportunities for private companies. The candidate will have the chance to test and apply his research in a practical context during the planned period at the ItAF relevant premises. A period abroad is also envisaged to benefit from the international collaboration with experts in the specific sector.
Educational objectives	This research involves the knowledge of the current state of SSA services and their capabilities, thus leading to the training of a professional figure able to interact in such an international context effectively. The practical implementation of the earlier mentioned analysis must pass through a literature review of the current state of the art of these strategies and methods, thus improving the candidate's scientific knowledge. This will contribute to training a highly qualified researcher who can tackle current space-related issues to contribute to the enhancement of the space sector. The candidate will gain profound knowledge about the concepts related to the fields of astrodynamics, estimation techniques, numerical methods, mathematical modelling, and computer programming. Soft skills in writing reports, searching bibliographic resources, preparing progress meetings, and presenting work advancements will also be achieved.

	In addition, by working in a mixed and vibrant academic and industrial context, the candidate will have the opportunity to learn on the job several transferable skills, including communication skills, team working, leadership, and ethical aspects associated with the use of innovative technologies. In support of this, the Ph.D. School of Politecnico di Milano provides a complete and rather diverse offer of courses. Each candidate must include in their syllabus at least 10 ECTS in transferable skills, to complement at least other 5 ECTS in technical disciplines associated with Aerospace Engineering, for a total of at least 20 ECTS.
Job opportunities	Activities aiming at guaranteeing a sustainable use of space are nowadays the focus of several companies, national agencies, and universities. Deep theoretical and practical knowledge of the topics investigated in this research will ensure a high appeal for the candidate in the space community. The research will develop in parallel to the establishment of: 1. the European Space Surveillance and Tracking Support Framework 2. the European Space Agency¿s Space Safety/Space Traffic Management programme 3. Any national initiatives aiming at establishing/improving a national SSA/STM capability, with the direct involvement of ItAF All programmes support the development of a network of European and national infrastructures to ensure the long-term availability of space surveillance services, including any existing/future SSA/STM services. This will be a great source of networking for the candidate. For this purpose, both programmes are fostering industrial and academic excellence in the field, which will need the long-term support of experienced professionals.
Composition of the research group	0 Full Professors 2 Associated Professors 0 Assistant Professors 6 PhD Students
Name of the research directors	Prof. Pierluigi Di Lizia

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

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Aeronautica Militare Italiana
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	Department of Aerospace and Mechanical Engineering, University of Arizona, AZ, USA
By number of months abroad	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 if needed. Apart from the compulsory ones, the Ph.D. candidate will have the opportunity to follow additional courses, receive economic support, attend summer schools, and participate in conferences. There will be the possibility of paid teaching assistantship.