POLITECNICO DI MILANO

PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 41st cycle

Research Area n. 4 - Telecommunications

INTERDISCIPLINARY Research Field: BEYOND 5G / 6G SYSTEMS FOR CONNECTED AND AUTOMATED LOGISTICS

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	Interdisciplinary PhD Grant The PhD research will be carried out in collaboration with research groups of the PhD programme in "**MANAGEMENT ENGINEERING**". See https://www.dottorato.polimi.it/?id=422&L=1 for further information. The research aims to investigate new-generation cellular technologies for enhancing the automation of logistics systems, including in-plant, warehouse and transportation logistics. Advanced-5G and 6G technologies will provide integrated sensing and communication functionalities in a same technology enabling the radio signals to be used not only for low-latency high-speed data sharing, but also for sensing the surroundings and localizing objects or people. This is key to supporting the mutual coordination and navigation of autonomous robots in warehouses or industries, as well as for automated vehicles in freight transportation. This research will focus on the design of new methodologies exploiting next-generation cellular networks for future automated logistics. To enable indoor-outdoor automated navigation of vehicles/robots or assets' tracking, the activity will include a theoretical study

	on the feasibility, as well as an experimental validation by testbed/prototype in a factory environment. Main focus will be on 5G-advanced / 6G localization, jointly accounting for indoor solutions, outdoor terrestrial networks, and even the assistance from non-terrestrial networks.
Methods and techniques that will be developed and used to carry out the research	The research focuses on the development, simulation and experimental validation of new-generation wireless technologies for high-precision localization and extended sensing in industrial contexts. An automated logistics system as a whole will be considered, addressing indoor challenges and outdoor augmentation or replacement of satellite positioning solutions. Technologies integrating communication and localization functionalities will be designed, targeting the KPIs of connected and automated vehicles/robots' applications. Thanks to the cooperation with industrial engineering experts, the research will investigate how to take benefit of new generation wireless networks to improve efficiency in automated and robotized warehouses (e.g., by control and coordination of connected AGV), to optimize processes (e.g., using collected data on tracked assets/vehicles for building predictive models) and to enable cooperative navigation for cost reduction (e.g., dense platooning in freight transportation). The research will be carried out within the DEIB-DIG interdepartmental laboratory IoTLab, leveraging the synergy between the telecommunications and management groups of Politecnico di Milano. On-field experiments with prototype systems in a real factory environment will be carried out, in collaboration with the MADE Competence Center Industry 4.0 and with the 5G-CRESCA (5G Connected REplicable Services for Connected cAmpus) project, which aims to develop a private 5G network inside MADE; this infrastructure will be a facility to be exploited for a validation of the research outcomes. Furthermore, the cooperation with the Contract Logistics "Gino Marchet" Observatory will facilitate the definition of the industrial use cases, the analysis of the main challenges, the requirements and the potential benefits in the logistics sector.

Educational objectives	Educational objectives include developing competences on innovative components, methodological competences at both theoretical and applied level, problem setting and solving capabilities, team-working attitude. A major objective is the development of multi-disciplinary expertise combining telecommunications and management, favoring the uptake in automated logistics systems by merging a technological/methodological approach with a broader vision of the industrial processes.
Job opportunities	Job opportunities include companies in sectors: • Telecommunications • Logistics • Navigation and Localization • Robotics Besides this, job opportunities comprise national and international academic and non-academic institutions and organizations, engaged in innovation, research and technical development.
Composition of the research group	1 Full Professors 2 Associated Professors 2 Assistant Professors 12 PhD Students
Name of the research directors	Prof. Antonio Capone, Prof. Elena Tappia

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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents	--

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
EDUCATIONAL ACTIVITIES (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student. TEACHING ASSISTANTSHIP: availability of funding in recognition of supporting teaching activities by the PhD student. There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations. COMPUTER AVAILABILITY: 1st year: Yes 2nd year: Yes 3rd year: Yes