



PhD in INGEGNERIA DELL'INFORMAZIONE / INFORMATION TECHNOLOGY - 40th cycle

Research Area n. 3 - Systems and Control

**THEMATIC Research Field: ADVANCED HUMAN-IN-THE-LOOP ACTIVE ASSISTANCE
SYSTEMS FOR INNOVATIVE GROUND AND AIR VEHICLES**

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**

Piloting modern vehicles, both ground and air ones, asks for the ability of managing increasingly complex missions, which can significantly increase the workload of the pilots themselves. As such, there is a strong need to develop highly specialized active assistance systems that can intervene and help the pilot take care of some tasks, possibly in an adaptive and context-dependent manner. While such functionalities are rather well developed for cars in common driving scenarios, they get more involved when they need to interact with partial autonomous features, and/or they need to support the drivers in high-performance contexts. As of now, in high-performance cars, such assistance systems are intentionally deactivated as they are not currently capable of exploiting the car dynamics' to its maximum extent. As for air vehicles, while such assistance is well-developed for in-flight conditions, ground-handling maneuvering - which will be the object of this research program -- has been, up to now, mostly managed by the pilot only, helped mainly only by an anti-skid controller. However, ground handling can be complex when lateral dynamics come into play due to asymmetries and/or the necessity to follow demanding trajectories with varying runway-tire grip conditions. Such critical situations can lead to so-called pilot-induced-oscillations, which can be dangerous and



	<p>undermine safety and performance as they are characterized by the human response coupling with the system's dynamics, and actually fighting against it. Furthermore, one has to optimally handle an over-actuated architecture, where control authorities have significant static and dynamic differences. In this research, we aim at developing innovative human-in-the-loop assistance systems that can help pilots of both ground and air vehicles to manage the ground handling maneuvers in demanding dynamic conditions that couple longitudinal and lateral dynamics. In particular, we aim to develop intelligent systems that can successfully cooperate with pilots when they are in the loop, maximising acceptance of the control action and minimizing antagonism, studying also the best Human Machine Interfaces (HMIs) and related cues to manage the communication between vehicle and humans.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>As is clear from the above discussion, the design of effective active assistance systems in the aforementioned settings is a challenging task, which requires diverse and integrated competencies. We will seek to develop a context-informed design of advanced, learning-based decision methods to support interactions with vehicle autonomous modes, which will need to integrate effectively with the underlying motion controllers and with pilot's interventions. To do so, the methods employed will stem from advanced control theory to encompass also estimation, dynamics optimization methods and machine-learning approaches. Further, human-factors will be considered, so as to define from control-related tools appropriate notions of optimality to evaluate the overall systems' performance and stability, together with the pilot's actions and reactions. Finally, the design of HMIs will be considered to enact an effective interaction between the pilot and the vehicle.</p>
<p>Educational objectives</p>	<p>The candidate will have a unique opportunity to work on a challenging and timely research project, combining both control-oriented and AI/learning-based aspects that are needed to address the challenging and timely topic presented above. This entails a growth path for the</p>



	candidate that will make them acquire different competencies - mainly technical and technological, in the disciplines mentioned in the methodology description. The research outputs will target publishing on international conferences and journals, with specific attention to all the venues of interest for the different facets of the research.
Job opportunities	Expertise in data analysis, machine-learning and control design certainly makes the PhD candidates very appealing for a wide range of high-end positions. These range from the more control-oriented ones to those more related to the considered technologies. Thus, our candidates might apply for positions both in technical companies and in academia.
Composition of the research group	3 Full Professors 2 Associated Professors 33 Assistant Professors 25 PhD Students
Name of the research directors	Prof. Mara Tanelli

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
<p><u>EDUCATIONAL ACTIVITIES</u> (purchase of study books and material, including computers, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student.</p> <p><u>TEACHING ASSISTANTSHIP</u>: availability of funding in recognition of supporting teaching</p>



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

Premiality

Premialities will be recognized to the PhD candidate.

Up to 2500 euros (gross amount) after the completion of the the 1st year;

Up to 3500 euros (gross amount) after the completion of the the 2nd year;

Up to 4500 euros (gross amount) after the completion of the 3rd year.

The premialities will be assigned provided that the candidate demonstrates a significant contribution to the growth of scientific excellence, the industrial valorization of research, and the networking and communication activities of the Department.