POLITECNICO DI MILANO

PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 39th cycle

PNRR 118 TDA Research Field: TECHNOLOGICAL READINESS ADVANCEMENTS AND APPLICATIONS OF OPTICAL FORCE SENSORS FOR PILOT-MACHINE INTERACTION

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	Recent aviation safety reports show that human factors are one of the major causes of safety issues in aircraft operations. Human–Machine Interfaces (HMI) play a central role in the achievement of mission goals in aircraft operations, especially for rotorcraft, where the human component of vehicle control is even more pronounced than in fixed-wing aircraft. Good design of cockpit ecology can be the difference between a successful mission and an incident or even an accident. One of the major focuses in recent research trends is the continuous monitoring and managing of pilot workload, through the monitoring of the pilot activity on the control inceptors, and/or physiological measurements. In the first category, the measurement of forces exchanged between the pilot and the control inceptor, at the inceptor grip, is one of the least exploited, yet it possesses a lot of attractive features. The research work will focus on the development and the application of an optical measurement system for hand grip forces, OPT-IN, which received a Starting Grant in the context of the 2020 Switch2Product Innovation Challenge and a further technological advancement grant in the context of the 2023 BOOSTECH program. Several first prototypes of the sensor have already been built and the general layout has been patented. The candidate will contribute to the advancement of the Technological Readiness Level (TRL) of the system and to its application to flight simulator control devices. The final goal of the candidate research will be twofold: to enhance the TRL of the measurement

	device and to develop, test and enhance methods and algorithms for pilot workload measurements during simulated flights. One of the possible applications is represented by the management of the pilot workload to reduce the proneness of the pilot-vehicle system to enter into high-frequency adverse couplings or Pilot-Assisted Oscillations.
Methods and techniques that will be developed and used to carry out the research	The candidate will first develop the skills required to perform the project, building on preexisting competencies of structural mechanics, dynamics, measurement systems and testing procedures, software development, and related mathematical methodologies. One fundamental aspect of the candidate skill development will be devoted to the acquisition of expertise in the field of metrological characterization of sensor devices, with experimental activities that will take place in the DAER Technological Laboratories. The OPT-IN system will be installed on the FRAME Sim fixed-base flight simulator and on the RPC Test Bed in the DAER Technological Labs, with the goal of integrating it into common experimental activities performed on the two testing machines. This setup will provide the opportunity to collect a large quantity of experimental data, to be exploited for the sensor development and the pilot-aircraft interaction analysis. The opportunity of developing a flyable version of the OPT-IN system, to be installed and tested in experimental aircraft, will be investigated.
Educational objectives	The candidate will develop specific skills related to structural dynamics, measurement systems, and computational methods, including specifically aimed at the metrological characterization of sensing devices and pilot-in-the-loop real-time simulation. 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	At the end of the PhD, the candidate will possess skills and experience that will be highly attractive to industries performing flight testing activities, training and simulation, and to potential industry partners interested in exploiting the OPT-IN patent.
Composition of the research group	2 Full Professors 0 Associated Professors 1 Assistant Professors 8 PhD Students
Name of the research directors	Dr. Andrea Zanoni

Contacts
FRAME-Sim laboratory, Dipartimento di Scienze e Tecnologie Aerospaziali - Politecnico di Milano Via La Masa 34, 20156, Milano - Italy +390223998035 - email: andrea.zanoni@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	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)	LWT3
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	ZHAW (CH)
By number of months abroad	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.