In consideration of the determination of the Regione Piemonte – Direzione Coesione sociale No. 445 of August 3, 2021 which approved the following apprenticeship position for the PhD project proposal submitted by the Politecnico di Torino in the framework of a specific regional call for proposals (Apprendistato di Alta Formazione e Ricerca 2016-2018 - Avviso Pubblico per la realizzazione dei percorsi formativi di: Laurea triennale e magistrale, Diploma Accademico di primo e secondo livello, Master di primo e secondo livello Universitario, Dottorato di ricerca e Diploma accademico di formazione alla ricerca, Attività di ricerca approvato con Determinazione 537 del 3/8/2016 e s.m.i.):

**PhD in Electrical, electronics and communications engineering**

**Research project “Navigation and control algorithms of micro-satellites using machine learning techniques”**

**Politecnico di Torino – Argotec srl**

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**Supervisors**

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**Contacts**

https://www.det.polito.it/research/research_groups/automatica/automatica

http://www.argotec.it/online/
The space industry has always been a powerful driver of innovation for several technologies, due to its high-level standards in terms of performance, safety, and efficiency. Traditionally, technological advances have been motivated mainly by space exploration missions led by government agencies (NASA, ESA, etc.). Upcoming space programmes make no exception, with relevant resources allocated for the development of exploration-related technologies. Besides the scientific aspects, a new space economy is currently emerging, which deals with the commercial exploitation of space assets and resources.

In this context, autonomy is a fundamental aspect of many future space exploration and exploitation missions. Operations such as spacecraft formation flying, rendezvous and docking, and planetary landing call for complex control tasks to be performed autonomously by the onboard Guidance, Navigation and Control (GNC) system. To this aim, it is customary to pursue methodological advances in learning, control and optimization techniques. These advances will allow the accomplishment of complex missions, where the spacecraft is able to perform different kinds of maneuvers without requiring a relevant human intervention. Despite a quite large number of mature learning, control and optimization techniques is available, the combined use of these methodologies in autonomous space missions is still at a preliminary stage. The research activity of this PhD project will be carried out in this context and will regard the development and combined use of novel learning, control and optimization algorithms, finalized at increasing the autonomy level and the performance of micro-satellites involved in advanced space missions.

The research activity will be carried out in collaboration with Argotec srl, a high-tech company developing innovative systems for different types of space missions, covering different mission aspects, such as requirement analysis, design, and in-orbit operations.

The Company Argotec has planned for the winner of this position a collaboration within a contract of high apprenticeship according to the Italian Legislative Decree 81/2015, art. 45.
The general goal of this PhD project is to develop and use in a combined way innovative learning, control and optimization algorithms, finalized at increasing the autonomy level and the performance of micro-satellites involved in advanced space missions.

Within this general goal, the following detailed research objectives will be pursued:

- Navigation algorithms based on machine learning methods will be developed and used in combination with standard spacecraft control algorithms.
- Control algorithms based on reinforcement learning will be proposed, allowing the spacecraft to adapt to different scenarios. These algorithms will be used together with standard or learning-based navigation algorithms.
- A simulation environment will be built up, allowing to test and possibly optimize the developed navigation and control algorithms.
- The simulation tests will regard challenging maneuvers like rendezvous and docking, and different kinds of orbital changes. A high level of autonomy will be required for these maneuvers.

The candidate shall be less than 30 years old at the moment of the hiring from the company. The skills of the candidate imply competences in the: orbital dynamics, spacecraft kinematics and dynamics, models and dynamic systems, automatic control, estimation/filtering, machine learning, convex and nonlinear optimization, Monte Carlo techniques, Matlab programming, Phyton programming, development of Simulink models.