Ph.D. in Information Technology
Thesis Defense

June 18th, 2026
At 10:30 a.m.
Sala Schiavoni - Building 20A

Chrystian Pool Edmundo YUCA HUANCA – XXXVIII Cycle

DESIGN AND ANALYSIS OF ADVANCED SWITCHING CONTROL STRATEGIES FOR MOBILE ROBOTIC SYSTEMS

Supervisor: Prof. Gian Paolo Incremona

Abstract:

The field of mobile robotics has experienced remarkable growth over the past decades, driven by a wide range of applications spanning from indoor services—such as cleaning, surveillance, and assistance—to more challenging outdoor scenarios, including underwater, space, and military operations. In these contexts, autonomous decision-making and reactive capabilities are fundamental to ensure both performance and safety. In particular, multi-robot systems endowed with interaction capabilities and collective behaviors have been extensively studied within the framework of swarm robotics, due to their inherent advantages in scalability, flexibility, and robustness. However, ensuring robustness and performance in real-world implementations remains a significant challenge, particularly when advanced control strategies are employed. This thesis contributes to the swarm robotics literature by developing novel switched optimal control and model predictive control schemes to address these challenges in both centralized and distributed settings, finally proposing also a learning-based safe control solution. While the initial results have been formulated and validated for ground mobile robots operating in planar environments, an interesting yet highly nontrivial extension concerns their application to unmanned aerial vehicles. Indeed, the transition from ground to aerial platforms introduces substantial additional complexity, due to the inherently nonlinear and higher-dimensional dynamics characterizing aerial systems. This thesis contributes to the literature by systematically extending the proposed control frameworks to such challenging scenarios, providing both rigorous theoretical developments and performance analysis. Furthermore, the effectiveness of the proposed algorithms has been validated through extensive experimental studies, demonstrating their applicability from a computational viewpoint, high scalability, and robustness in the face of uncertainties and possible collisions among agents or with obstacles in realistic multi-robot settings. A promising research direction is the combination of biologically inspired strategies with the formal guarantees of model-based control and learning-based safety layers towards achieving scalable, adaptive, and fully autonomous swarm systems.

PhD Committee

Dr. Alessio La Bella, **Politecnico di Milano**

Prof. Antonio Russo, **Università degli Studi di Bergamo**

Prof. Alberto Cavallo, **Università degli Studi della Campania Luigi Vanvitelli**