

**Ph.D. in Information Technology  
Thesis Defenses**

**March 6<sup>th</sup>, 2026**

**At 9:30 a.m.**

**Room Alpha - Building 24**

**Marcello CELLINA – XXXVIII Cycle**

**PERCEPTION METHODOLOGIES FOR OFF-HIGHWAY AUTONOMOUS VEHICLES**

Supervisor: Prof. Matteo Corno

**Abstract:**

Autonomous Vehicles operating in Off-Highway scenarios provide demanding yet controlled settings to evaluate full-stack autonomy, from high-speed multi-vehicle interaction to navigation in unknown and unstructured terrain.

This thesis presents and validates novel algorithmic methodologies for three research problems concerning sensing methodologies for AVs: Vehicle Detection and Tracking, Navigable Area Estimation, and LiDAR-based Mapping and Localization, across two complementary vehicle platforms, namely the Dallara AV-21 for autonomous racing and the Autonomous LMV for off-road navigation.

These methods are implemented on the edge computers, operate in real time, and have been validated experimentally in track and field trials, achieving fully autonomous overtakes up to  $275 \text{ km/h}$  over different racetracks, and completing multi-kilometer autonomous navigation, exploration and return-to-home missions in off-road proving grounds.

**Luca GAMBAROTTO – XXXVIII Cycle**

**ANALYSIS AND DEVELOPMENT OF AUGMENTED REALITY AND COMPUTER VISION ALGORITHMS FOR AUTOMOTIVE APPLICATIONS**

Supervisor: Prof. Matteo Corno

Augmented Reality (AR) technologies are transforming industry by merging digital and physical information, yet their use in non-inertial environments, such as moving vehicles, has not been fully explored. This thesis develops methods and algorithms to enable reliable AR in moving vehicles, particularly on Head-Mounted Displays (HMDs).

The research targets two main goals: estimating the six-degree-of-freedom (6-DoF) pose of an HMD within a moving vehicle and localizing the vehicle with accuracy sufficient for geo-referenced AR visualization.

For HMD pose estimation, a visual-inertial fusion architecture is introduced to compute motion relative to the cockpit, compensating for vehicle dynamics. Regarding the visual component, two novel computer-vision algorithms are presented, leveraging both monocular and stereo cameras installed in modern HMDs.

For vehicle localization, two pipelines are introduced: one fuses GPS-RTK and attitude data for precise on-track mapping and positioning, while the other uses stereo vision for GPS-denied environments such as fields or vineyards. A reprojection-based validation method evaluates localization accuracy without ground truth.

To demonstrate the validity of the approach in heterogeneous scenarios, sample AR applications are presented, leveraging the proposed algorithms. These include a coaching tool for on-track experiences, a smart-farming system to improve the productivity of in-field operations, and an automatic dataset generation pipeline for neural network training that exploits AR for generating and labeling synthetic images.

All the work proposed in this thesis has been tested in collaboration with HMDrive s.r.l., and most of the algorithms have been integrated into their AR software stack, demonstrating the industrial impact of this work.

## **PhD Committee**

Prof. Stefano Radrizzani, **Politecnico di Milano**

Prof. Simone Baldi, **Southeast University**

Prof. Mirko Mazzoleni, **Università degli Studi di Bergamo**