Politecnico di Torino
Ph.D. In Electrical, Electronics and Communications Engineering - XXXV cycle

# Machine-Learning Based Algorithms for Robotic Navigation and Perception

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Ph.D. thesis summary for the Board Secretary

## Abstract

In the latest years, a lot of academic and industrial research interest has been focused on the world of Artificial Intelligence. In particular, the rise of Machine Learning and Deep Learning has revolutionized the AI world, setting a new standard for using data to solve a great number of tasks. Fields such as Computer Vision, Pattern Recognition, Speech Recognition, Natural Language Understanding, and many others have taken the greatest advantages from these new algorithmic paradigms, reaching new state-of-the-art results that outperformed classical methodologies. In this context, also the robotic field can benefit from the adoption of these modern AI approaches, in order to bring machine intelligence and autonomous agents to a higher level. Among the different robotic categories, service robots, defined as robots that perform useful tasks for humans or equipment, are rapidly evolving. Service robotic prototypes can be applied to a number of different contexts, ranging from smart agriculture to elderly assistance.

This thesis presents different methodologies that merge the AI world with service robotics. Deep learning solutions are proposed to tackle several tasks from the sensing to the application levels. An algorithmic pipeline for autonomous service robotic navigation in smart agriculture contexts is presented, adopting multiple deep learning methods in different levels of the stack. Moreover, learning-based methodologies are adopted to solve perception tasks targeting different applications, such as object detection for precision agriculture, indoor localization, human action recognition from visual data, and efficient video streaming for remote robotic teleoperation. All the proposed methods are explained from a theoretical point of view and thoroughly tested with precise experimentation setup in order to prove their effectiveness in solving the target tasks. State-of-the-art related works present in the literature are deeply analyzed and used to build comparisons with the proposed approaches. Moreover, great care is also given to the embedded implementation of the algorithms, especially when they are needed to run directly on the robots. Several approaches are used in order to increase the algorithmic inference efficiency and different hardware platforms are analyzed in terms of their ability to run machine learning methods in real-time. Collectively, this dissertation constitutes a step toward the full integration between robotics and AI and paves the way for future research in this direction.