

Research theme title:

Algorithms for management and control of mobile agent fleets for logistics 4.0

Description:

In the Logistics 4.0 paradigm, which aims at creating intelligent, interoperable and autonomous logistics environments, the problem of managing and controlling fleets of mobile agents is attracting enormous interest for efficient and sustainable logistics. Traffic management of cooperating agents for cargo handling in automated warehouses of smart factories and distribution centers is a significant challenge for real-time control aimed at predicting and preventing congestion, while ensuring productivity and business flexibility.

The overall objective of this PhD project is the optimal management of a fleet of mobile agents within a warehouse 4.0 [1-3]. This category of problems differs on the basis of boundary conditions such as the structure of the warehouse, the type and number of agents and any further constraints. The warehouse could be more or less large and branched, could have corridors in one or more directions or a matrix structure. The agents can be AGVs (automated guided vehicles), possibly of different types, or hand trucks. The traffic manager may need to fully manage each individual agent or, in the case of "smart" agents [4], can work at a superior level in agent routing to minimize congestion and maximize performance.

Thus, this PhD scholarship consists in the study, design and development of mobile agent traffic management algorithms that are particularly effective in addressing one or more categories of these problems. In general, the problem can be divided into: 1) task planning and assignment, 2) route calculation and 3) resolution of any conflicts. In order to improve the efficiency of mobile agents, maximize productivity and minimize downtime, the main challenges in this scholarship will lie in the definition of algorithms aimed at tackling these deeply interconnected sub-problems, or in separately or partially or completely coordinated.

The research activities will be conducted in strict collaboration between the Decision and Control Laboratory (<http://dclab.poliba.it/>) of Polytechnic of Bari and E80 Group SpA (<https://www.e80group.com/it/>), an Italian company specialized in automated solutions for Logistics 4.0. Moreover, the PhD project is of absolute centrality for the Italian National PhD Program in Autonomous Systems, given that it can be considered as a step forward toward the concept of autonomous production powered by robots performing tasks intelligently, with the focus on safety, flexibility, versatility, and collaboration.

Finally, it is worthwhile mentioning that the objective of the PhD project is aligned with the national development strategies as well as the international research directions, which are undergoing radical transformations, enabled by the progressive and pervasive adoption of digital and automation technologies in the industrial sector. In particular, the project is coherent with the strategic pillars and horizontal principles of the Italian National Recovery and Resilience Plan (PNRR), being fundamental for Strategy M2C2 "Digitalization, innovation, and competitiveness in production systems".

References:

- [1] Zhe Liu et al. "Prediction, planning, and coordination of thousand-warehousing-robot networks with motion and communication uncertainties". In: IEEE Transactions on Automation Science and Engineering 18.4 (2020), pp. 1705–1717.
- [2] Zhe Liu et al. "Integrated task allocation and path coordination for large-scale robot networks with uncertainties". In: IEEE Transactions on Automation Science and Engineering (2021).
- [3] Mirko Ferrati and Lucia Pallottino. "A time expanded network based algorithm for safe and efficient distributed multi-agent coordination". In: 52nd IEEE Conference on Decision and Control. IEEE. 2013, pp. 2805–2810.
- [4] Jian Liu et al. "Path scheduling for multi-AGV system based on two-staged traffic scheduling scheme and genetic algorithm". In: Journal of Computational Methods in Sciences and Engineering 15.2 (2015), pp. 163–169.

Type of scholarship:

DM 117/2023 – Project on PNRR (Italy's Recovery and Resilience Plan)

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Study and research period outside the Hosting Institution:

Study and research period at the company:

E80 Group SpA (<https://www.e80group.com/it/>)