Advanced AGV control and navigation

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Task No.	6.1	Global object representation environmental model and communication
	6.2	Risk assessment and emergency collision avoidance
	6.3	Path planning and navigation
	6.4	Pallets loading and unloading functions
	6.5	Control Center (CC) and operator HMI
Coordinator		Kay Fuerstenberg, SICK AG
Author(s)		Lorenzo Sabattini, UniMORE
		Valerio Digani, UniMORE
		Elena Cardarelli, UniMORE
		Markus Boehning, SICK
		Robert Varga, UCLUJ
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Executive summary

The purpose of this deliverable is to describe how the key technologies and systems developed within PAN-Robots are integrated into the innovative logistics system.

In modern factories, a high degree of automation in product processing and packaging has often been achieved. This leads to addressing reduction of the energy consumption, and improvement of flexibility and efficiency of the overall system. However, the degree of automation in factory logistics, that is the transportation of raw materials to storage areas or production lines as well as of final products from the production lines to storage areas or directly to shipment points, is only marginal. Factory logistics thus constitutes a major bottleneck for mass production, creating a need for significant optimization. On these lines, PAN-Robots aims at obtaining a highly automated logistics system supporting future factories to achieve maximum flexibility, cost and energy efficiency while at the same time ensuring safety.

This objective is obtained integrating the key technologies developed within Work Package 5, whose outcome is described in details in deliverables D5.1 [25], D5.2 [26], D5.3 [27], D5.4 [28], D5.5 [29], and D5.6 [30]. Namely, data acquired from innovative sensors are combined and fused for obtaining a global live view of the industrial plant, and for innovative risk assessment. These data are then exploited for obtaining the innovative functionalities of the PAN-Robots system, namely innovative mission assignment and fleet management, autonomous load handling, and intuitive operator HMI. These functionalities lead to defining a logistics system that has increased efficiency, flexibility and safety, as expected by the PAN-Robots system.

In detail, the advanced on-board sensing systems are described in deliverables D5.1 [25] and D5.2 [26], which describes the advanced omnidirectional stereo camera, and how it is integrated with on-board laser scanners to provide an advanced on-board sensing system, respectively. Sensing data fusion techniques are then described in deliverable D5.5 [29]. On-board sensing is complemented by laser scanners installed on the infrastructure, as detailed in deliverable D5.6 [30].

The semi-automated plant exploration system is described in deliverable D5.3 [27], as the sequence of operations that lead to the mapping of the environment and the definition of the route map.

The integration of these key technologies in the PAN-Robots systems is described in this deliverable. In particular, the document describes how data acquired from different cooperative sensing sources (both on-board and on the infrastructure) are integrated to obtain a centralized global live view (global object representation environmental model) of the industrial plant, that contains the positions of the AGVs, as well as the position of any acquired obstacle or object.

This huge amount of information is then exploited for defining advanced techniques for **risk assessment and emergency collision avoidance**.

The motion of the AGVs through the industrial plant is managed exploiting an advanced **global navigation** (path planning and navigation) algorithm that assigns missions in an optimized manner, and subsequently manages the execution of the missions taking into account the status of the traffic.

In order to increase the efficiency of the coordination algorithm, the motion of the AGVs is constrained along a set of roads that define the route map. In the presence of obstacles, local deviations from the route map are possible, using a **local path planning** algorithm that exploits sensing data to perform the manoeuvre in a safe manner.

On the same lines, advanced sensing is exploited for defining innovative methodologies for letting AGVs autonomously perform **pallet loading and unloading**. The proposed methodology is based on the use of an appropriately defined stereo camera.

The centralized **control center** (CC) is a central computation unit that manages all the PAN-Robots elements. Besides centralized data fusion and global navigation functionalities, the CC is in charge of providing global synchronization for all the PAN-Robots modules. Moreover, an **intuitive HMI** has been developed, that allows untrained operators to assess the status of the industrial plant (i.e. position of the AGVs, position of detected obstacles, etc.), and of defining custom missions to be performed.