PAN-Robots
Collaborative project
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P1

Publishable Summary

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Publishable Summary

In modern factories, product processing and packaging have often reached a high degree of automation, in which energy consumption, agile manufacturing and product customization are well addressed. 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. This fact substantiates the project vision of PAN-Robots: a highly automated logistics system supporting future factories to achieve maximum flexibility, cost and energy efficiency while at the same time ensuring accident-free operation.

Unfortunately, today's technology for factory logistics automation is still in an early stage of development and its deployment in the factory requires a trained staff and involves several time-consuming, costly, inflexible and sometimes even error-prone manual tasks. Therefore, the overall project objective of PAN-Robots is to develop, demonstrate and validate a generic automation system for factory logistics in modern factories based on the use of advanced automated guided vehicles (AGVs).

The PAN-Robots consortium proposes a new generation of flexible, cost effective, safe and green AGVs that will be able to transport material and products in modern factories autonomously, intelligently and efficiently. In order to achieve this project objective and to support the project vision, current technologies need to be significantly enhanced and a number of new approaches and technologies need to be developed, as illustrated in Figure 1 below.

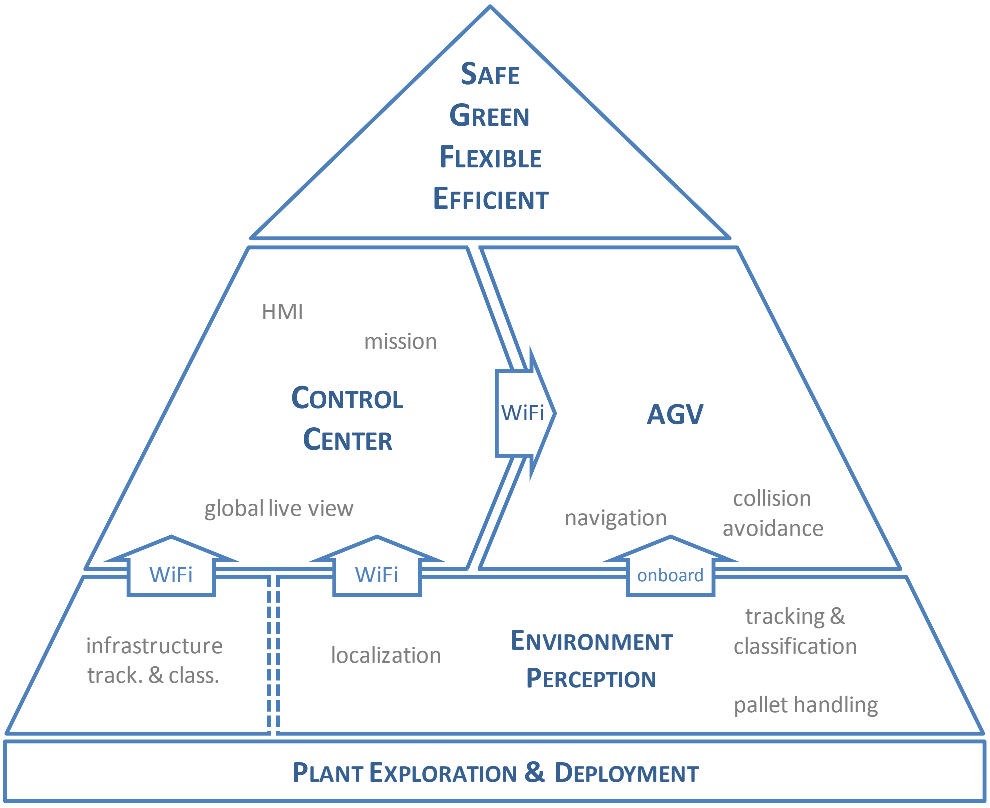

Figure 1: PAN-Robots key technologies

The process of plant exploration and AGV deployment, currently involving many costly, time-consuming, error-prone manual tasks, needs to be greatly automated using high-precision sensor technology and advanced data processing algorithms.

The currently rather rigid AGV fleet and mission management performed in the control center needs to be replaced by a flexible assignment of resources, intelligent AGV navigation and increased system safety. This is achieved by managing a multi-layer map of static and dynamic objects in a so called global live view that is fed with the information acquired by the on-board sensors of the AGV fleet and the infrastructure-based environment perception systems. Additionally, human operators need to be able to easily assign custom missions to available AGVs.

Intelligent global and local AGV navigation is approached by two complementary functionalities: flexible global route assignment for each mission avoiding congestion zones or other reported obstacles by the control center on the one hand, local path planning on-board the AGV in case of unexpected obstacles in the current path.

Load handling, the task of loading and unloading of goods, is currently a time-consuming, sometimes unreliable procedure. A comprehensive, general and reliable autonomous load handling system suitable for all different load handling tasks is required. This is addressed e.g. by a dedicated stereo camera for picking position identification and for visual servoing of the AGV to the required operation point in front of the pallet.

While reflector-based self-localization works reliably in the presence of sufficient artificial landmarks, the work load for reflector layout planning, mounting and mapping is very high and costly. A new approach relying on the identification of natural landmarks in the warehouse provides a much more effective contour-based self-localization. A seamless transition between these two modes provides reliable and accurate self-localization of the AGVs in all areas of the warehouse.

The existing 2D safety concept based on safety Laserscanners provides reliable collision avoidance. However, the system is challenged by highly dynamic objects, objects occluded by structural elements, protruding from the side or dangling from the ceiling. By advanced on-board 2D safety enhanced by 3D omnidirectional perception in combination with sophisticated risk assessment and collision avoidance strategies, these challenges can be mastered to provide accident-free and more efficient AGV operation.

An entirely new concept will be the installation of infrastructure-based environment perception systems for blind spot monitoring for cooperative safety. The information about tracked objects near the blind spot is communicated to AGVs in the vicinity via the control center in order to avoid collisions and increase efficiency.

In total, PAN-Robots will develop four main systems: the control center as the heart of AGV fleet and mission management, the plant exploration system for the 3D mapping of the warehouse, advanced production AGVs, as well as infrastructure-based environment perception systems. The figure below shows these four systems, the hosted key technologies, the partner responsibilities as well as the system interconnections.

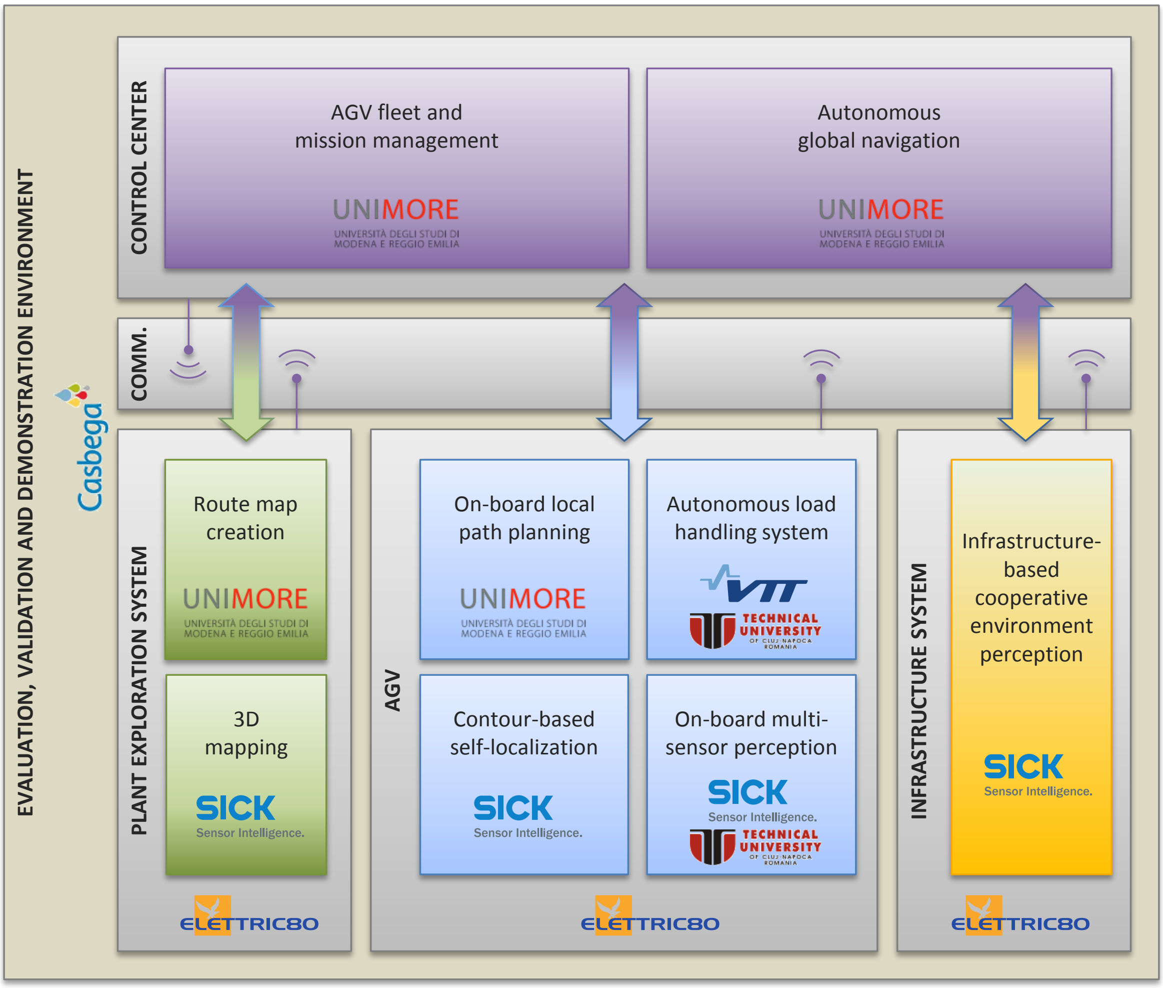

Figure 2: PAN-Robots main systems, information exchange and partner responsibilities

In the course of the first period of the PAN-Robots project, all planned steps towards these objectives have been performed successfully. This includes the non-technical activities such as dissemination and exploitation tasks.

In the first months of the project, a PAN-Robots logo has been designed and a harmonized Project Presentation has been created and the project is now available to the general public via the www.pan-robots.eu website, as shown in **Fehler! Verweisquelle konnte nicht gefunden werden.** (deliverable D1.1). In addition, PAN-Robots is connected to the most important social networks such as YouTube, Twitter, Google+, Facebook and LinkedIn. To increase the public awareness and attention of PAN-Robots, a project Dissemination Plan (deliverable D2.2) has been developed.

Furthermore, PAN-Robots disseminated its objectives and intermediate results at several reputed conferences such as the IEEE International Conference on Robotics and Automation (ICRA) in Karlsruhe (Germany), the Finnish Optics Days 2013 in Helsinki (Finland), and the IEEE International Conference on Intelligent Computer Communication and Processing (ICCP) in Cluj-Napoca (Romania), where two dedicated PAN-Robots sessions with eight presentations were organized. PAN-Robots was also represented at the Drinktec 2013 in Munich (Germany), the world's leading trade fair for the beverage and liquid food industry with around 1,400 exhibitors from over 76 countries and more than 67,000 visitors from 183 countries.

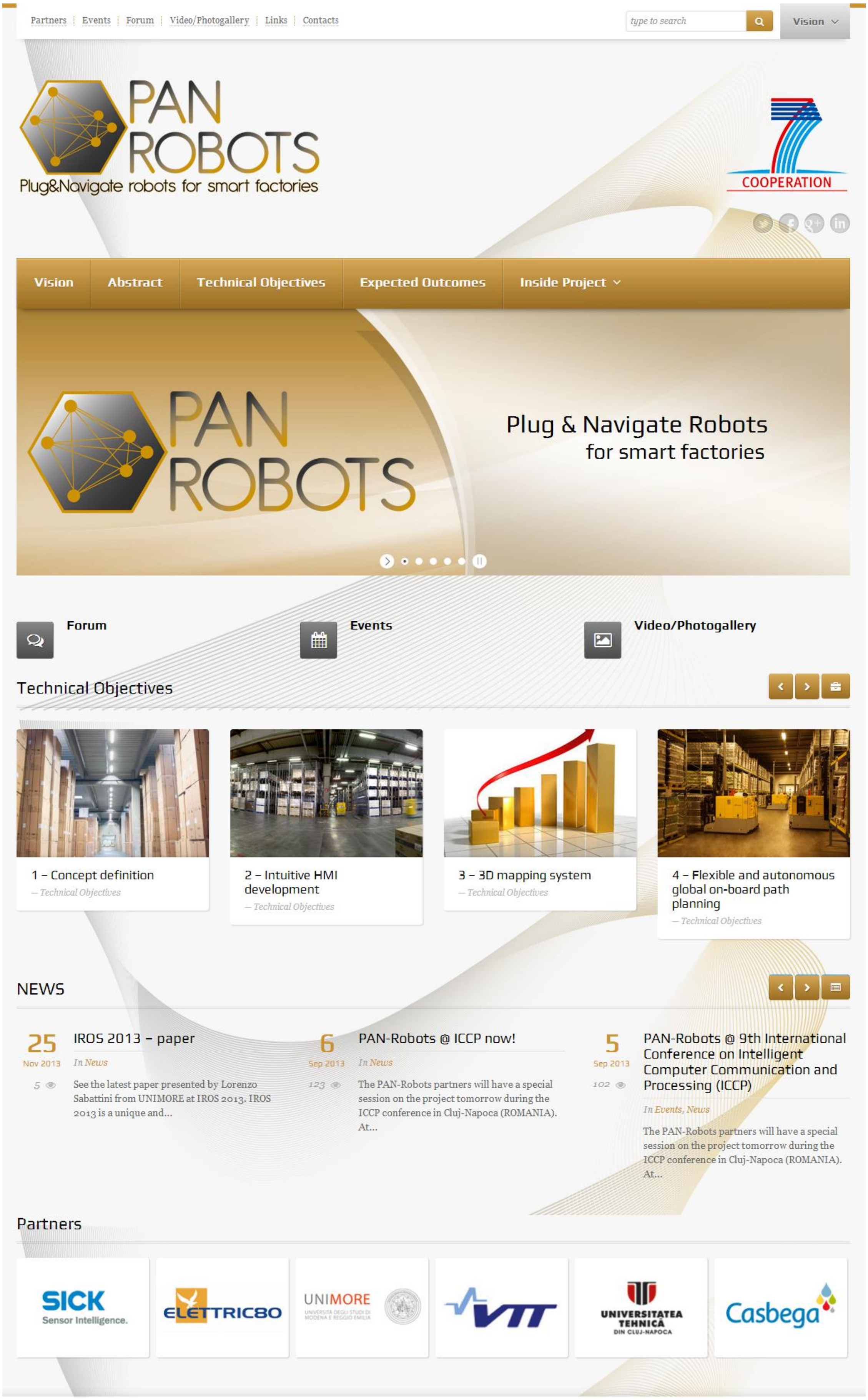

Figure 3: PAN-Robots homepage

In the first project month, a detailed planning of the work packages starting in the first period was done by the project management and the dedicated work package leaders including risk planning.

The user needs and requirements documentation has been approached starting with the analysis of user issues identified by an AGV user survey. The results underlined the need for developing a new generation of flexible, cost effective, safe and green AGVs that handle logistics tasks autonomously, intelligently and efficiently. From the list of identified user issues, a set of key target scenarios was derived and it was shown how these are addressed by the PAN-Robots key technologies. The details about derivation of user needs and requirements have been provided in the deliverable D3.1, completing the milestone M1.

Based on these requirements, the specifications for the PAN-Robots key technologies and the architecture of the individual systems and subsystems have been elaborated, resulting in the specification and architecture deliverable D4.1, accomplishing milestone M2. PAN-Robots will develop four main systems as illustrated in Figure 2 above, hosting the different key technologies.

In the second half of the first period the development of key technology components and modules has been started with iterations of discussion, design and simulation. An extensive measurement campaign at Casbega in Madrid (Spain) was performed in September.

In the last quarter of the first year, an evaluation and validation plan has been compiled and is provided in deliverable D8.1. It defines the process and the procedures on how to test and evaluate the PAN-Robots components, sub-systems and systems.

In parallel to the dissemination and exploitation as well as all technical tasks, the project management has coordinated the project work and ensured the focus of all partners to their specific tasks in line with overall objectives. For a transparent and continuous project controlling, quarterly reports have been compiled, describing the work performed in detail as well as the used resources and meetings held. As mentioned above, the dissemination of the PAN-Robots project is a key factor for a successful project. Consequently, a clear dissemination process was defined and implemented, ensuring high quality and the agreement of every partner on publication of the content.

The overall project has started successfully, mastering the first challenges with the comprehensive analysis of user needs and requirements as well as the detailed specification and architecture of all systems to be developed within PAN-Robots. It is expected that the outcome of the project will be significant improvements in AGV deployment time, operation safety and efficiency, to be exemplified in a demonstration event in a Casbega warehouse at the end of the project in October 2015. The developed systems will pave the way for a new generation of smart AGVs for factories of the future.