ESMERA RETAIL CHALLENGES

Retail and intralogistics are some of the sectors in which professional service robots can play a key role in the short to mid-term. Warehouse based systems (order picking) and intra-logistics operations in factories and retail are some of the most promising applications.

In fact, according to the 2018 IFR World Robotics report '*69,000 logistic systems were installed in 2017, 162% more than in 2016 (26,294), accounting for 63% of the total units and 36% of the total sales (in value) of professional service robots. 6,721 automated guided vehicles in manufacturing environments and 62,211 in non-manufacturing environments are building up this increase of 162% compared to automated guided vehicles sales numbers in 2016. It is assumed that the actual number of newly deployed systems is far higher. The value of sales of logistic systems is estimated at about US$ 2.383m, and increased by 138% compared with 2016*'.

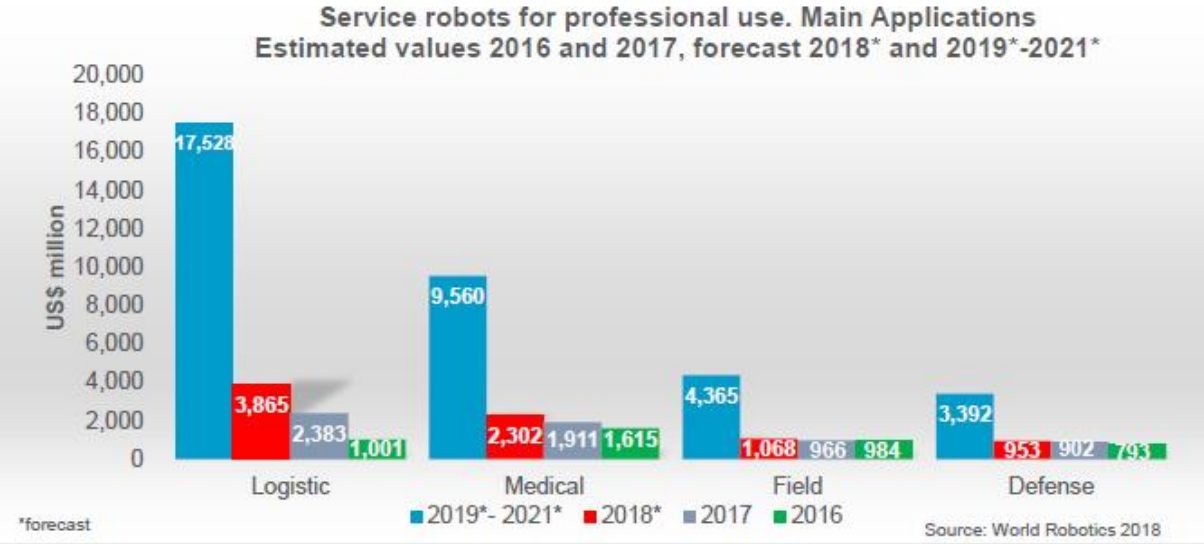

Figure 1. The distribution of service robots in different areas[1]

There is a need for much cheaper and more flexible systems than current Automated Guided Vehicle (AGV) systems, able to work alongside humans for full flexibility.

This domain offers the following technical topics of interest:

- Autonomous vehicles: autonomous navigation, map building and localisation, operation in dynamic environments; operation in close proximity with humans; and adaptability to environments with changing layouts.
- Warehouse optimisation and operations planning: this includes the need for improved autonomous planning and scheduling methods that will need to take into account the risk of failure or delay, and variability in human and robot behaviour.

By answering to this challenge, it would be possible to contribute to overcome some of the key barriers to market of robotic systems in logistics, i.e., (1) lack of flexibility and adaptation of systems to changing needs, (2) high cost of ownership and long term return on investment, (3) user concerns about system complexity and (4) lack of standard interfaces between systems.

[1] This graph was taken from https://ifr.org/downloads/press2018/Executive_Summary_WR_Service_Robots_2018.pdf

ESMERA has identified the following challenge as potential scenarios that proposals can use to develop and test their innovative ideas. Under each Retail challenge, ESMERA propose two options of industrial challenges that can be solved, option a) ESMERA proposed challenge and option b) Open challenge.

Retail-Intralogistics Challenge 1: Robotic platforms fleet management for intra-logistics operations in collaboration with humans

Under this challenge it is expected to develop a system which can work with humans to handle intra-logistics operations.

As defined in the Robotics 2020 Multi-Annual Roadmap, the key abilities that are relevant for this challenge are:

- **Adaptability:** In order to improve overall efficiency, logistics and transportation systems must be able to adapt to changes in the environment:
    - Process optimization (e.g., routes taken, warehouse layout optimization, task allocation optimization)
    - Re-planning of operations under changing conditions, e.g. rescheduling of operations over robots and humans
- **Interaction:** Systems have to work in close proximity to humans. Thus, systems should be designed with inbuilt safety capabilities, as well as adequate interaction abilities.
    - Shared workspaces and human safety
    - Recognition of and adaptation to human behaviour
- **Dependability:** System failures can cause considerable delays in product delivery and high economic losses.
    - Long-term, failure-free navigation
    - Long-term, deadlock-free coordination
    - Risk-aware planning, scheduling and optimisation of operations to reduce risk as demands vary
- **Perception ability:** Vehicles need to be capable of determining precisely their location with respect to the environment over long periods of time; to maintain consistent and up-to-date maps of their immediate surrounding; to identify target destinations for loading and unloading operations; to identify humans and other dynamic entities and to track their position.
    - Accurate and precise long-term localization in dynamic environments
    - Automatic map building and maintenance
    - Tracking of humans, understanding of human actions and intents
- **Cognitive abilities and decisional autonomy:** Cognitive reasoning ability is critical to planning and reasoning around optimisation and scheduling of multi-actor systems.
    - Autonomous optimisation, rescheduling and planning of whole warehousing operations taking into account changing workloads
    - Continuous 24/7 operation of fleets, seamless vehicle substitution
    - Coordination and task allocation with guaranteed formal properties (e.g., absence of deadlocks, adherence to temporal constraints and orderings, avoidance of “off-limits” zones)
    - Autonomous navigation through diverse environments (e.g., from a distribution point to a store, etc.)
    - Ability to semantically annotate the map of the fleet's working environment (e.g., the store, the warehouse, the paths/corridors, etc.)
    - Integrated task scheduling and motion planning, fleet coordination, and vehicle control

It is expecting from the solution to fulfill the following metrics:

- **Collaborative and safe**: Working in the close vicinity of an operator and other workers while performing specific task.
- **Availability at the point and time requested:** It is expected from the system to be available in the start point at the time when it is needed.
- **Navigation capability:** Successfully navigating around, or through the facility while fulfilling the task.

Under the above challenge, ESMERA project proposes two options. The proposer must address one of these challenges or highlighting where elements of the proposed system could be used for the benefit of more than one system would be beneficial.

A) ESMERA proposed challenges: this challenge is extracted from *one* industrial use case which is:

RETAIL CHALLENGE 1. A1 (R1.A)

Part transportation: automated robots passing through several picking locations where human pickers load the cart carried by the robots or the robots themselves. Each of these can manage different orders (multiple boxes or compartments).

The robot will need to operate in a typical warehouse environment (mimicking supermarket store with 2 m- wide aisles) with leveled grounds, moving away from pillars and shelves and, in particular, in a human-robot collaboration scenario (there is no customer, but there are workers and eventual obstacles (columns, boxes, etc..) in the environment).

In this challenge it is crucial to guarantee that robots are in the target destination whenever they are requested by the picker, to avoid delays in the delivery of goods. It is also expected from the solution to interact with the order management system. An order is an online purchase from a particular customer. It is variable and can contain namely any type of food products/groceries in a wide-range (such as milk bottles, meat trays, yogurt trays, snacks, fruits and vegetables…). All orders fit into bags (supermarket bags) that goes for delivery. In the current situation, pickers with a cart can take 12 online orders at a time (each order a couple of bags, a couple of kg which is variable) and the developed solution must have improvement on that number.

In addition, the maximum robot size should be around 2 meters and highly-constrained maneuvers are not “must” for this challenge. The operator has to read the EAN from the item before placing it the right box.

The current picking process is done by a human operator (a picker) that receives commands in a PDA to pick products of different types from the shelves, following a pre-determined and optimized route. The items that fulfil different orders are placed in a cart that can take several orders at the same time. This challenge is provided by the company SONAE.

Figure 1: Human pickers and mobile robots collaborating in order preparation

B) Open challenge (RETAIL CHALLENGE 1.B (R1.B))

Any other proposal for similar technologies is eligible for funding, provided that a thorough explanation of the industrial needs is presented. The proposals will also have to clearly identify the state of the art in commercially available solutions and highlight the differences/advances over it. More specific each proposal in order to be in line with the ESMERA requirements has to provide:

- Clear indication of the company, institution or other that are in need of the proposed solution (no funding is allocated to challenge providers)
- Description of the problem that the company or companies need to be solved.
- Proof that currently there is no comparable solution (concept or approach, performance, cost…) in the market.