

Appendix to:

“Robotic Visions to 2020 and beyond – The Strategic Research Agenda for robotics in Europe, 07/2009”

Methodology

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“Robotic Visions to 2020 and beyond – The Strategic Research Agenda for robotics in Europe, 07/2009” can be obtained from:

EUROP Secretariat
C/o EUnited Robotics
Diamant Building, Bd. A. Reyers 80
1030 Brussels, Belgium

Phone: +32 2706-8222
Fax: +32 2706-8223
Email: info@robotics-platform.eu
Internet: www.robotics-platform.eu

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1. Introduction

The aim in CARE is to analyse developments and identify chances and risks for the European market position in the robotics sectors. The target group of the SRA are politicians, stake holders in robotics and funders. The effectiveness of this roadmap depends to a large part on the quality of the information which is gathered and analysed within the roadmapping exercise. The approach for the development of the "SRA 2020" is a mix of forward and backward prospective analysis combining the technology-push and market-pull approach which are described below.

Any roadmapping exercise aims mainly at getting people to talk to each other and extract the relevant information from this discussion. This aim can be achieved through structuring the process and visualising the information within a roadmap. CARE manages to structure the process in a scientifically precise manner, but needs to highlight the correspondence and integration with experts. Data extraction and data fusion has to be performed with the help of experts coming from the community.

2. Market Pull

The backward prospective analysis, which works on the basis of Product Visions, considers today's understanding and possibilities to forecast future developments and requirements. This obviously neglects those products that cannot be foreseen and might develop from break-through- and coincidence-innovations.

First step within the development of the SRA was the division of the robotics world into different sectors specifying competence fields and industrial focus. Each sector has a sectorial lead who represents a working group with a wider group of experts in the specified field. The sectors are:

- Industrial robotics
- Domestic service robotics
- Professional service robotics
- Security robotics
- Space robotics

The analysis starts by working within the working groups of the different sectors identifying existing projects, demands and market requirements. Coming from current development projects, customer requirements and existing science and technology development initiatives the prospective analysis will be used to describe Application Requirements that have to be fulfilled short, mid and long term. Below this is discussed in terms of the timeframe *2010*, *2015* and *2020+*. Here *2010* is considered to be close to current state-of-the-art products and prototypes, which will be turned into products by 2010. *2015* refers to mid term developments. *2020+* generally describes the long term goals. Considering the ambitious nature of most of these, 2020 is not considered a strict deadline for the launch of these products.

Next Product Visions are analysed to determine the level of performance required to be able to realise a successful product. An example may be that the robot has to be able to reach a certain position with a high degree of accuracy. These Application Requirements are again analysed with the aforementioned time line in mind. Timely development of Application Requirements and their evaluation can offer great benefits for the users. Benchmark information gives concrete numbers and quantitative information in the context of a Product Vision. The application can be named and linked to quantitative information as a guideline for the user or reader.

Comparing the Product Visions and their Application Requirements six groups were identified. Each group contained Product Visions from several sectors and every Product Vision could be assigned to a group. These groups are called Application Scenarios:

- Robotic worker
- Robotic co-worker
- Logistics robots

- Robots for surveillance and intervention
- Robots for exploration and inspection
- Edutainment robots

Both, technology experts within the industrially driven working groups, and experts within the scientific community, then find, validate and define possible technologies meeting the expectations from the Applications Requirements. This is done through identifying the research gaps which obstruct forward progress for successfully developing the given applications and Product Visions.

3. Technology Push

Technology-push prospective roadmaps start with existing research projects, and fill in the remainder of the roadmap by identifying the diversity of capabilities to which this research could lead. The development is carried out as follows:

1. A technology glossary is generated and is updated throughout the process.
2. The technology mindmap, which contains all information about technologies collected to date, is constantly updated and restructured based on the information from the working groups and interviews with individual technology experts. It will form the basis for the Mini-Delphi study.
3. First, relevant technologies are collected through brainstorming within the consortium. Sources for the technologies are market-pull and technology-push considerations: the technologies necessary for the Application Requirements, and those known through personal/ industrial contacts.
4. The next step is to complete/ add/ verify the technology world on the process within working groups of the consortium. Experts for verifying technology view are members of the consortium or contacts from personal networks of consortium partners: academia, industry, and others.
5. The technology world is clustered into technology groups which are possible approaches in order to help fulfil the Application Requirements.
6. Pre-Delphi: As a first step, the verification of the technology mindmap takes place through experts outside of the CARE consortium; trial runs are carried out with experts from the Fraunhofer network, at KUKA, and individual experts from universities and institutes.
7. The mindmap is restructured and remodelled on the basis of recommendations and comments from pre-Delphi (an estimated 80% solution).
8. Delphi: The branches of the mindmap are sent out to selected experts within the scientific community; A final verification of the mindmap takes place; further information regarding benchmarking data of the technology methodologies is filled in, in order to achieve further 10-20% of the solution.

This analysis contribute largely to understanding the development, highlighting core technologies and identifying the potential of the technologies. But two further factors are of importance when prioritising the technologies: the drivers of each area and whether Europe is currently in a strong or weak position. Good examples of robotics-driven technology group are “manipulation”, “navigation”, and “perception”. Batteries provide a good example of the technologies where advances will benefit robotics, but where, for now, robotics will not be a driving force. Regarding the second aspect, Europe cannot afford to only concentrate on areas of strength, it will also need to foster technologies that could become critical barriers to market. In areas of relative weakness an informed decision has to be made whether a dependence on others is acceptable. Having collected all this information a prioritisation of the technologies is performed in order to identify key technologies and thus future research potentials. It is also noted, however, that this can only give an overview. Detailed priorities have to be developed with a specific Product Vision or, at least, a Application Scenario in mind.