Leading European Robotics

Robotic Visions to 2020 and beyond – The Strategic Research Agenda for robotics in Europe

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Mission statement

This Strategic Research Agenda aims to promote robotics development and business activity in Europe
EUROP – European Robotics Technology Platform

EUROP Vision

- To enable European robotics companies to build and maintain world leading positions in all robotics markets to the benefit of European society.

EUROP Goals

- Develop the strategic goals of the European robotics industry and foster their implementation
- Provide networking support for the European robotics community
- Promote European Robotics

SRA for Robotics in Europe presented July 2009
EUROP – Five market-driven domains

- Industrial
- Domestic Service
- Professional Service
- Security
- Space

Robotic Market
Converging Technologies
→ Need Cross-fertilisation
Robot Classification

Robot

- Industrial
- Service
- Professional
- Security
- Space
- Everything Else
- Domestic
Why use a robot? – Industrial robots
Why use a robot? – Service robots
European Robotics Technology Platform (EUROP)
EUROP – Membership

members’ locations

Legend
- private companies
- research & education
- cooperation partners
- KUKA (EUROP President and EUROP Coordinator)
SRA Development Process

May 2006
1st Glossy
SRA

May 2008
Intermediate
SRA

June 2008
Glossy
Executive Summary

July 2009
2nd Glossy
SRA
Setting up a joint Research Agenda for robotics in Europe

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INDUSTRY

MARKET PULL: FROM PRODUCT VISIONS TO APPLICATION REQUIREMENTS

ACADEMIA

TECHNOLOGY PUSH: FROM FUNDAMENTAL SCIENCES TO TECHNOLOGY BREAKTHROUGHS

CARE WORKING GROUPS, DELPHI STUDIES, CONSENSUS MEETINGS

EUROPEAN ROBOTICS SRA

INDUSTRIAL INNOVATION IN ROBOTICS
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Roadmapping methodology

Step 1: Identified 39 Product Visions

Step 2: What level of performance is needed to make these reality? → Application Requirements

Step 3: Compare Application Requirements of all Product Visions → grouping into Application Scenarios

Step 4: Identify Technologies able to fulfil the Application Requirements
### Step 1: Product visions from all sectors…

#### Industrial Robotics
- Rapidly adaptable manufacturing cell
- Coordinated mobile manipulators
- Large structure manufacturing (incl. civil ens.)
- Human-like assembly robot
- Postproduction automation (recycling, remanufacturing)
- Robot with integrated process control

#### Professional Service Robotics
- Autonomous transport of people
- Maintenance robot
- Underwater robot
- Mining robot
- Motion simulator
- Forestry and agriculture robot
- Robot trainer
- Professional cleaning robot
- Robot guide
- Robot assistant for professionals
- Robot teacher
- Surgical robot
- Autonomous transport of goods
- Rehabilitation robot

#### Domestic Service Robotics
- Personal robot
- Robot assistant in security contexts
- Robot companion
- Robot toy
- Robot assistant for physically challenged
- Site protection (domestic and professional)

#### Security Robotics
- Robot assistant in security contexts
- Border surveillance
- Robot assistant for physically challenged
- Site protection (domestic and professional)
- Security checks of persons and people
- Inspection in environments inaccessible to humans

#### Space Robotics
- Orbital robot agent
- Planetary robot agent
- Orbital robot assistant
- Planetary robot assistant
- Orbital robot explorer
- Planetary robot explorer
Step 2: …result in 12 Application Requirements…

01 SUSTAINABILITY
02 CONFIGURATION
03 ADAPTATION

04 AUTONOMY
05 POSITIONING
06 MANIPULATION & GRASPING

07 ROBOT-ROBOT INTERACTION
08 HUMAN-ROBOT INTERACTION
09 PROCESS QUALITY

10 DEPENDABILITY
11 PHYSICAL PROPERTIES
12 STANDARDISATION
Step 3: … leading to Application Scenarios…

Worker

Co-worker

Logistics

Surveillance & intervention

Exploration & inspection

Edutainment

Worker

Co-worker

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Surveillance & intervention

Exploration & inspection

Edutainment

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Step 3: … covering all market sectors…

- Industrial
- Professional services
- Domestic services
- Security
- Space
Step 4:  
18 Technologies fulfil Application Requirements

<table>
<thead>
<tr>
<th>Mostly driven by others</th>
<th>Driven by robotics and others</th>
<th>Mostly driven by robotics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SYSTEM</strong></td>
<td><strong>REAL-TIME</strong></td>
<td><strong>COOPERATING</strong></td>
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<td><strong>ARCHITECTURE</strong></td>
<td><strong>COMMUNICATION</strong></td>
<td><strong>ROBOTS &amp;</strong></td>
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<td><strong>POWER MANAGEMENT</strong></td>
<td><strong>HUMAN-MACHINE</strong></td>
<td><strong>AMBIENT</strong></td>
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<td><strong>SYSTEM ENGINEERING</strong></td>
<td><strong>INTERFACE</strong></td>
<td><strong>INTELLIGENCE</strong></td>
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<td><strong>TOOLS</strong></td>
<td><strong>SAFETY</strong></td>
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<td><strong>MODELLING</strong></td>
<td><strong>ACTUATION</strong></td>
<td><strong>END EFFECTORS</strong></td>
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<td></td>
<td><strong>LOCOMOTION</strong></td>
<td><strong>NAVIGATION</strong></td>
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<td><strong>SENSORS</strong></td>
<td><strong>SENSING &amp; PERCEPTION</strong></td>
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Technologies in the SRA

- Definition
- Drivers of the technology
- European strengths and weaknesses

- 2010: state of the art / short term development
- 2015: mid term development
- 2020+: long term goals
Ethical, legal, and societal issues

- Ethical issues
  - Robot or robotic device acts in an unintended manner (does “wrong”)
  - Robot or robotic device is applied inappropriately

- Legal issues
  - Who takes responsibility for the robot’s/devices’ actions?

- Societal issues
  - Changing labour profiles
  - Social division
  - Robot acceptability

→ potential barriers to market
The eight SRA commandments

- Take advantage of robotics technology in all aspects of life
- Master the challenge of system integration
- Create a European robotics supply chain
- Focus on the right research and technologies
- Create new markets through SME support and technology transfer
- Support cross-fertilisation to maximise the impact of R&D
- Enhance robotics training and education
- Avoid ethical, legal, and societal issues becoming barriers
EUROP’s position in the multi-annual roadmap

EUROP as “ManuFuture-connected ETP” contributed:

6 product visions from industrial robotics domain

- Rapidly adapting manufacturing cells
- New task-oriented robot control by integrated process models
- Robot automation for small and medium sized manufacturing
- Robots for post-production automation
- Robotised human-like assembly
- Robot assistants in industrial environments
EUROP’s position in the multi-annual roadmap

R&D challenges of (industrial) robot systems are to some extent synergistic with R&D challenges of manufacturing systems in all areas of the FoF roadmap:

- Sustainable Manufacturing
- ICT-enabled intelligent manufacturing
- High-performance manufacturing
- (Exploiting new materials through manufacturing)

⇒ Robotics is a key technology for the future of manufacturing!
  (and can use a number of developments coming out of the roadmap)
Industrial robotics challenges in the multi-annual roadmap (1/2)

- Sustainable Manufacturing

- ICT-enabled intelligent manufacturing
  - E.g Smart Factories - agile manufacturing and customisation: small batch and craft manufacturing”
  - E.g. Virtual Factories - value creation, global networked manufacturing and logistics: product upgrades
  - E.g. Virtual factories - manufacturing design and product life cycle management: “early concept modelling, simulation and evaluation
Industrial robotics challenges in the multi-annual roadmap (2/2)

- High-performance manufacturing
  - E.g. Flexible adaptive production equipment, systems and plants for rapid (re)configurations and optimal energy use: “cooperative production tasks between humans and robots”
  - E.g. Zero defect manufacturing: “knowledge-based self-learning systems”

- Exploiting new materials through manufacturing
  - E.g. “new technologies for casting, material removing and forming processes” – especially small & medium batch production
Summary and Conclusions

- Europe is ready to lead worldwide robotics developments
  - Particularly in Industrial and Professional Service Robots
- The SRA will help to guide investment
- Use the common strategic vision!
  - Follow conclusions of the SRA
  - Focus all robotic stakeholders (industry, academia, private & public investors)
- EUROP is ready to facilitate the process
- Robotics is a key component of the Factory of the Future
- Industrial Robotics can develop and prove new technologies for Service Robots
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THE END