Robotics impacts Industry and Society: What are the Numbers and Trends?

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The Fraunhofer-Gesellschaft Locations in Germany

- 72 institutes and research units
- 25,327 staff
- € 2.3bn research volume (2017)
Fraunhofer IPA
Technology consultant and innovation driver since 1959

- Operating budget 2017: 63 million Euro
- Total investment budget: 4 million Euro
- Total industrial revenues: >24 million Euro
- More than >450 FTE engineers/scientists

Note: Key figures for 2017, all locations

New technical center “Gebäude D” in Stuttgart

Fraunhofer Institute Center in Stuttgart
Technical equipment and laboratories

- Application Center Industrie 4.0
- Future Work Lab
- Labs for cutting, joining and sawing
- Cleanrooms & cleanliness rooms
- Motion laboratory
- Electroplating laboratory
- Intervention room
- Coating technology center
- Robotic experimentation area
- Biomanufacturing laboratory
- Model factory for functional coatings
- Factory planning and production laboratory
- Labs for additive manufacturing
- nICLAS Laboratory automation
- Virtual Orthopedic Lab
Active Research Environment for the Next generation of Automobiles: A complete research factory starting operation in Jan 2017

www.arena2036.de
Worldwide shipments of industrial robotics in 2017
Most relevant industrial application areas and processes

<table>
<thead>
<tr>
<th>Handling (47%)</th>
<th>Clean Room (11%)</th>
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<tbody>
<tr>
<td>Welding (22%)</td>
<td>Assembly (12.75%)</td>
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<tr>
<td>Machining (1.6%)</td>
<td>Dispensing (3.1%)</td>
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Industrial robot shipments (new installations)
All time high in 2017 and positive prospects

Industrial robot shipments worldwide [\*1000 units]

- Germany (5%)
- North America (-1%)
- Japan (19%)
- Europe (7%)
- China (21%)
- Shipments worldwide (10%)

Increase 2017/2016: 30%
2020 robot stock estimated 3m
CAGR China since 2014: 29%
IR share in automotive ~47%
Major growth applications:
  - Metal industry 55%
  - 3C (mainly Asia) 33%
  - Food (on low volume) 19%

Robot density 2018: Number [units] of installed industrial robots per 10,000 employees in the respective domains

- Worldwide average density 85
- Europe 106
- China 2020 target density 150

www.worldrobotics.org, Oktober 2018, Fraunhofer IPA
Technology Trends in Industrial Robotics

1. Cost effectiveness
   - Cost 1991 = 100%
   - Labor cost (D): €3.5k (2017)
   - Robot unit price: $42k (2017)

2. Human-Robot Collaboration
   - Physical interaction
   - Learning control
   - Strategies, skills

3. Cognitive capabilities

4. Networked Industrie 4.0
   - Skill-based, intuitive robot instruction

Robot Optimization by AI/Machine Learning

1. Processes, tasks
   - Physical interaction
   - Learning control
   - Strategies, skills

2. Program generation
   - Planning
   - HMI
   - Behavior explanation

3. Robot performance
   - Accuracy
   - Dynamics
   - Durability etc.
Service Robots for Professional Use I

Service Robots for Professional Use II


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Industrial and service robotics supply industries

**Industrial Robotics annual turn-over**

- US$15bn turn-over Industrial Robots (IR)
- 55 IR manufacturers worldwide
- 1k systems integrators
- $50bn total turnover IR industries
- 15% CAGR until 2020+ (estimated)
- Average unit price US$53k (2012) → 42k (2017)

**Key figures Industrial Robotics IR (est.)**

**Service Robotics annual turn-over**

- >$11.5bn turn-over (US$8.7bn professional service robotics, 2.6bn in “domestic/personal”)
- 720 suppliers/manufacturers of SR, 30% start-ups (max 5 years)
- 70% use ROS in one form or the other (estimated)
- 14% (since 2009) CAGR for professional SR
- 23% CAGR for domestic/personal SR

“Ready to use”, relatively little systems integration

**Key figures Service Robotics SR**
Statistics Scheme and Classification of Service Robots by Application Areas

- **Professional use**
  - 16-21 Field robotics
  - 22-26 Professional cleaning
  - 27-29 Inspection, maintenance systems
  - 30-33 Construction and demolition
  - 34-38 Logistic systems
  - 39-42 Medical robotics
  - 43-45 Rescue & security applications
  - 46-50 Defense applications
  - 51 Underwater systems (civil/general use)
  - 52 Powered Human Exoskeletons
  - 53 Mobile Platforms in general use
  - 54-58 Underwater systems (civil/general use)
  - 59 Other

Service robot manufacturer → Mailing → Collection, compression → 60 areas → Service robotics application area

- Size
- Age
- Status
- Region

Robot sales previous year → Robot units

Sales forecast for next 4 years → Robots in value [currency]
Service Robots for Professional and Domestic Use (Main Applications)
Estimated Values 2016 an 2017; forecasts(*) 2018 and 2019-2021

**Professional Applications**


**Domestic Applications**


*Attention: Accumulated sales for 3 years*

*forecast*
Robotics Outside the Manufacturing Scenario

Service robot (SR) annual sales worldwide for professional, domestic applications in [bnUS$]

- **SR professional**
- **SR domestic**

Main applications:
- Logistics
- Agricultural
- Medical
- Public relations

2016: Drones taken out

Number of service robot manufacturers (professional and domestic use) by country of origin (2018, excerpt)

- **Established** service robot manufacturer
- **Start-ups** (aged max 5 years, with product on the market)

Source: World Robotics 2018; [www.worldrobotics.org](http://www.worldrobotics.org), Fraunhofer IPA
Number of service robot manufacturers by main types (professional use) and by region of origin, status 2017 (selection)

- Agriculture
- AGV in manufacturing
- Surveillance / security
- AGVs non-manufacturing
- Robot assisted
- Mobile Platforms
- Unmanned ground based
- Rehabilitation systems
- Powered Human
- Underwater systems (civil)
- Other inspection and...
- Other professional SR
- Unmanned aerial vehicles
- Mobile guidance robots
- Other medical robots
- Robots in marketing

Europe
North America
Asia

www.worldrobotics.org, Oktober 2018, Fraunhofer IPA
Business sizes of service robots of all types in numbers of employees (by region of origin, 2017)

- Europe
- North America
- Asia

www.worldrobotics.org, Oktober 2018, Fraunhofer IPA
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