

Robot



3. 로봇산업 핵심기술

구분	유망제품 ↳ 핵심기술㉠㉢㉣	핵심지표 (목표수준)
1	협동기반 차세대 제조로봇 ↳ 작업 대상물 인식, 소형부품/유연 작업물 조작 및 조립, 작업장 공유를 위한 안전기능	조립성공률(95%) 유연물체 인식율(95%)
2	자율주행 모바일 매뉴플레이터 ↳ 다양한 제품에 대한 정확한 인식 기술 및 최적 동작을 통한 제품 조작 기술	인식정확도(98%이상) 조작가능무게(10Kg)
3	사회안전로봇시스템 ↳ 재난재해 확산방지 및 인명탐색과 구조를 위한 사회안전시스템 기술	안전로봇이동플랫폼 기술 (협지이동 플랫폼 개발)
4	헬스케어 로봇 ↳ 전문시설용 환자 양중/이동 로봇 및 실버케어 로봇 기술	사용자 의도인식 - 음성(5m 이내 자연어 인식 98%)
5	수술재활로봇 ↳ 사용자 맞춤형 재활 로봇 기술	재활기구-동시적용 자유도(8DOF이상)
6	다중로봇운영시스템 ↳ 다중환경 모델링 및 임무 통제를 위한 제어 및 통신기반 관제 시스템	다중환경모델링 기술 (3차원 환경 재구성 모델링 기술 개발)
7	웨어러블 로봇 ↳ 딥러닝 기반의 착용자 운동패턴 구분 및 학습엔진 기술	신호처리속도(1ms) 의도판단 정확도(90%)
8	농업·축산로봇 ↳ 빅데이터기반 스마트팜을 위한 작물/과실 자동인식기술 및 로봇 이동/정밀조작 시스템	이동 및 조작 정밀도 (0.5m/s 및 ± 1 cm)

9	개인이동로봇 ↳ 일상 생활환경 자율이동 기술	일상 생활환경 자율 이동(의미론적 지도 작성 및 안전한 자율 이동 등)
10	스마트 물류 로봇 ↳ 실내외 환경에서 강인한 고정밀 /고속 위치인식 및 이동기술	위치인식 오차범위 (± 1 cm) 이동속도(2m/s)
11	소셜 로봇 ↳ 스마트홈 환경에서 인간과 공존 하며 제어, 인식 등 상호작용이 가능한 고정확도 인식 기술	감정인식(복잡한 인간의 감정을 정확하게 인식 하여 이를 통한 상호 작용 가능)
12	가사도우미 로봇 ↳ 매니플레이션 기술, 데이터 수집을 위한 IoT장치 연동, 인공지능, 사용자 환경 인식 등을 위한 클라우드 서버 연동 빅데이터 등을 통한 로봇 서비스 융합 기술	비행시간(5시간) 운용반경(150km) 수직이착륙 (Sea Stats Lv. 4)

Global robot market between 2016 and 2019:

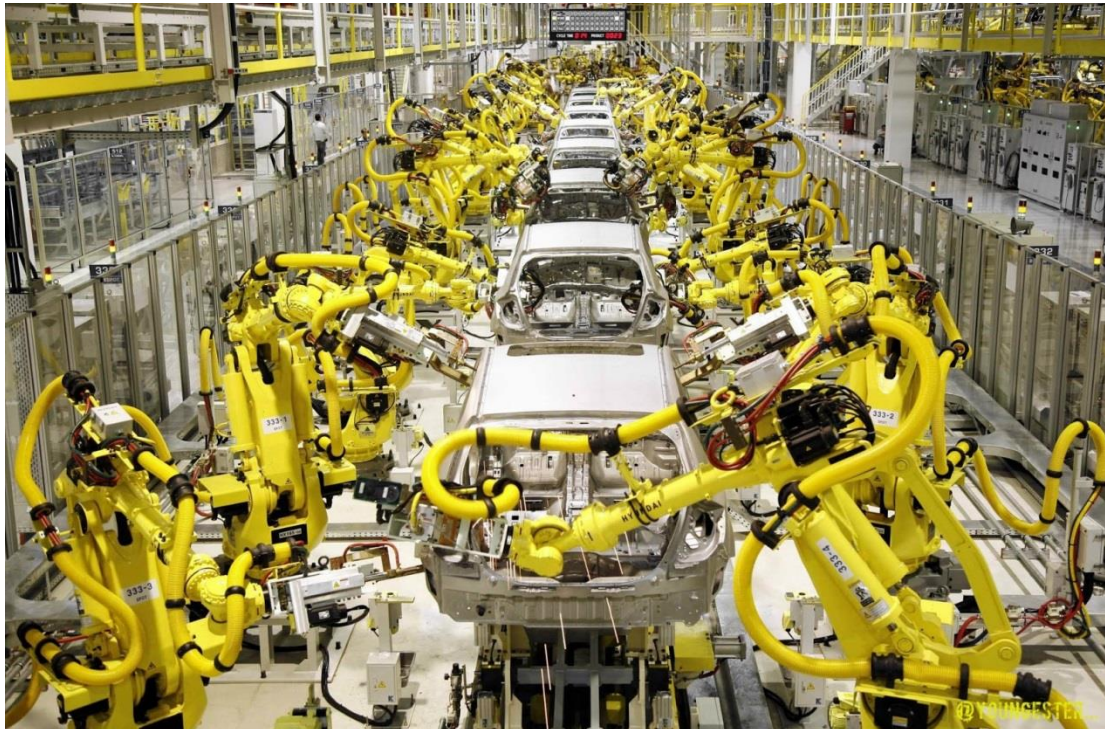
- 1.4 million industrial robots will be installed in the factories to increase productivity
- 333,000 service robots for professional use will be sold to non-manufacturing and to manufacturing sectors

and

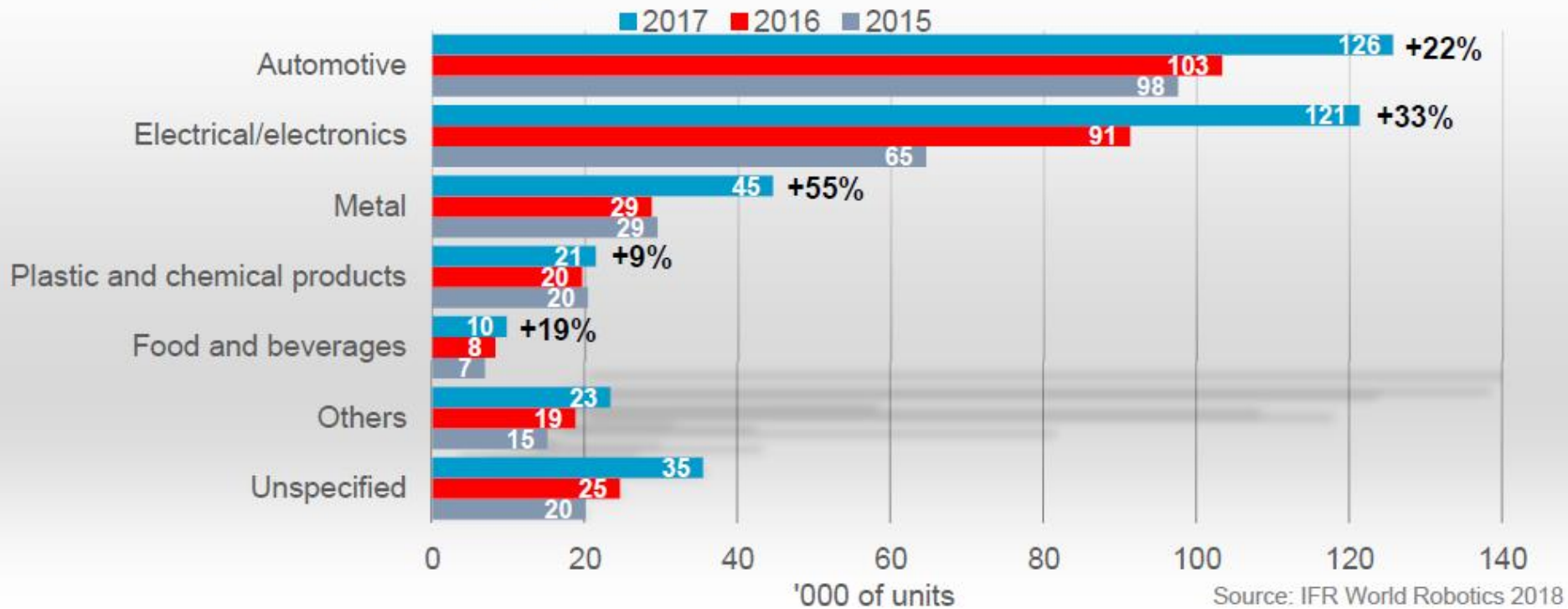
- 42 million service robots for personal and domestic use (consumer robots) will be used in our private life

Industrial Robotics

- to automate tasks to achieve a homogenous quality of production or a high speed of execution

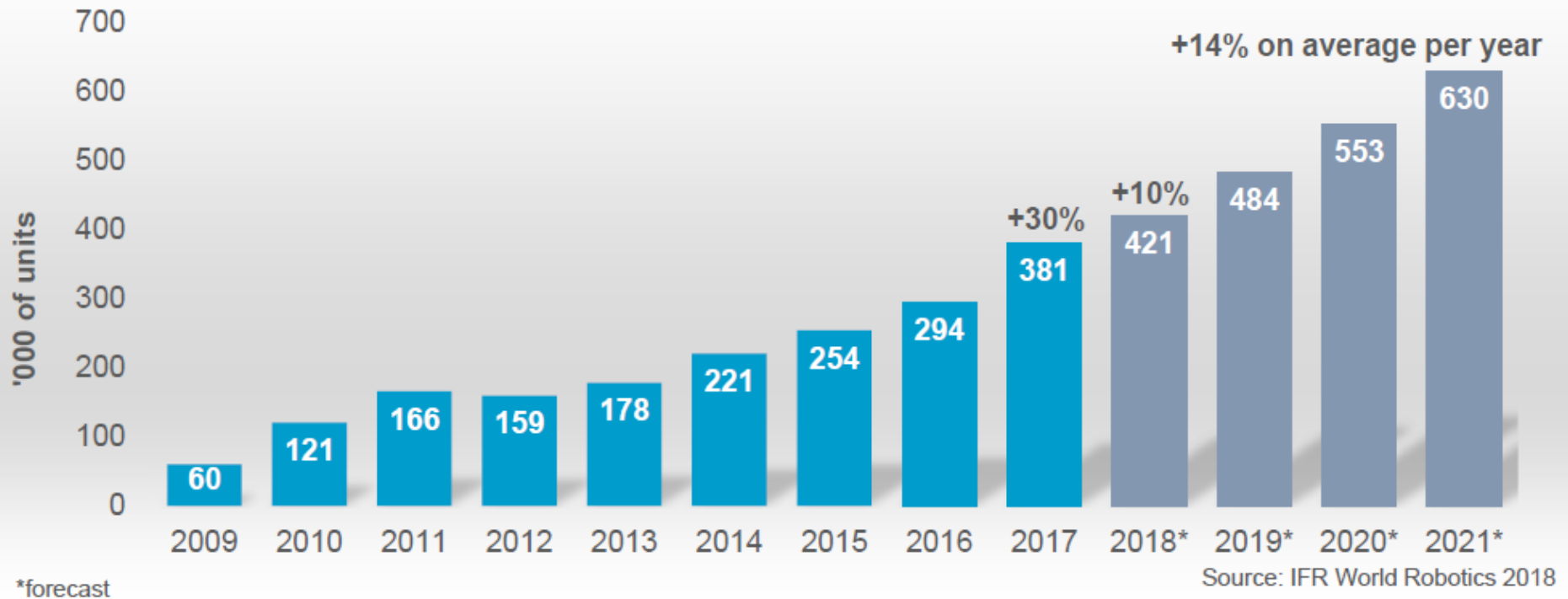


Estimated annual supply of industrial robots at year-end by industries worldwide 2015-2017

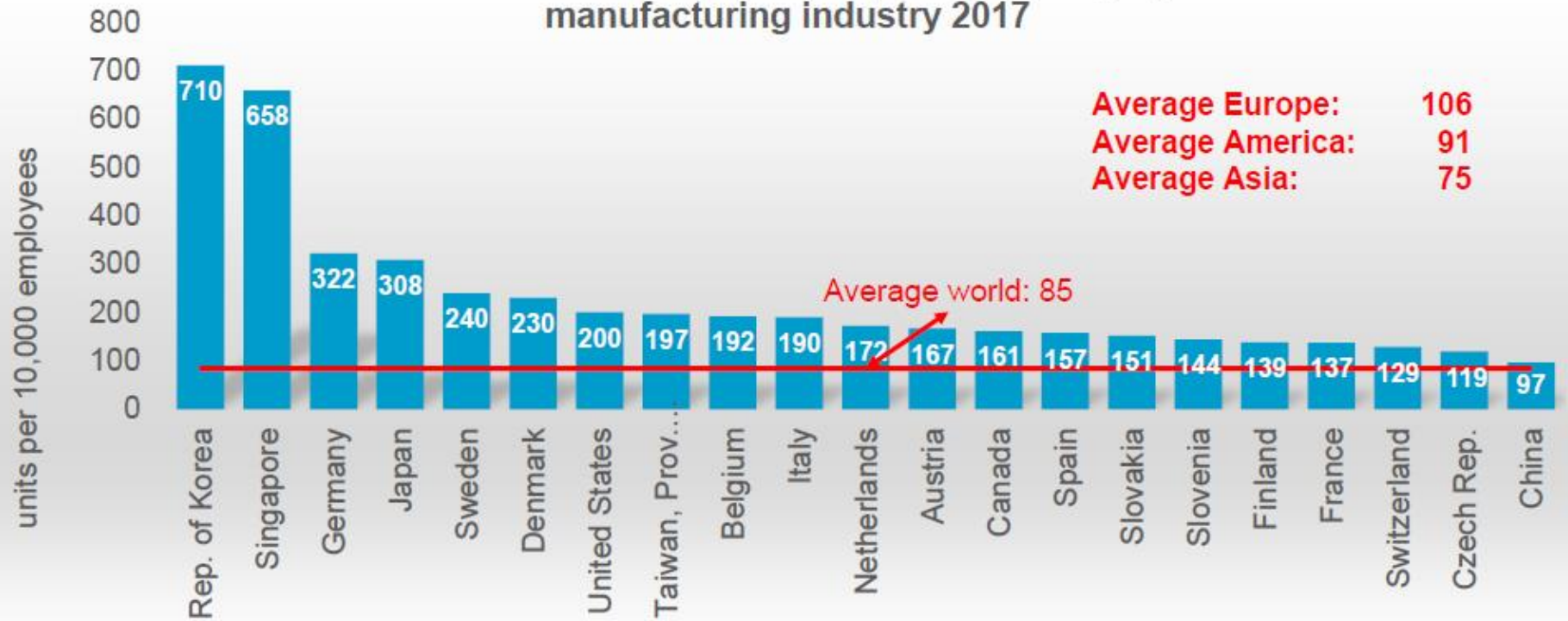


Industrial Robot Market

Estimated annual worldwide supply of industrial robots
2009-2017 and 2018*-2021*



Number of installed industrial robots per 10,000 employees in the manufacturing industry 2017



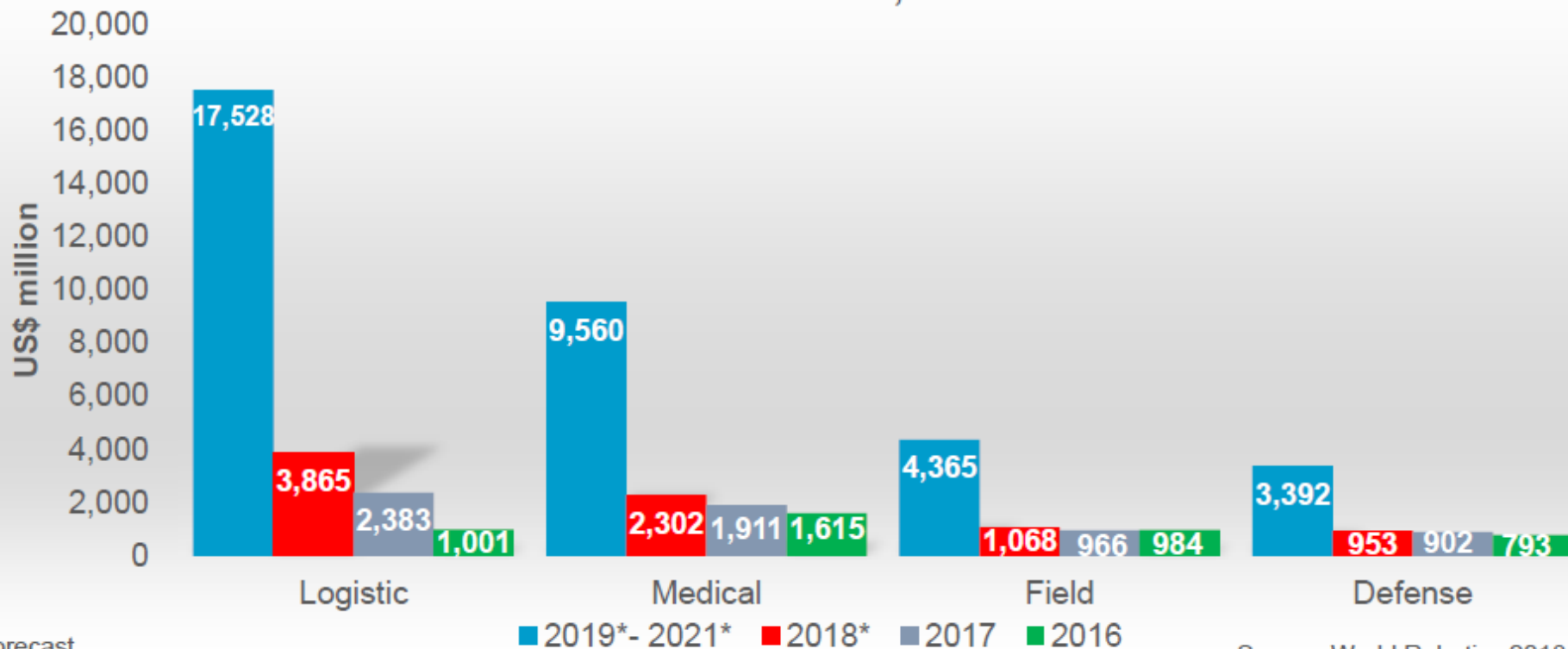
Source: IFR World Robotics 2018

Service Robotics

- Service Robotics
 - robotic systems that assist people in their daily lives at work, in their houses, for leisure, and as part of assistance in aging, and/or to help people with physical, cognitive, or sensory impairments
 - perform tasks in spaces occupied by humans and often in direct collaboration with people
- Professional service robotics
 - serve as a workforce multiplier for increased economic growth
 - inspection of power plants and infrastructure such as bridges, logistics applications such as delivery of meals and pharmaceuticals at hospitals, as well as commercial-scale lawn and cleaning technologies
 - annual growth in professional service robots is 30%
 - 172,000 professional robots are in use today

Service robots for professional use. Main Applications

Estimated values 2016 and 2017, forecast 2018* and 2019*-2021*



Source: World Robotics 2018

Logistics: automated delivery, movement of goods

- 8% of the U.S. GDP
- important component of supply-chain management
- Amazon's Kiva Systems robots
- hotel delivery robots from Savyoke
- hospital delivery robots from Aethon and Vecna
- store inventory robots from Bossa Nova
- people-friendly warehouse solutions from Fetch
- last-mile local delivery services from Starship Technologies
- automated FedEx or UPS distribution centers
- aerial delivery drones from Amazon Prime Air and Google Project Wing



Figure 2 Logistics industry robots for store inventory from Bossa Nova, warehouse distribution from Fetch, hospital delivery from Aethon and hotel delivery from Savyoke.



AGVs in factories, warehouses, logistic centers, hospitals...

69,000 units installed in 2017, 162% more than in 2016

- 6,700 units in manufacturing
- 62,200 units in warehouses, logistic centers, hospitals ...

2018:

115,000 units, 66% higher than in 2017

2019-2021:

485,000 units, +18% on average per year



Medical robots – most valuable service robots: US\$ 1.9 billion in 2017

- 2017: 2,900 units, +75%
- 2018: 4,400 units, +49%
- 2019-2021: 22,100 units, +27% (CAGR)

Field robots – mostly milking robots

- 5,400 milking robots in 2017, slight increase
- Still low number but high increase: agricultural robots – 520 units in 2017 up from 190 units
- 2018: 7,200 field robots, +17%
- 2019-2021: 32,700, +22% (CAGR)

Infrastructure protection and inspection

- inspection and maintenance of our nation's bridges, highways, pipelines, and other infrastructure using ground, aerial and maritime robots
- oil and gas industry



Figure 3 Infrastructure inspection robots: unmanned aerial inspection by ULC, and pipe inspection crawlers from EnviroSight and Honeybee Robotics.

Telepresence and Tele-Labor

- Telepresence systems : Beam, VGo and Double
- Telemedicine robotic platforms : InTouch Health Vita



Figure 4 Telepresence Beam platform from Suitable, telemedicine robot Vita from InTouch Health and the social robot Pepper from SoftBank Robotics.

Entertainment

- Automation for the movie industry : Bot & Dolly (now at Google)
- Intelligent and interactive toys : Anki Cozmo
- Programmable build-kit toys : Lego Mindstorms

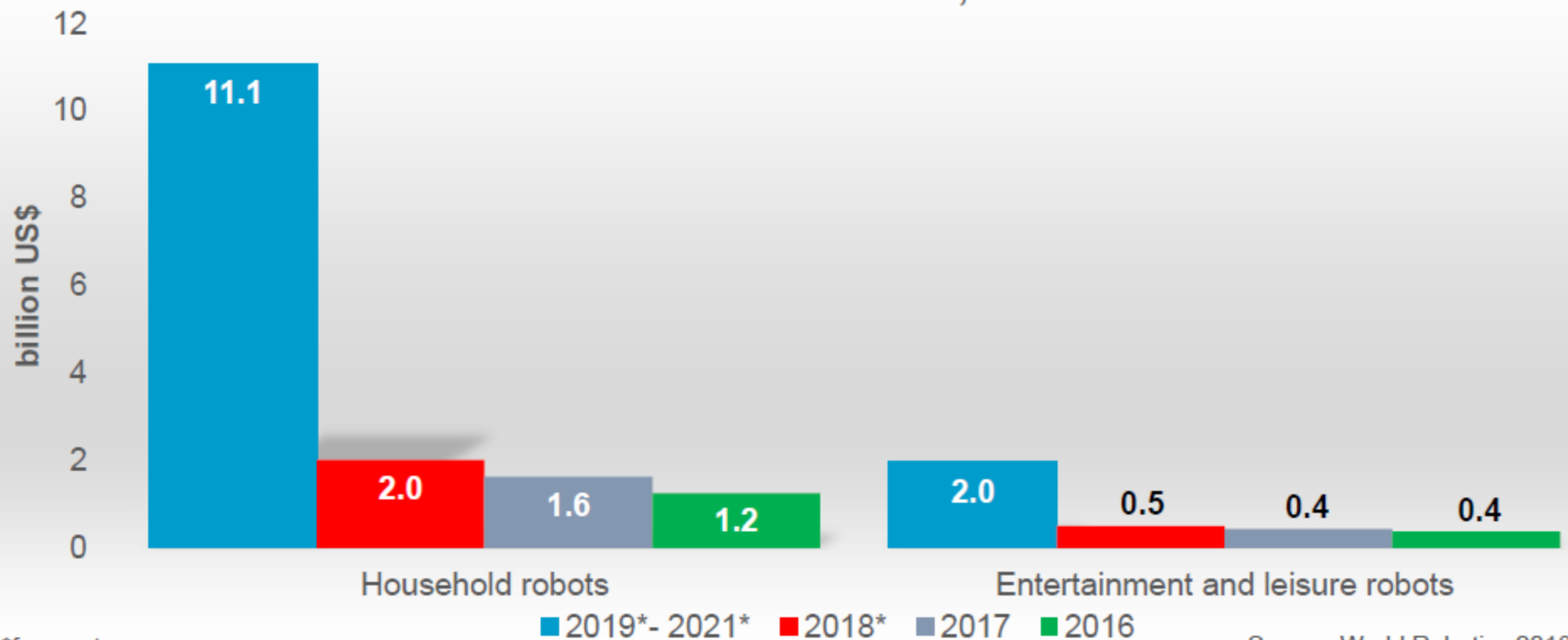


Figure 5: On the left: Cozmo robot, from Anki Robotics; incorporates sensors, onboard computing and "personality," along with a computer interface for user programming. On the Right: The Iris cinematic motion control system by Bot & Dolly (company recently purchased by Google).

Personal service robots

- deployed for assistance to people in their daily lives in their homes, or as assistants to overcome mental and physical limitations
- domestic vacuum cleaners : over 10 million iRobot Roombas sold
- entertainment applications such as artificial pets, personal assistants, etc
- 28% annual growth
- 4.7 million personal service robots sold in 2014 alone
- Autonomous aerial vehicles and self-driving cars will become disruptive

Service robots for personal/domestic use.
Estimated value 2016 and 2017, forecast 2018* and 2019*-2021*



Source: World Robotics 2018

Consumer Service Robots

- vacuum and floor cleaning, lawn-mowing robots, and entertainment and leisure robots, including toy robots, hobby systems, hobby drones, and education platforms



Figure 6 Popular consumer robots: Parrot Disco FPV Drone, Wonder Workshop Dash robot for education, iRobot Roomba vacuum and John Deere Tango lawn mower.

2016 - 2019: 42 million new service robots for personal and domestic use

■ Main categories:

- Vacuum and floor cleaning
- Lawn-mowing robots
- Entertainment and leisure robots
- Robots for elderly and handicap assistance



Source: Kärcher (Vacuum cleaning)



Source: Aisoy Robotics S.L



Source: Ezrobot

RESEARCH ROADMAP

- **Mechanisms and Actuators**
- **Mobility and Manipulation**
 - The 2015 DARPA Robotics Challenge
- **Perception**
- **Formal Methods**
- **Learning and Adaptation**
 - Learning from Demonstration
 - Reinforcement Learning and Deep Learning
- **Human Robot Interaction**
- **Multi-Agent Robotics**

LEGAL, ETHICAL, AND ECONOMIC CONTEXT

- **Safety**
 - Robots have to be safe. But how safe is safe enough?
- **Liability**
 - liability rules by which to compensate victims of robot-related hazards while preserving incentives for innovation
- **Impact on Labor**
 - universal income, a basic income for every citizen subsidized by the gains in productivity and efficiency from automation
- **Social Interaction**
 - Are robots social entities ?
- **Privacy and Security**