MOBILE ROBOTS AND AUTONOMOUS VEHICLES

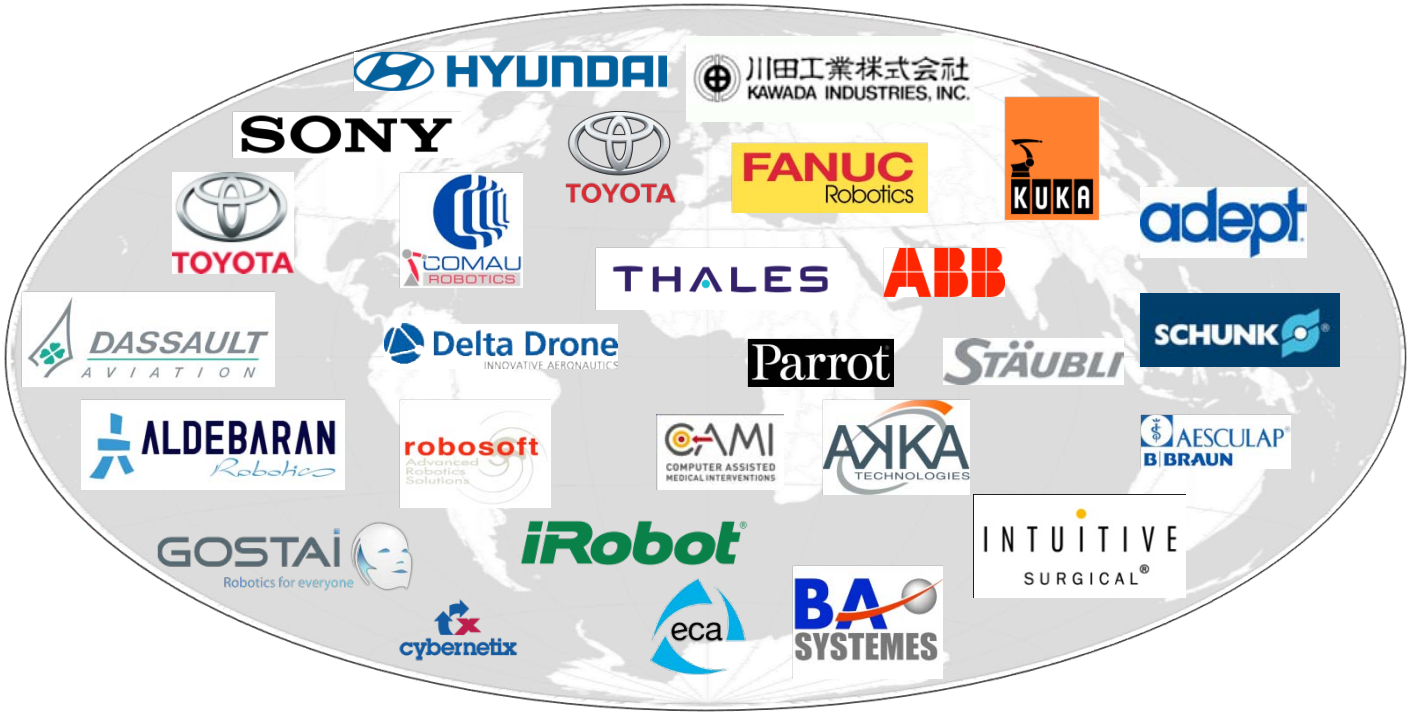
1. **Objectives, Challenges, State of the Art, Technologies**
2. Bayes & Kalman Filters
3. Extended Kalman Filter, Observability properties
4. Perception & Situation Awareness & Decision Making
5. Behavior Modeling & Learning

Christian Laugier

W1. Objectives, Challenges, State of the Art, Technologies

- **Socio-economic context**
- Technological evolution of Robotics & State of the Art
- New challenges for Robotics in Human Environments
- Decisional & Control Architecture for Autonomous Mobile Robots & IV
- Sensing technologies: Object Detection
- Sensing technologies: Robot Control & HRI
- Basic technologies for Navigation in Dynamic Human Environments
- Intelligent Vehicles: Context & State of the Art
- Intelligent Vehicles: Technical Challenges & Driving Skills

Intelligent Robotics Industry & Applications



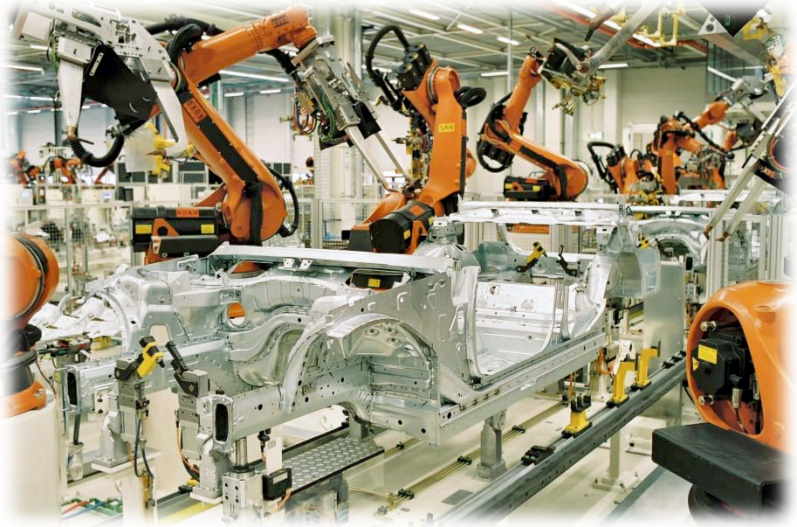
A large number of Industrial Companies throughout the world, including SME & Multinational groups

… with more and more application fields

Intelligent Robotics Industry & Applications

An increasing number of application fields

- **Automation & Manufacturing** *(initial main market)*



Intelligent Robotics Industry & Applications

An increasing number of application fields

- Automation & Manufacturing
- **Defense & Civil Surveillance / Intervention**

Intelligent Robotics Industry & Applications

An increasing number of application fields

- Automation & Manufacturing
- Defense & Civil Surveillance / Intervention
- **Health care, Surgery & Assistance**

Intelligent Robotics Industry & Applications

An increasing number of application fields

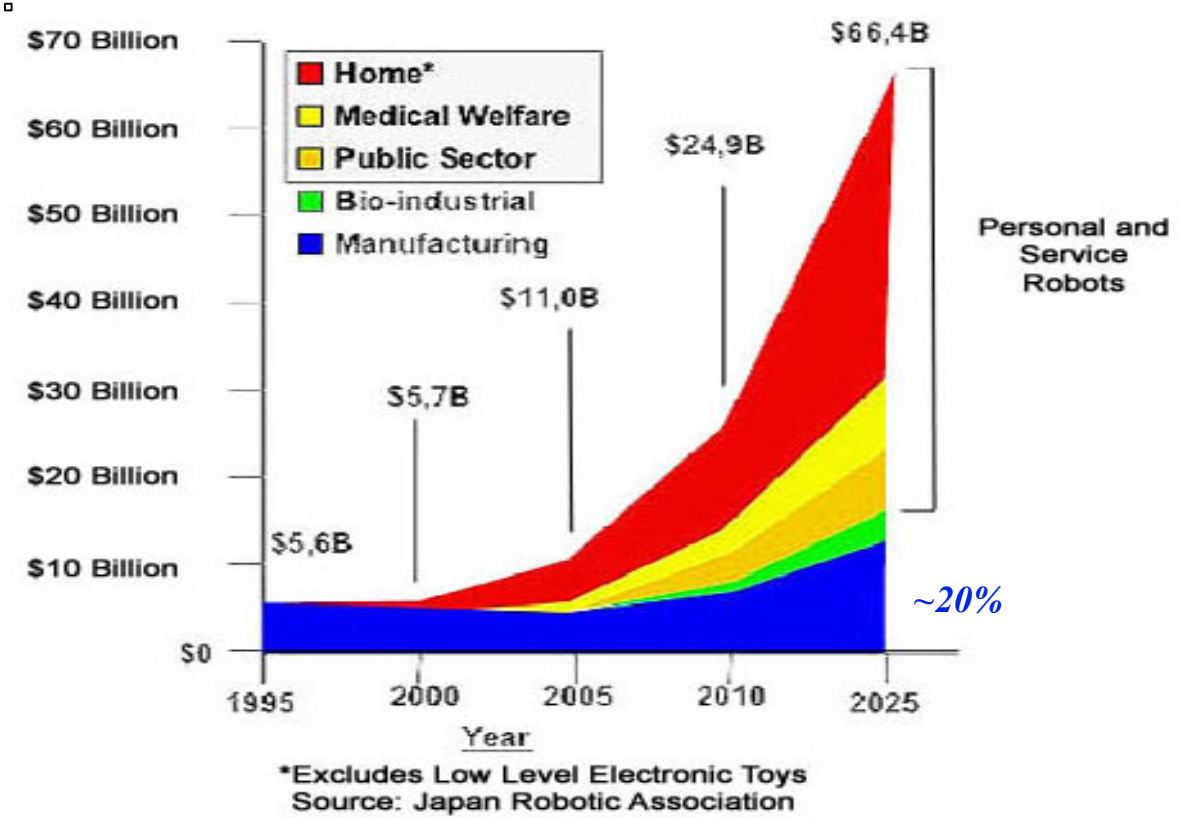
- Automation & Manufacturing
- Defense & Civil Surveillance / Intervention
- Health care, Surgery & Assistance
- **Personal Service Robots & Entertainment**

Intelligent Robotics Industry & Applications

An increasing number of application fields

- Automation & Manufacturing
- Defense & Civil Surveillance / Intervention
- Health care, Surgery & Assistance
- Personal Service Robots & Entertainment
- **Intelligent Vehicles & ITS**

Worldwide Robotics Market Growth

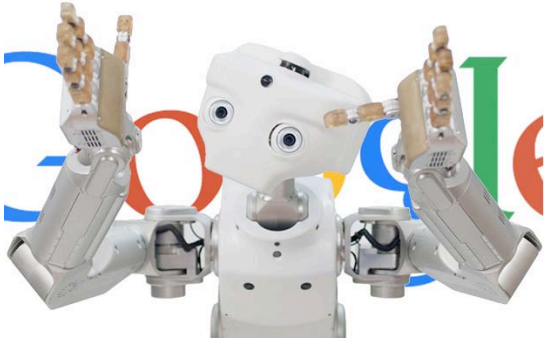


2011 Statistics & Forecast *(Japan Robotics Association)*

Recent changes in Robotics Industry

Google Acquisition of 7 Robot Companies (2013)

➔ *Wants a big role in Robotics*



Meka Robotics

Boston Dynamics

Google Self-Driving Car

Recent changes in Robotics Industry

amazon.com® Acquisition of Kiva Systems *(775 M$, 2013)*

Robotized warehouse operations

Recent changes in Robotics Industry

川田工業株式会社
KAWADA INDUSTRIES, INC.

Nextage – Next generation of industrial robot (“Cobot” concept)

Hiro

Recent changes in Robotics Industry

- **Automotive & ITS Industry:** Nissan, Renault, Toyota, Volvo, Mercedes, BMW, Tesla…+ car suppliers
- Concept of **connected car** & More autonomy ***(ADAS & Autonomous Driving)***

Market forecast

- 2020 => 8000 cars sold
- 2035 => 95 Million

Some sale numbers in non-manufacturing sectors

- **Defense**

PackBot, iRobot (2003-07)
➔ ***13 000 units sold***

Predator (2005) **~5 M$**
➔ *Used in most of recent wars (US Army)*


Control station (in a truck)

Some sale numbers in non-manufacturing sectors

- **Surgery**

Da-Vinci, Intuitive Surgical (2002)

~2 M€

➔ ***1750*** *in use in 2011*

Some sale numbers in non-manufacturing sectors

- **Personal Service Robots & Entertainment**

iRobot

Vacuum Cleaner Roomba (2002)

➔ ***4 Millions sold in 7 years***

ALDEBARAN Robotics

Nao (2006)

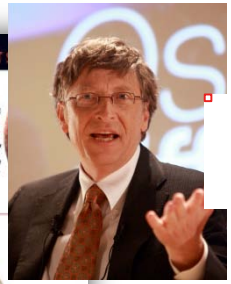
➔ ***Over 3000** sales*

SONY

Aibo (2000-06)

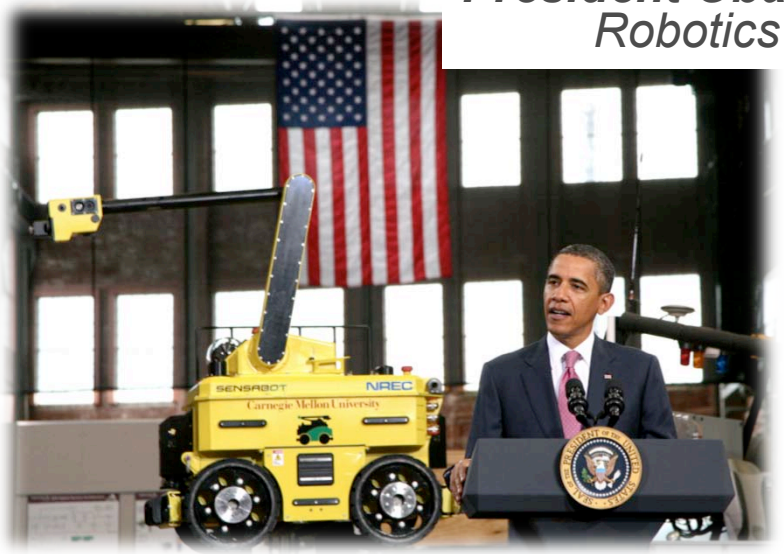
➔ **150 000** sales

Governments plans for supporting Robotics (USA)

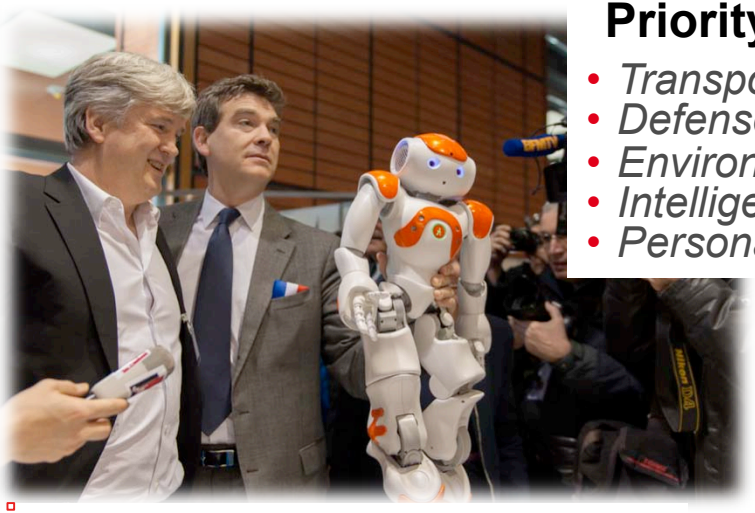


Bill Gates: *"The next hot field will be Robotics" - January 2007*

President Obama *announced Major Robotics Initiatives - 2011*



Governments plans for supporting Robotics (France)



Priority Axes (100 M€) - 2013

- *Transportation & Logistics*
- *Defense & Security*
- *Environment*
- *Intelligent Machines*
- *Personal Assistance*

34 Industrial Plans (3.5 B€)

- *Robotics*
- *Driverless Car*
- *Embedded Systems*
- *Factory of the future*
- *…*

Governments plans for supporting Robotics

- **Japan**: *Next Generation Robots = **one of the 8 important areas** promoted by the Government*
- **Korea**: *A **10 years Government plan** (US$ 316M) for developing Intelligent Robots*
- **Taiwan**: ***Intelligent Robotics Industry** designated as the **next-generation industry** by the Government (objective: over NT$ 90 billion in period 2009~13)*

Taiwan – France Robotics Lab (2012)

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