



Living in Robots – the future building

Roland Siegwart, ETH Zurich

www.asl.ethz.ch

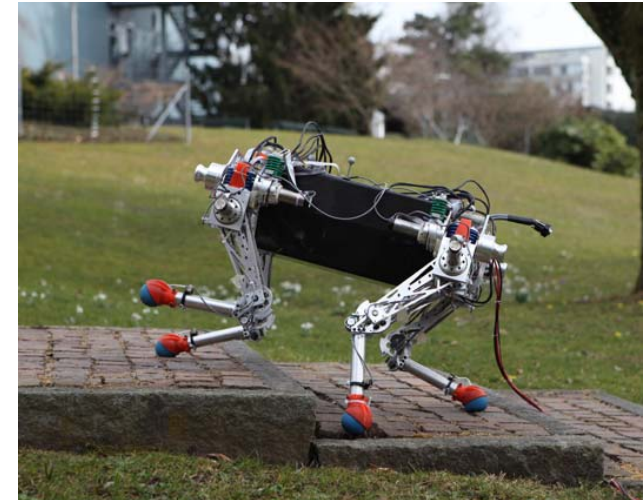


2. Digital Real Estate Summit 2016

Dienstag 1. März 2016, Fachhochschule Nordwestschweiz, Brugg-Windisch

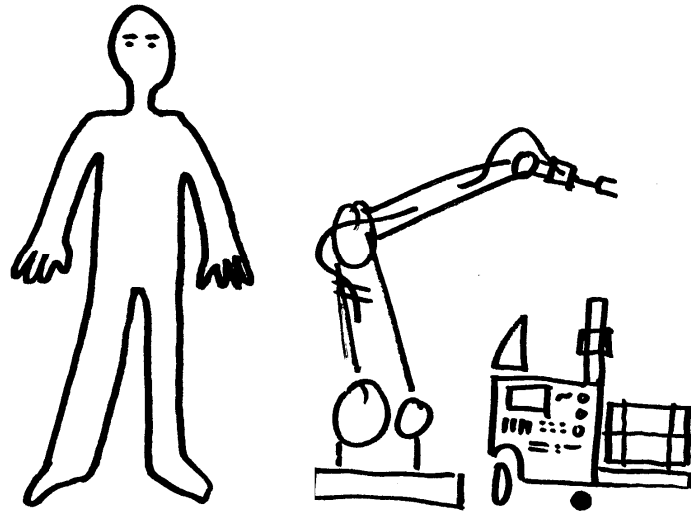
Content

- Technologie und Herausforderungen
 - «Seeing» and «Acting»
- Einige Beispiele aus der Forschung
 - Robotic pedestrian assistant
 - Stair-climbing wheel-chair
 - Construction robotics - NCCR digital fabrication
 - Autonomous car
 - 3D Mapping with flying robot
 - Household robots
- Anwendungsfelder und Entwicklung

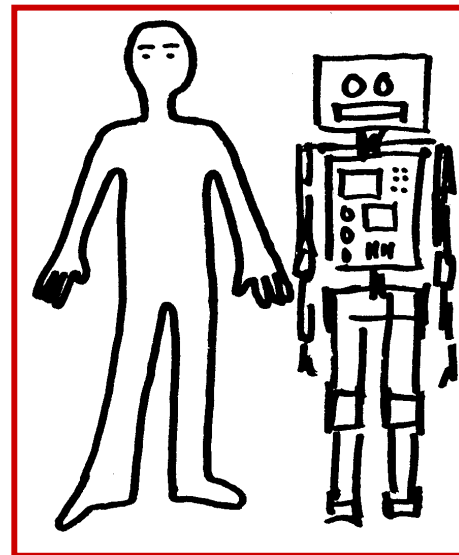


Next generation of Robots

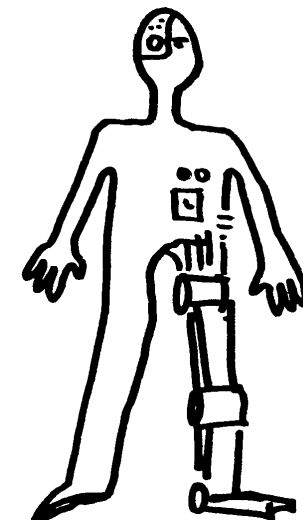
| adaptive and closer to humans



Industrial Robots



*Service and
Personal Robots*



Cyborgs

Fascination Robotics



FESTO | BionicOpter



Spot | hydraulic quadruped



Winner:
Hubo, KAIST

DARPA Robotics Challenge

07.06.2015,

Video: Team NEDO-JSK, Japan

12 x original speed!!

Fascination Robotics



FESTO | BionicOpter

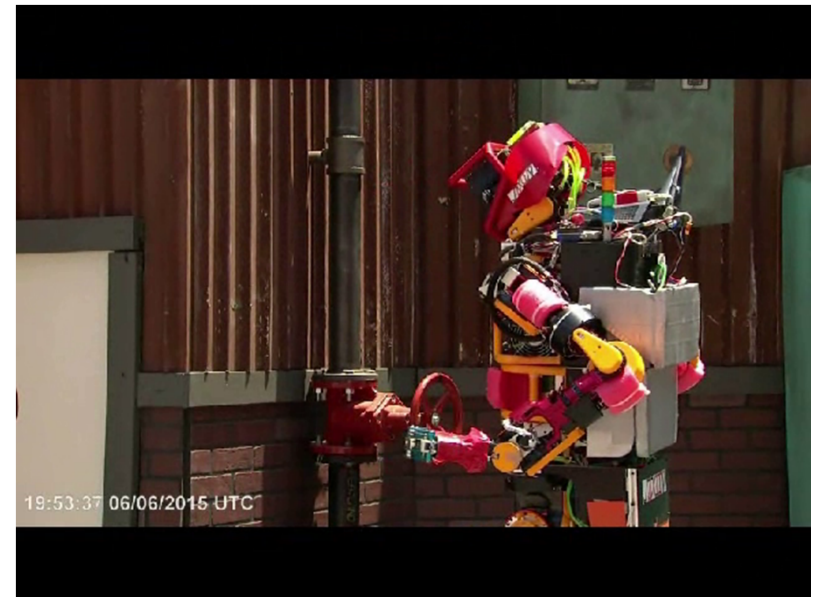
https://www.youtube.com/watch?v=Vhz_UuJq7us

<https://www.youtube.com/watch?v=8P9geWwi9e0>



Spot | hydraulic quadruped

<https://www.youtube.com/watch?v=M8YjvHYbZ9w>



DARPA Robotics Challenge

07.06.2015,

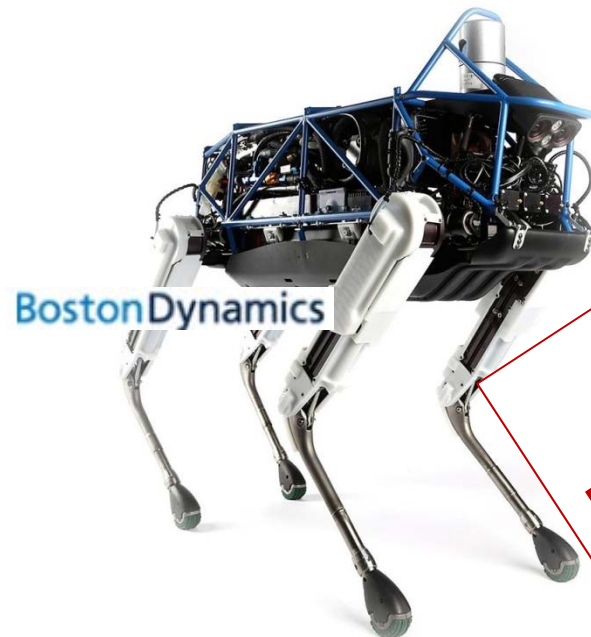
Video: Team NEDO-JSK, Japan

12 x original speed!!

Fascination Robotics



FESTO IFR



Boston Dynamics

Spot | hydraulic quadruped

**inefficient, rigid,
blind, no understanding**



Winner:
Hubo, KAIST

DARPA Robotics Challenge

07.06.2015,

Video: Team NEDO-JSK, Japan

12 x original speed!!

Technologie und Herausforderungen

“Acting” | Vertigo wall climber designed by students

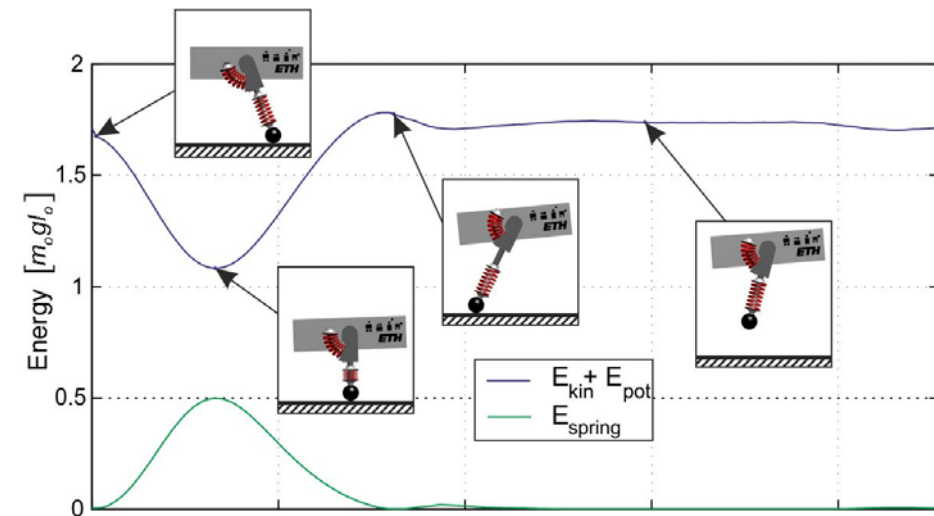
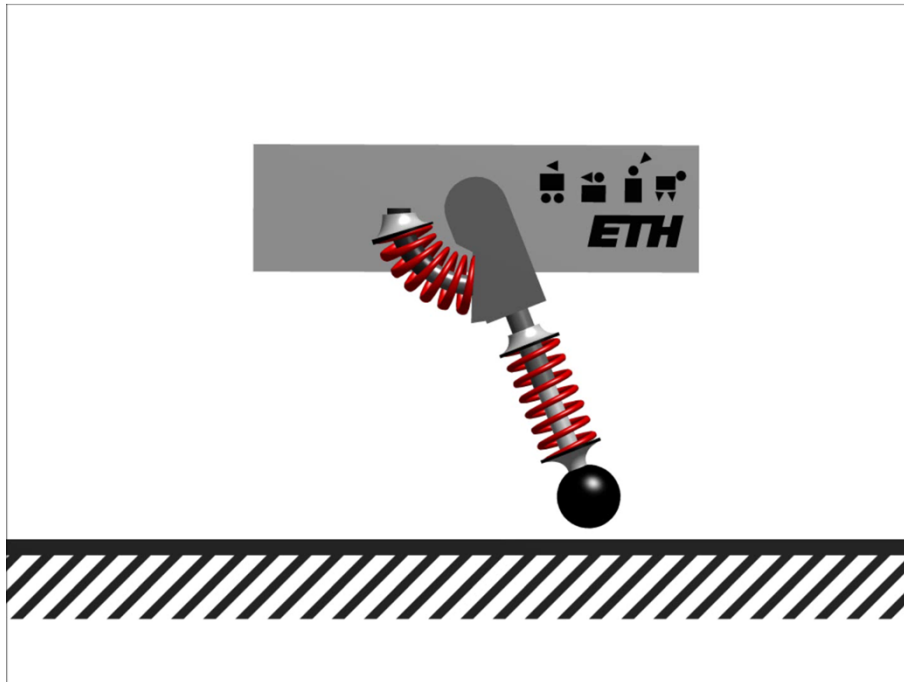
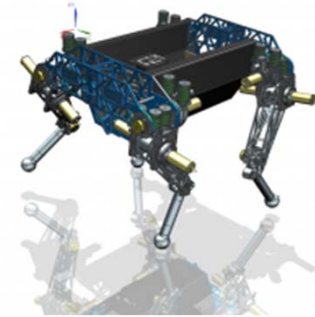


“Seeing” and “Acting” | what nature evolved (Extreme Jumpy Dog)



- <http://www.youtube.com/watch?v=Jql6TSyudFE>

“Acting” | serial elastic actuation



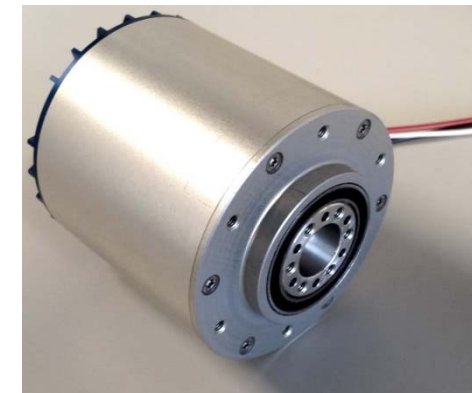
<https://www.youtube.com/watch?v=6igNZiVtbxU>

“Acting” | Safe and compact elastic actuator

- Enclosed Series Elastic Joint
 - Combine motors, gears, springs, electronics
 - High torque and speed (40Nm, 20rad/s)
 - Low weight (<1kg)
- **High performance torque and position control**
- **Minimal impedance and high impact robustness**



Prof. Marco Hutter



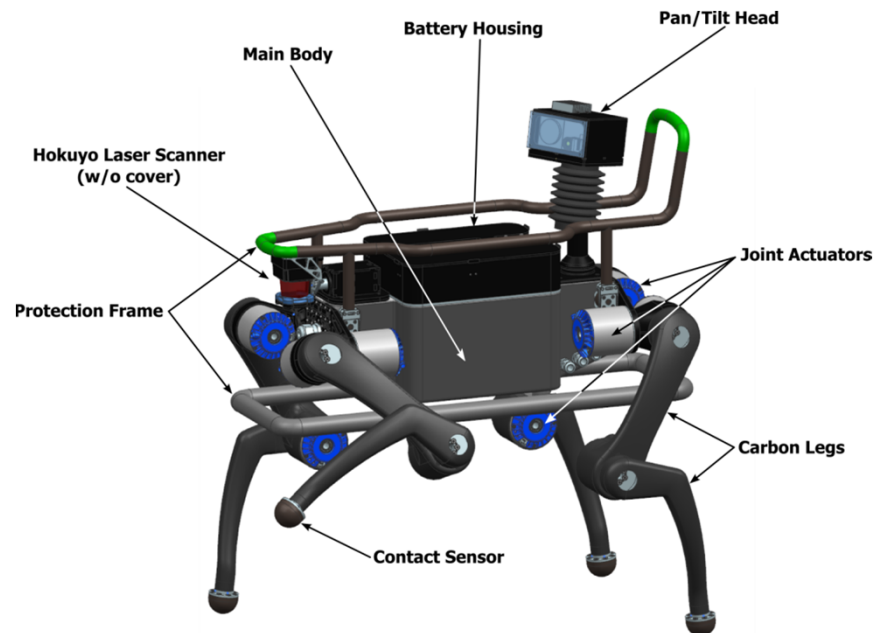
⇒ Enables the development of various robots that are perfectly suited for interaction!

“Acting” | ANYmal for real-world scenarios

- High mobility
 - *“to go where today only humans can go”*
- 10 kg of payload
- 2 h of continuous operations



Prof. Marco Hutter



“Seeing” | Laser-based 3D mapping



“Seeing” | Visual-Inertial Motion Estimation

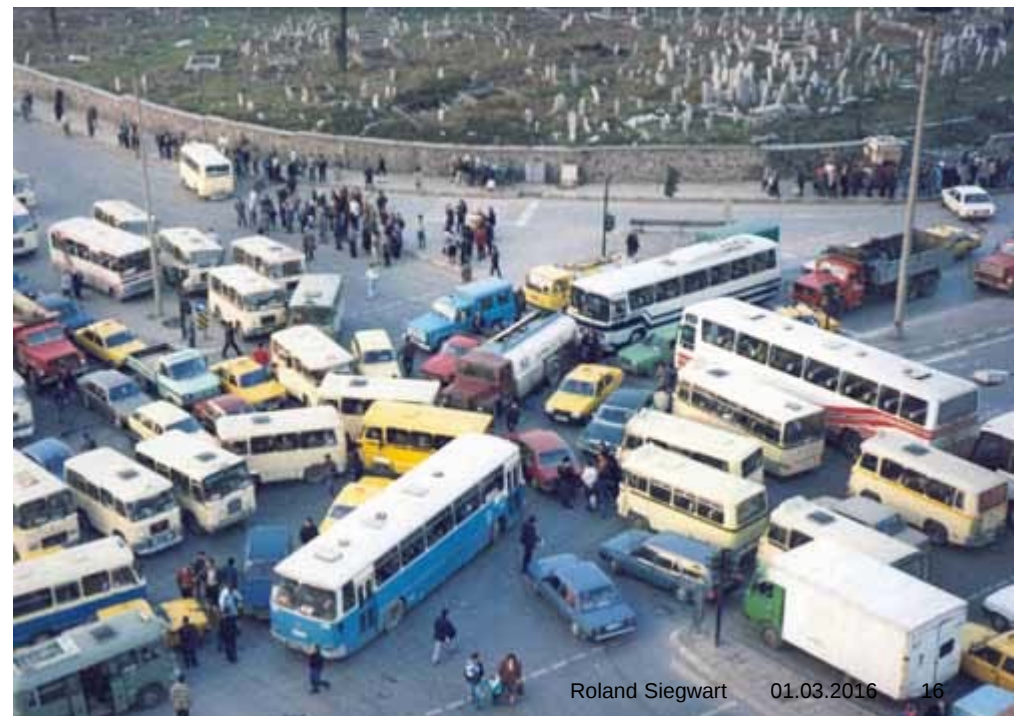


“Understanding” the world

- Humans are unbeatable
in taking decisions in complex situations



- Computers are better
in taking simple but fast decisions (ABS, ESP, ...)

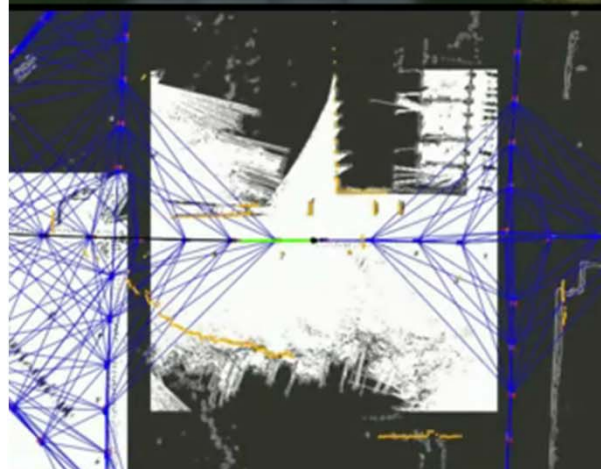
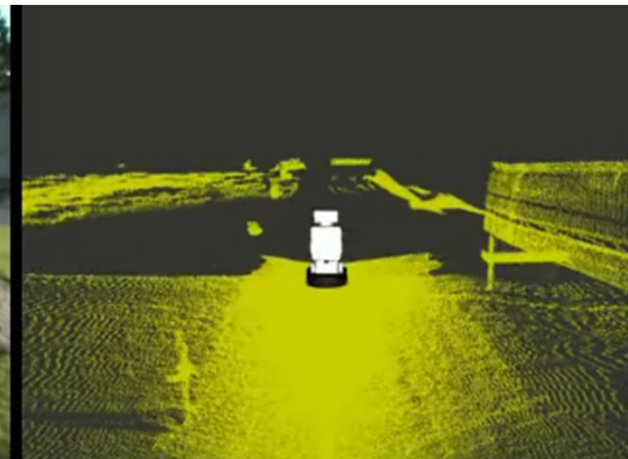


Beispiele aus der Forschung



European Robotic Pedestrian Assistant

- In collaboration with
 - University of Freiburg,
 - Univ. of Oxford
 - KU Leuven
 - RWTH Aachen
 - BlueBotics



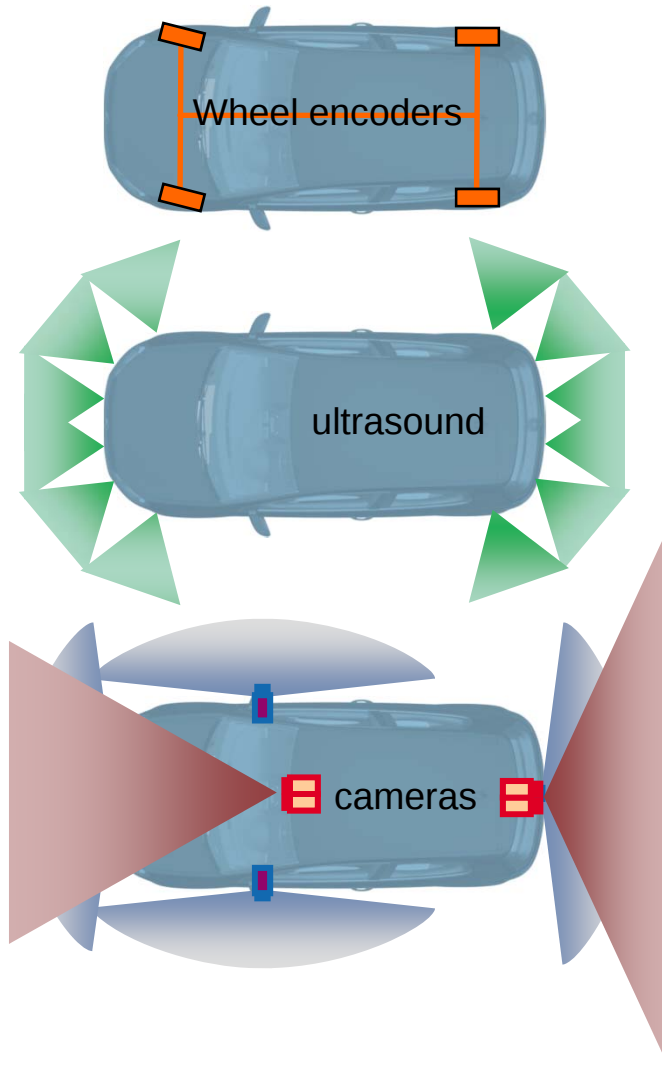
Stair-Climbing Wheelchair | Scalevo (2015)



NCCR Digital Fabrication



V-Charge | seamless integration of mobility



V-Charge | seamless integration of mobility



UAV | facade scanning and 3D reconstruction

- Enhanced teleoperation or autonomous operation
- Visual-inertial localization for optimal 3D reconstruction



HEXAGON

Leica
Geosystems

Household robot | PR2-Robot from Willow Garage



Courtesy of
**Willow
Garage**

Anwendungsfelder und Entwicklung

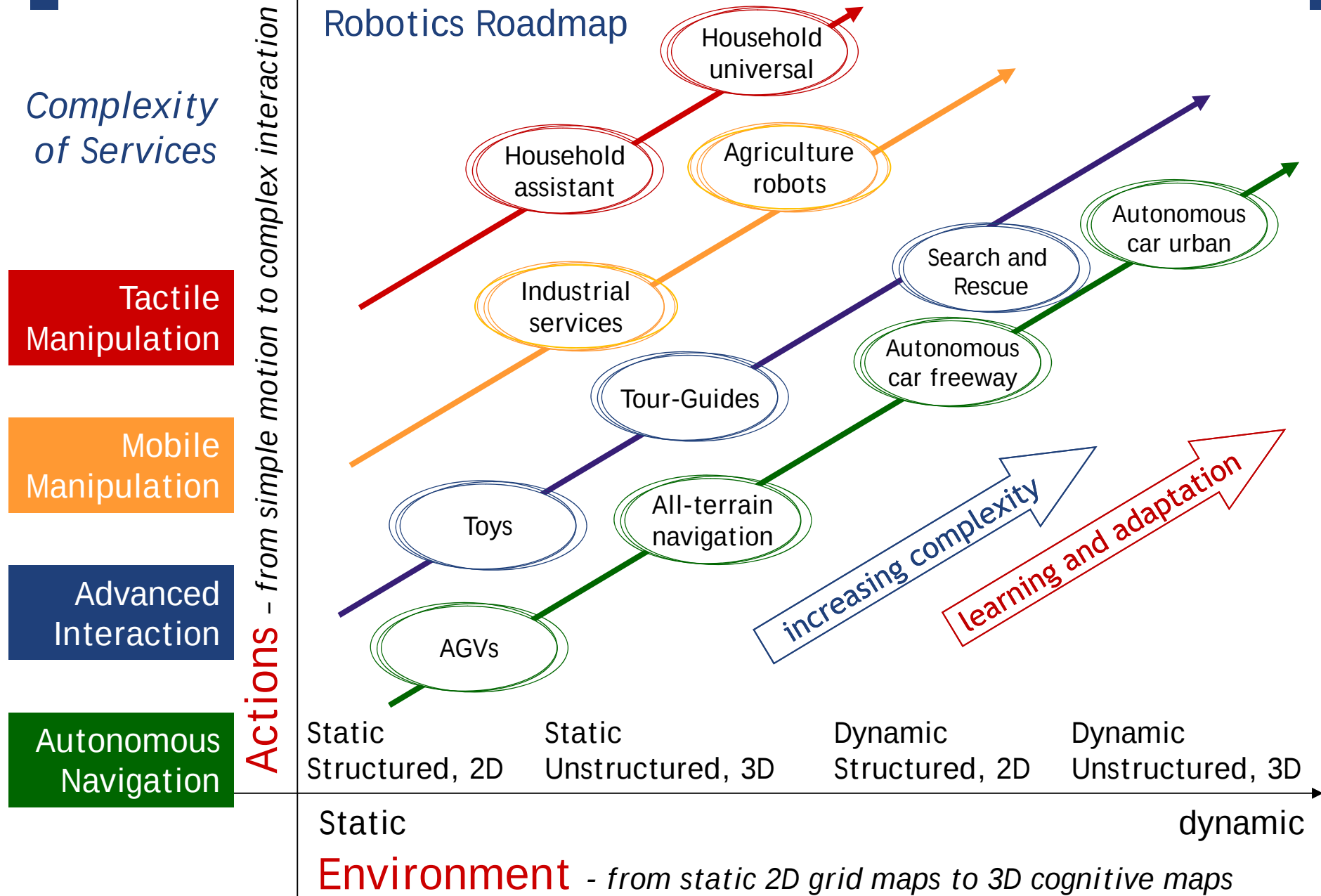
Opportunities / Markets

- Industrial transportation
- Cleaning
- Medical robotics
- Entertainment / edutainment
- Logistics
- Autonomous Cars
- Industrial inspection
- Surveillance and rescue
- Construction and mining
- Agriculture
- Health and elderly care
- Personal / services robots



The coffee servant
Nespresso / Bluebotics, Switzerland





Switzerland, the Silicon Valley of Robotics

- Chris Anderson
- *CEO of 3DRobotics*
- *WIRED, editor-in-chief until 2012*

«Die Schweiz ist das Silicon Valley der Robotik»

Von Alain Zucker. Aktualisiert am 04.04.2013

Internetguru Chris Anderson prophezeit eine neue industrielle Revolution. Diesmal will er als Unternehmer selbst dabei sein.



«Mein Grossvater, ein Schweizer Ingenieur, erfand den automatischen Rasensprinkler»: Internetguru Chris Anderson. (17. März 2013)