



ETH Shaping the future

Automatisierung der Zukunft – die Roboter verlassen die Produktionshallen

Prof. Dr. Roland Siegwart

www.asl.ethz.ch

www.wysszurich.ch

Impulstagung des Kaufmännischen Verbands
Der Weg in die unbekannte Zukunft der Arbeit

GDI Rüslikon, 24.01.2018

Technologies disrupting services | digitalization / industry 4.0

1981

2017

autonomy and intelligence

Personal Computer

Internet | information sharing

Smart Phones | permanent connectivity

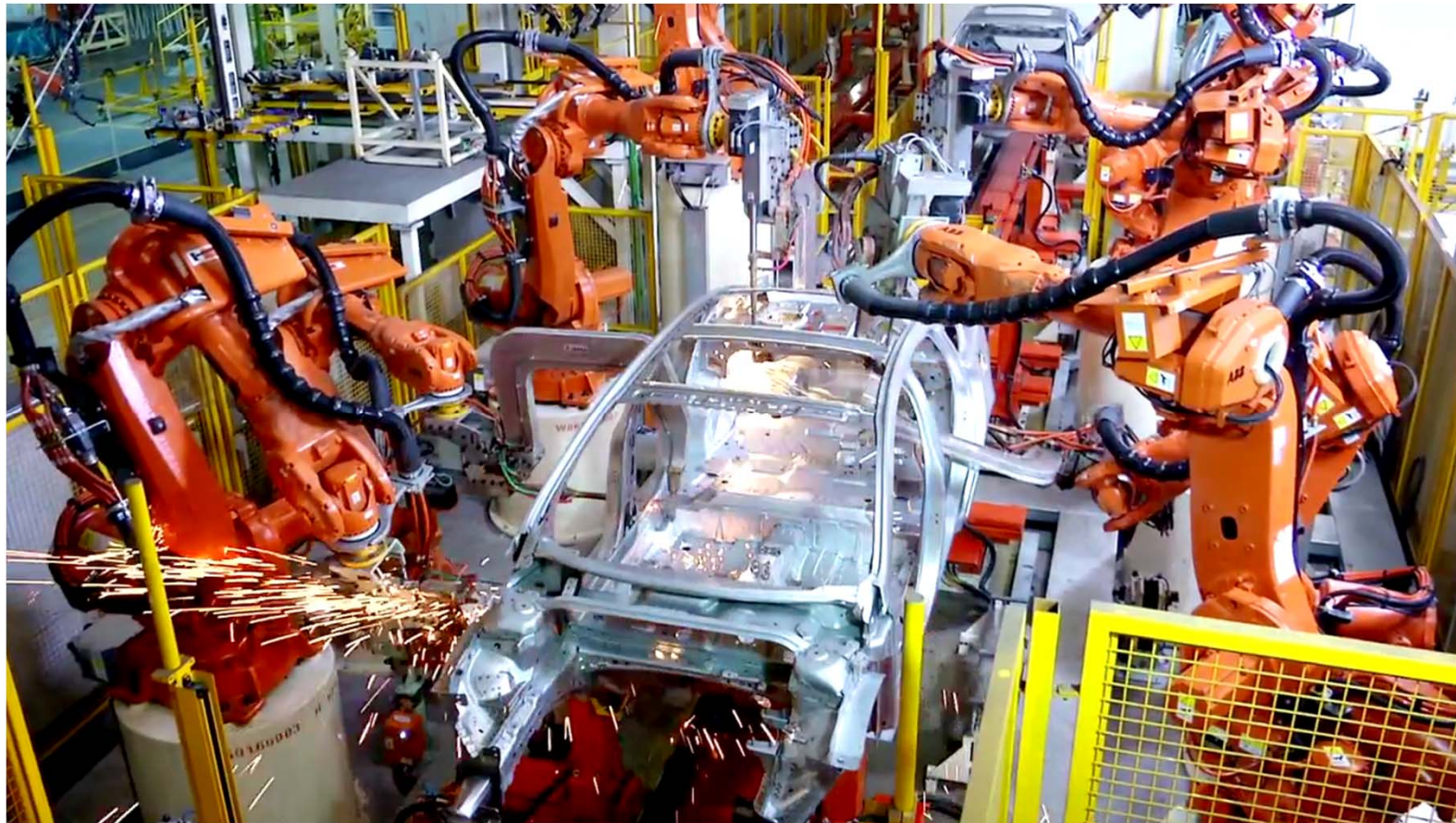
IoT / Cyber-Physical Systems / Robots

Data World is connecting with physically
→ exponential increase of complexity



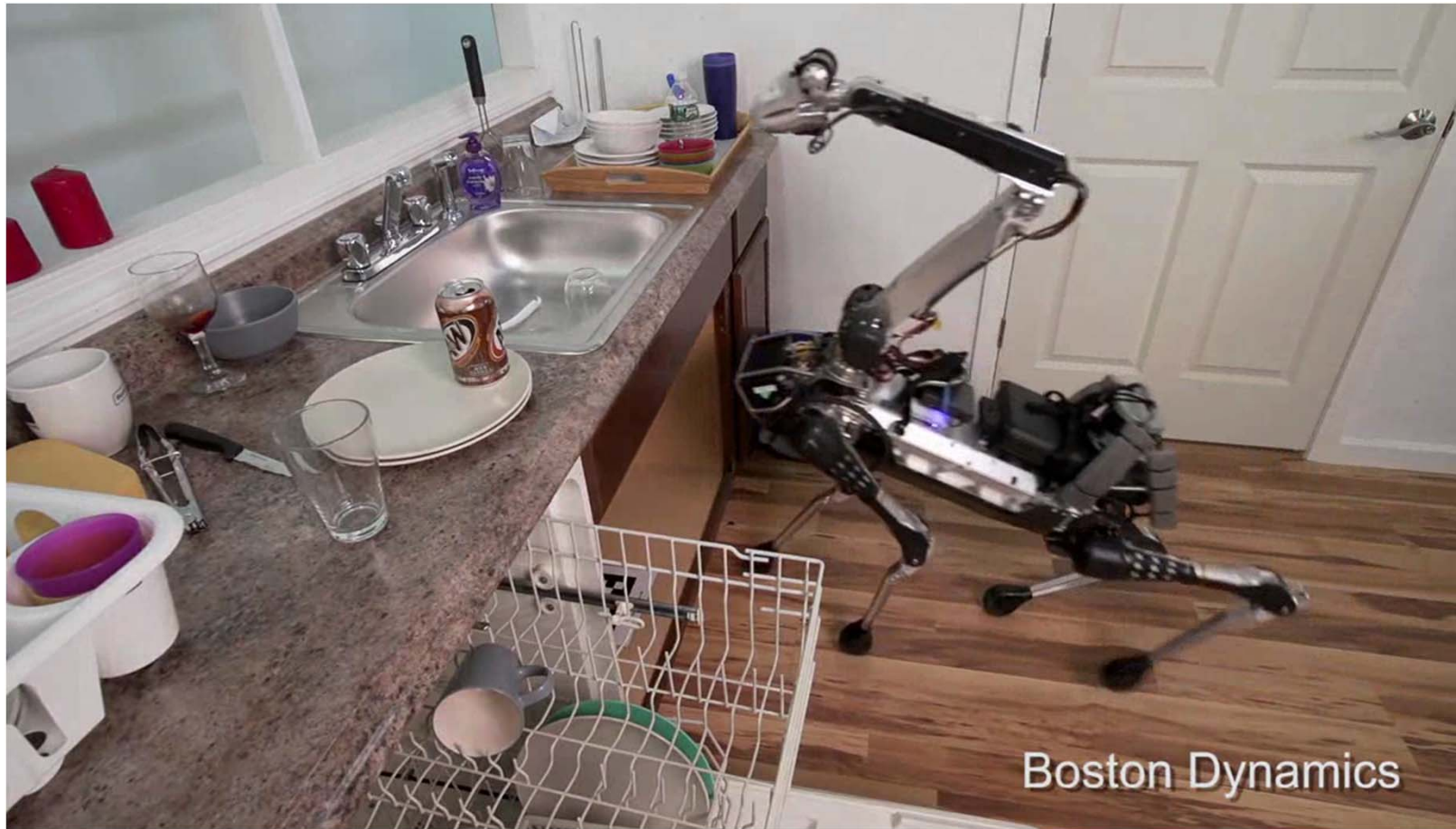
Robotik heute (Changan-Ford China)

248'000 Industrieroboter
wurden 2015 verkauft,
68'000 davon in China



<https://www.youtube.com/watch?v=SeloQy0oXjl>

Robotik morgen – in unserem täglichen Umfeld?



SpotMini | electric quadruped, Boston Dynamics

<https://www.youtube.com/watch?v=tf7IEVTDjng>

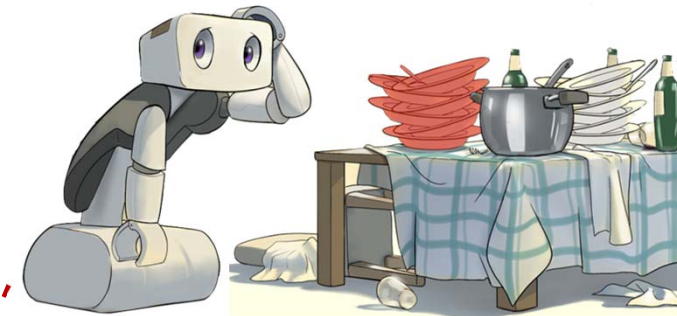
Serviceroboter | die Herausforderungen

- Roboter müssen mit *unsicherer* und nur *teilweise verfügbarer multimodaler Information* umgehen können.
 - Roboter müssen *sehen, spüren* und *verstehen* können.
 - Roboter müssen taktil mit der Umgebung interagieren können
→ («soft robots» mit Kraftreglung)
 - Roboter müssen *intuitive programmierbar* sein
 - Roboter *lern-* und *anpassungsfähig* sein
- **Um das zu erfüllen braucht es Künstliche Intelligenz, aber neue neue Sensoren, Aktoren und Roboterkonzepte**



50x speed

<https://www.youtube.com/watch?v=gy5g33S0Gzo>



Autonomous Systems Lab @ ETH

Institute of Robotics and Intelligent Systems
Prof. Dr. Roland Siegwart

■ Unsere Mission

- Erforschung von intelligenten Robotern die in unserem täglichen Umfeld selbständig Aufgaben erfüllen können.

■ Forschungsschwerpunkte

- Neue Roboterkonzepte die optimal für Anwendungen auf dem Boden, in der Luft oder im Wasser angepasst sind.
- Neue Algorithmen für die Wahrnehmung, Lokalisierung und Planung die den Robotern einen autonomen Einsatz in komplexen Umgebungen ermöglicht.



Research Fields



Autonomous Cars

Visual navigation and autonomous operation in city environments



Unmanned Aerial Vehicles

Design, control and fully autonomous operation and interaction in complex environments



Solar Airplanes

Continuous flight for long-term environment monitoring



All Terrain Robots

Design and collaborative navigation of flying and ground robots



Mobile Manipulation

Object handling for manufacturing, logistics, and e-commerce



Service Robots

Navigation and transportation in our daily environment

Service Robots

– wheeled and walking robots for challenging tasks

BeachBot (with Disney) – developed by students

| the beach artist

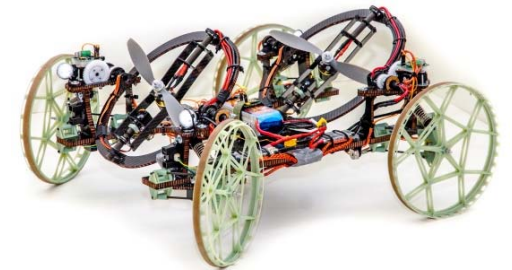
<https://www.youtube.com/watch?v=eBRrQBPtdak>



Vertigo – developed by students

| the ultimate wall climber

<https://www.youtube.com/watch?v=KRYT2kYbgo4>



AnyMal – “soft” interaction with the environment

| the ultimate quadruped

<https://www.youtube.com/watch?v=El1zBTYpXW0>



Prof. Marco Hutter



Service Robots – flying robots for challenging tasks



wingtra – developed by students

| the VTOL UAV

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



Atlantik olar

| 81 hours non-stop in summer 2015

| 5.64 m, 6.2 kg

https://www.youtube.com/watch?v=8m4_NpTQn0E

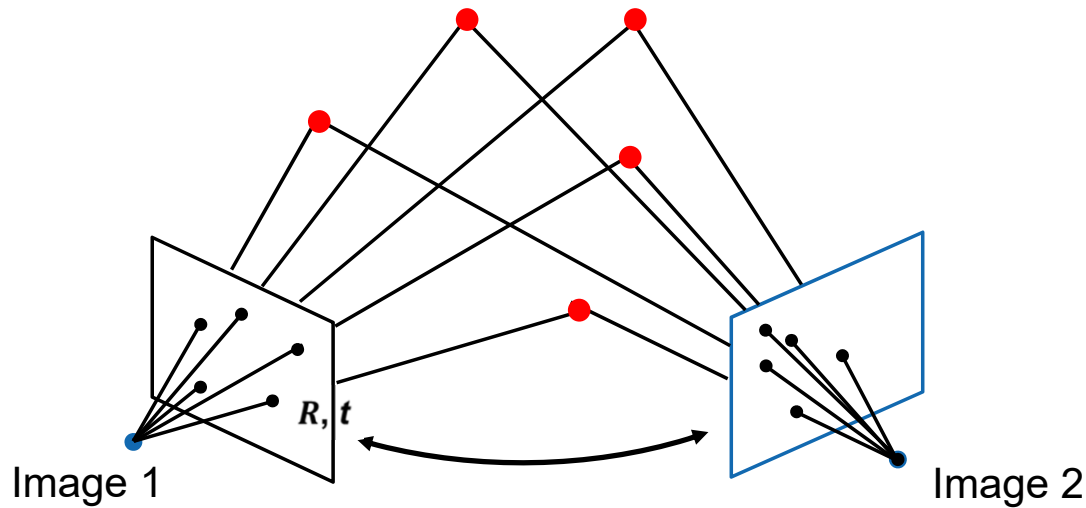
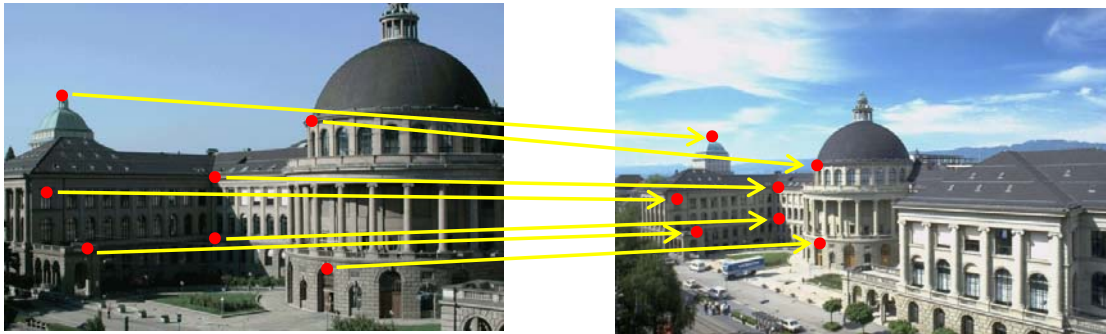
https://www.youtube.com/watch?v=wyS6W1t_ryQ



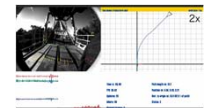
“Sehen” | Laser-basierte 3D Pläne



“Sehen” | Bewegungsschätzung mit Kamera und Inertialsensor (IMU)



Google
Project Tango



<https://www.youtube.com/watch?v=yvgPrZNp4So>

Autonomous Cars Today | cameras (lane tracking, ...) → no map



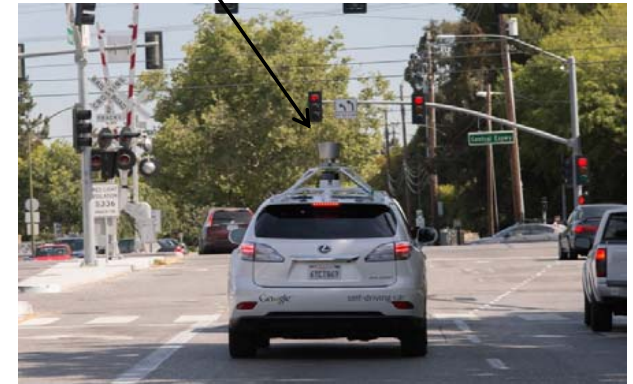
- Detection and tracking of ...
 - Lanes,
 - street signs,
 - other cars,
 - ...

<https://www.youtube.com/watch?v=aGW4nRzx8lw>

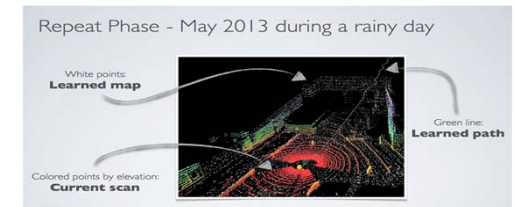


Today | 3D laser sensors → map based

Expensive, complex and cumbersome

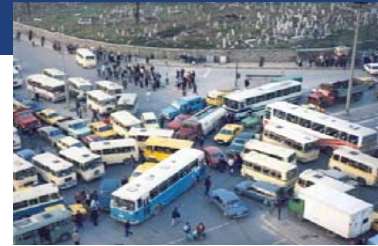


- Google Self-Driving Car Project (status summer 2015)
 - > 20 vehicles in use
 - > 2,7 mio km, 1.5 mio km in autonomous mode
 - > 11 accidents
 - No people insured
 - Non of them caused by car control algorithm



<https://www.youtube.com/watch?v=eJCR2TaeSFc>

Autonomous Cars | roadmap



Fully autonomous Car
(you can sleep)

Autonomous car freeway



Interaction / negotiation between traffic participants

increasing complexity / understanding

learning and adaptation



Autonomous car urban

Driving Speed



Complexity of Environment → Perception and Interaction

Autonomous Cars | a bright future without traffic jams

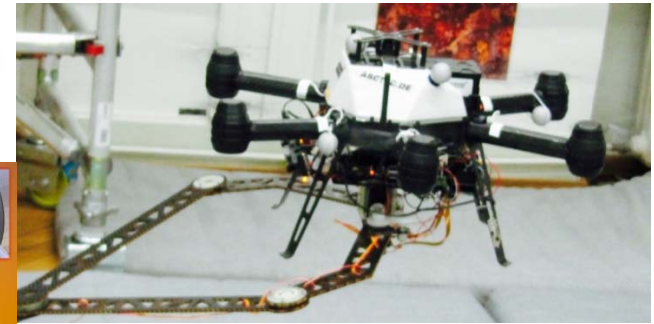


Flying Robots | inspection, agriculture, search and rescue

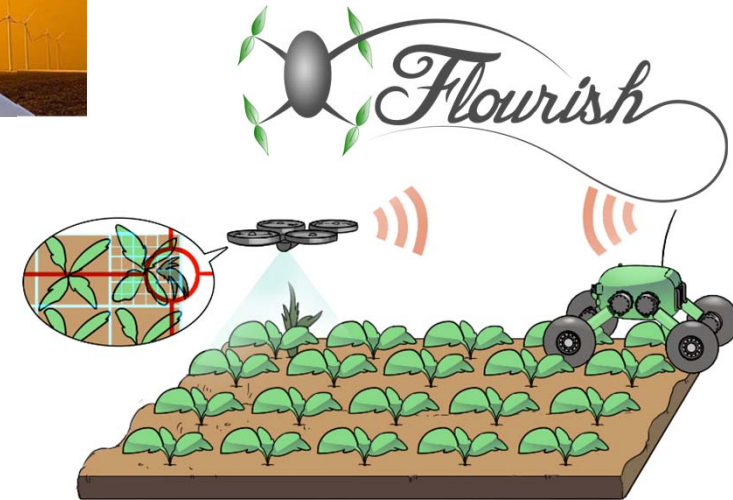


European
Robotics
Challenges

AERO
WORKS

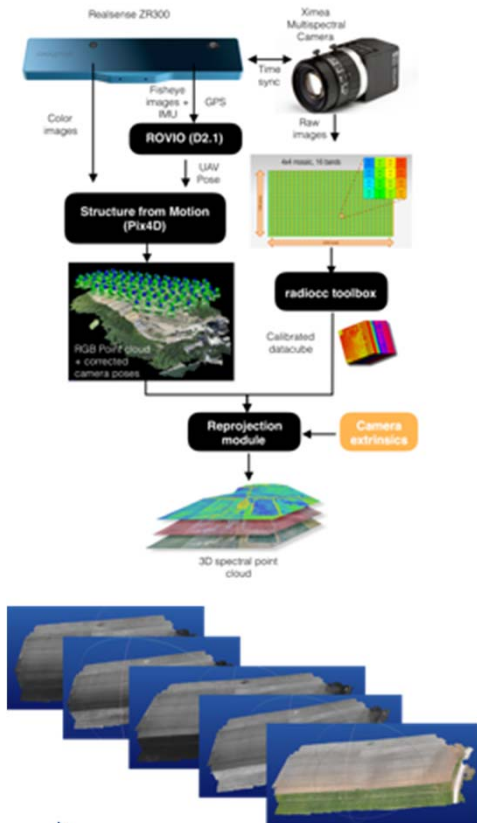


SHERPA



Flourish – Aerial Data Collection and Analysis, and Automated Ground Intervention for Precision Farming

Spatio-Temporal Spectral Environment Modeling

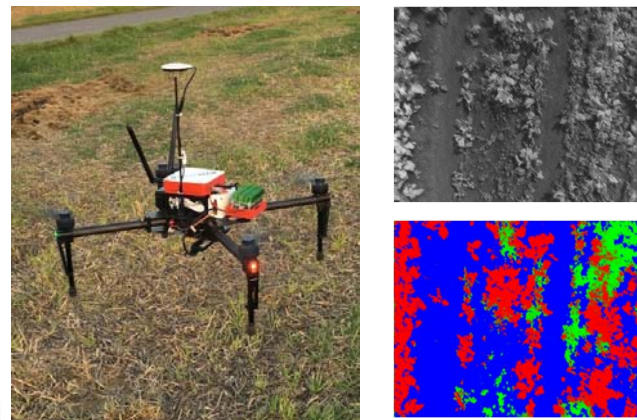


<https://youtu.be/5f1EtfW76Qc>

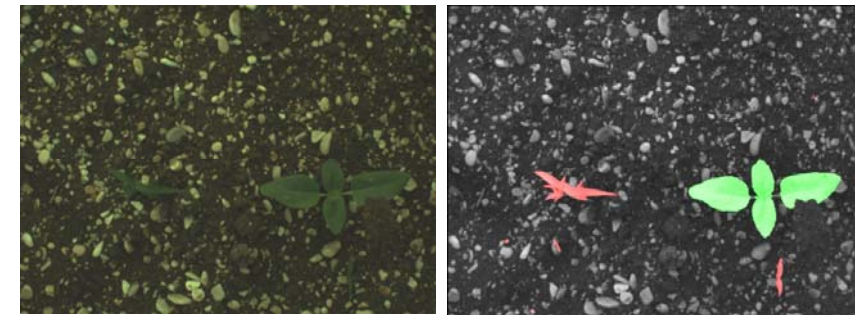
Autonomous UAV landing



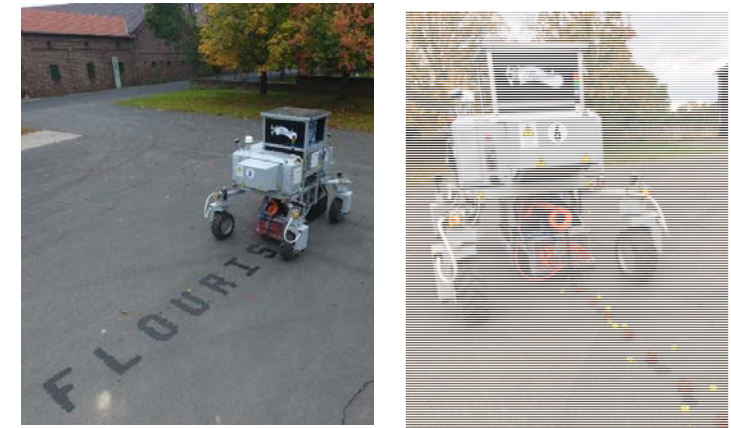
UAV onboard weed detection



Weed classification on UGV (Sunflower ~95% acc.)



Automated spraying and stamping



Collaborative Visual-Inertial Navigation | teach and repeat



<https://www.youtube.com/watch?v=pDIQXsOrgI4>

Kollaborative visuelle Navigation

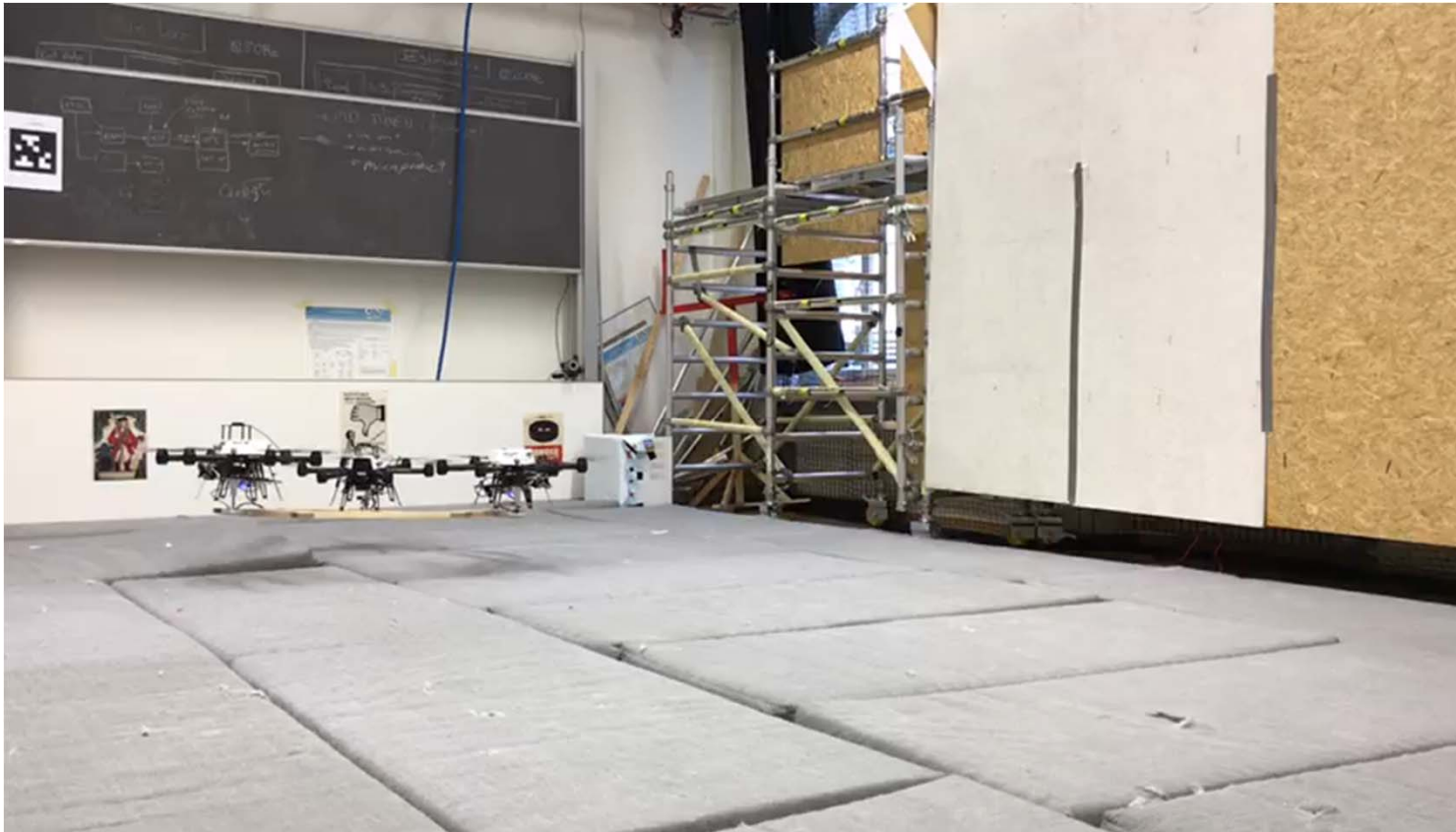


in Zusammenarbeit mit



<https://www.youtube.com/watch?v=9PprNdIKRaw>

Collaborative Transportation | master-slave control and visual navigation



<https://www.youtube.com/watch?v=pDIQXsOrgI4>

Robotics Roadmap

Complexity of Services

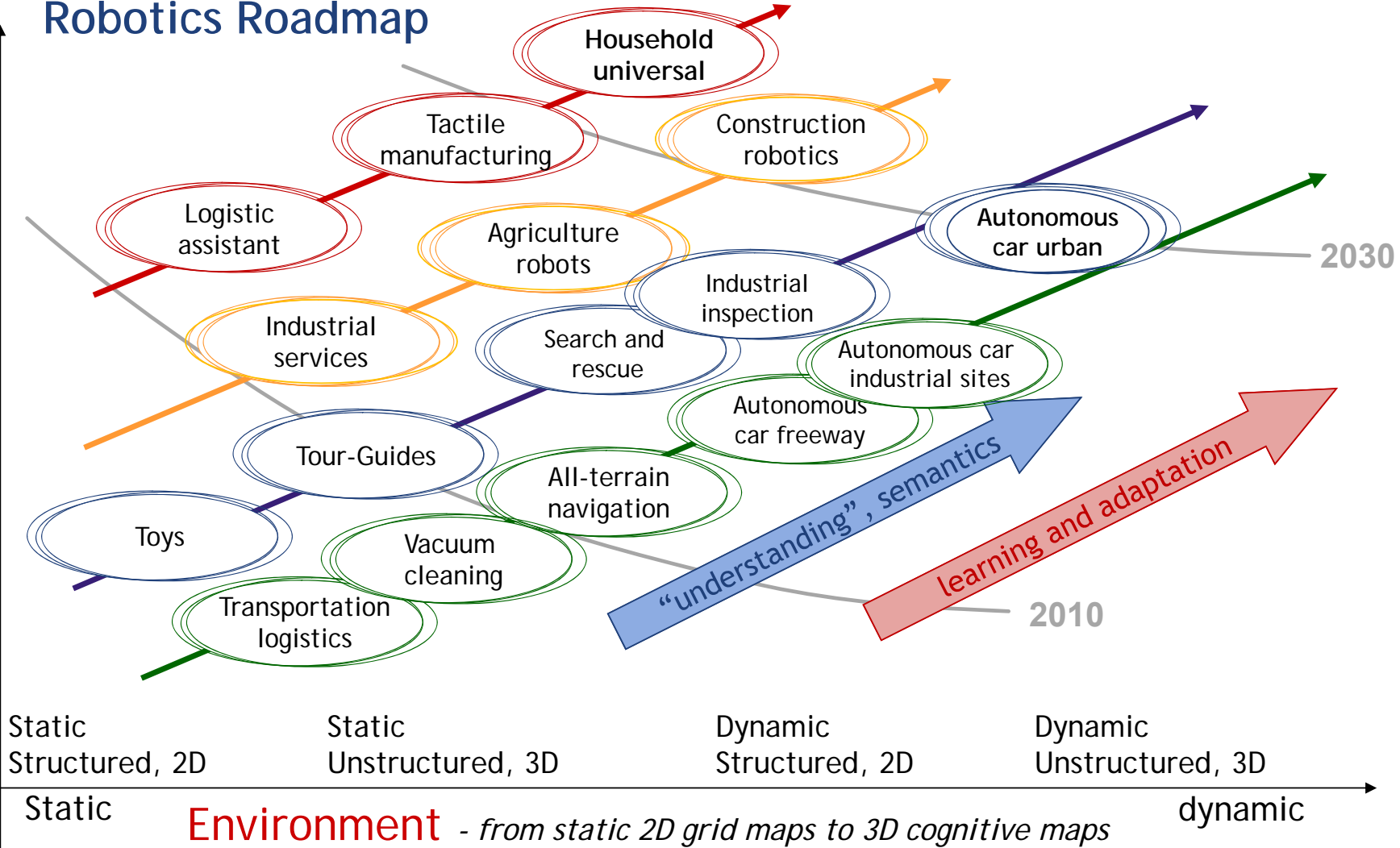
Tactile Manipulation

Mobile Manipulation

Advanced Interaction

Autonomous Navigation

Actions - from simple motion to complex interaction



Switzerland | a melting pot for robotics technology

Initiatives



Spin-offs (*ASL)



Industrial Collaborations (ASL)



Take Home Message

- Ja, Robotik boomte
 - ... es braucht aber noch viel F&E um diese komplexen Systeme auf den Markt zu bringen.
- Ja, Europa und speziell die Schweiz hat das Potential diesen wichtigen Markt zu erobern und somit nachhaltig Arbeitsplätze zu schaffen. Es geht um:
 - Hervorragende Forschung und grossartige Talente
 - Präzisionsmechanik und Künstliche Intelligenz
 - Innovation und Unternehmertum
- Für die Skalierung von Robotik-Technologie und Startups brauchen wir Talente, **mehr Risikobereitschaft und langfristig ausgerichtetes Risikokapital (> 10 Jahre)**

