



ETH Shaping the future

Roboter verlassen die Produktionshallen

Prof. Dr. Roland Siegwart

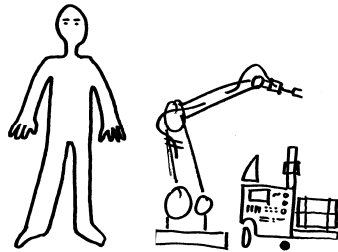
www.asl.ethz.ch

www.wysszurich.ch

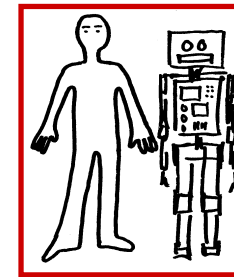
18. Thurgauer Technologietage
UNIMA AG, MATZINGEN, 23.03.2018

Nächste Generation von Robotern

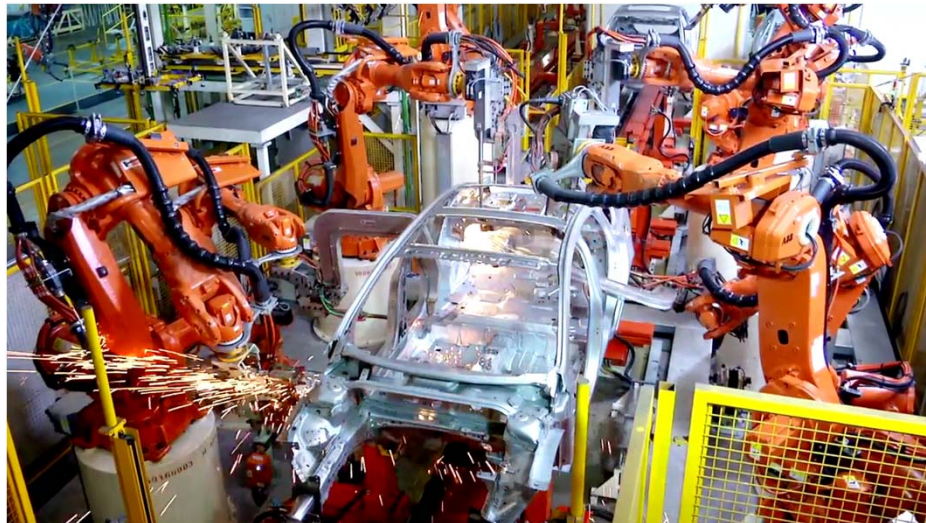
| mobil, verbunden, intelligent, adaptiv und unter uns



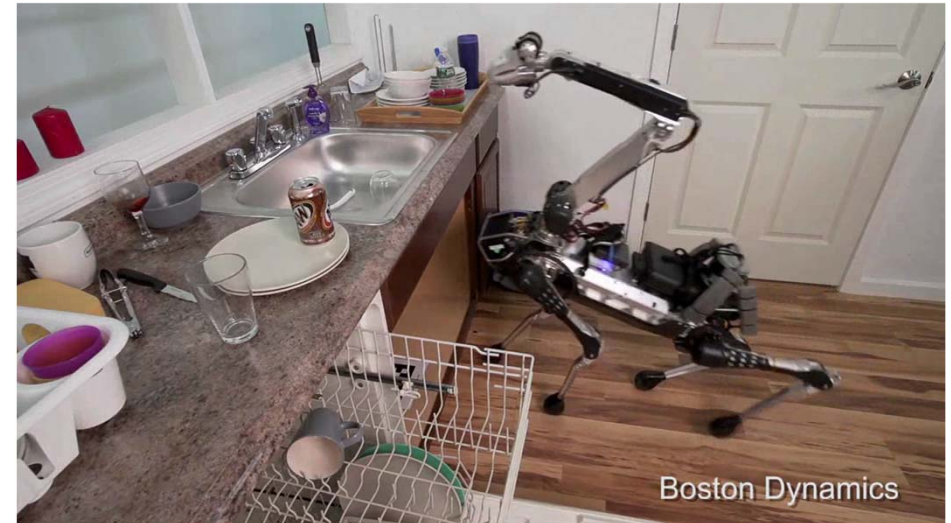
Industrial Robots



Service Robots



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



Boston Dynamics

<https://www.youtube.com/watch?v=tf71EVTdjng>

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 *intuitiv programmierbar* sein
 - Roboter müssen *lern-* und *anpassungsfähig* sein
- **Um das zu erfüllen, braucht es Künstliche Intelligenz, aber auch neue Sensoren, Aktoren und Roboterkonzepte**



50x speed

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



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>

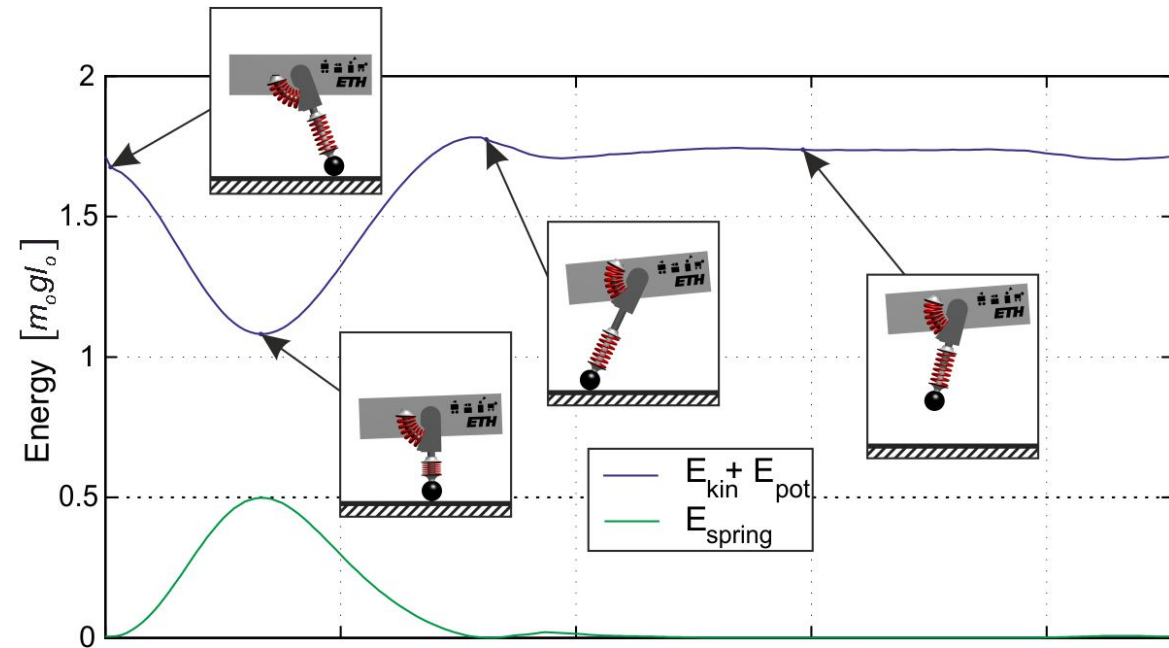
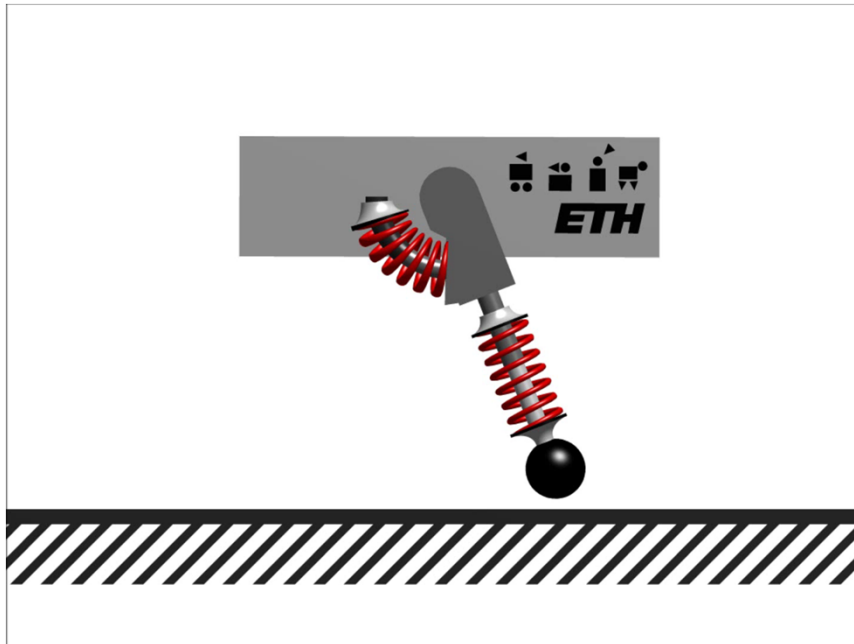
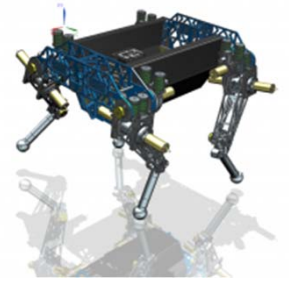


Efficient Walking and Running | what nature evolved (Extreme Jumpy Dog)



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

Efficient Walking and Running | serial elastic actuation



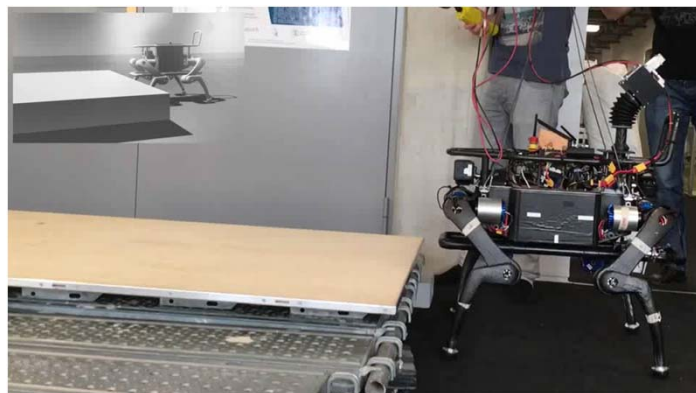
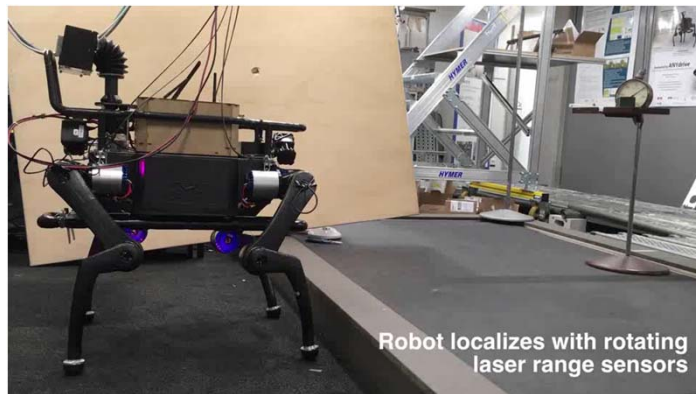
<https://www.youtube.com/watch?v=6igNZiVtbxU>

ANYmal

Combining dynamic motion skills with large mobility



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

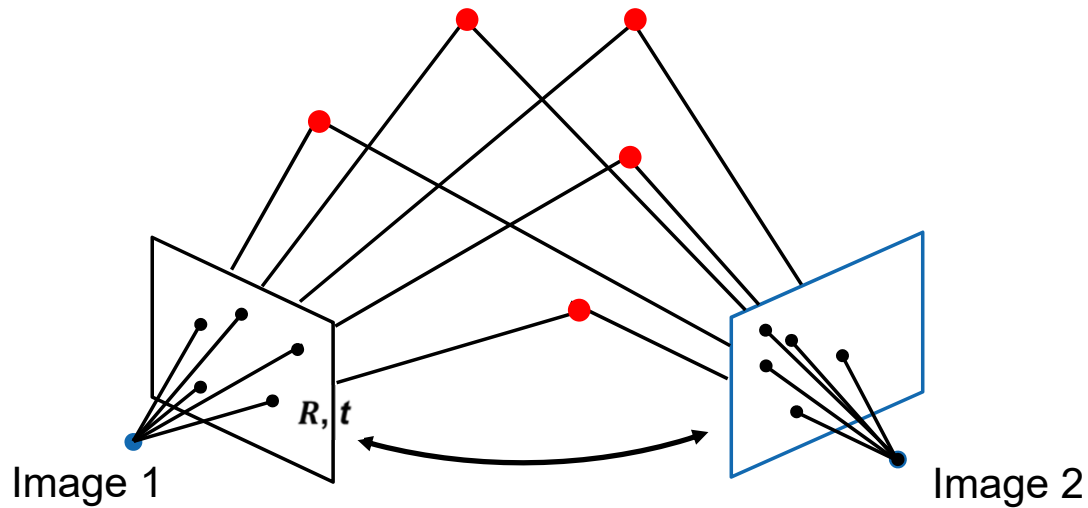
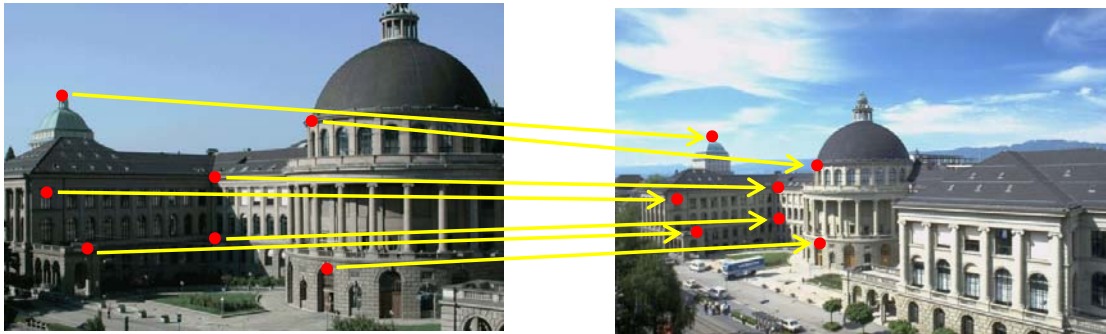
https://www.youtube.com/watch?v=wyS6W1t_ryQ



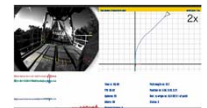
“Sehen” | Laser-basierte 3D Pläne



“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



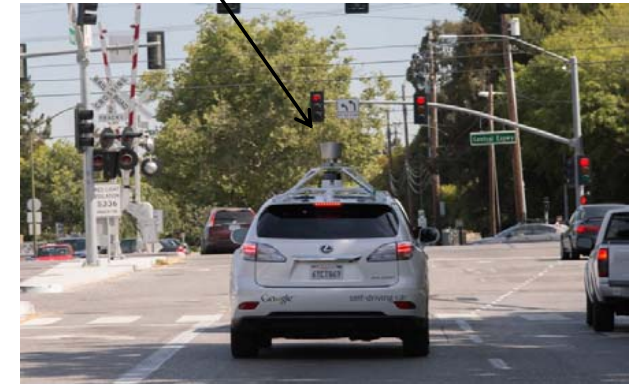
- Detection and tracking of ...
 - Lanes,
 - street signs,
 - other cars,
 - ...

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

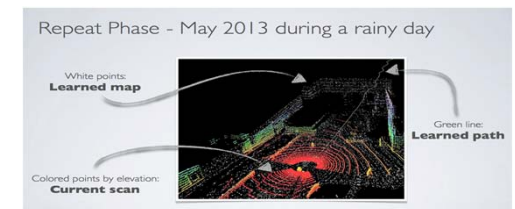


Today | 3D laser sensors → map based

Expensive, complex and cumbersome

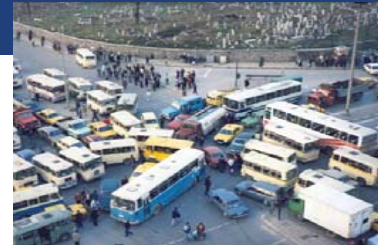


- Google Self-Driving Car Project (status summer 2015)
 - > 20 vehicles in use
 - > 2,7 mio km, 1.5 mio km in autonomous mode
 - > 11 accidents
 - No people insured
 - Non of them caused by car control algorithm



<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



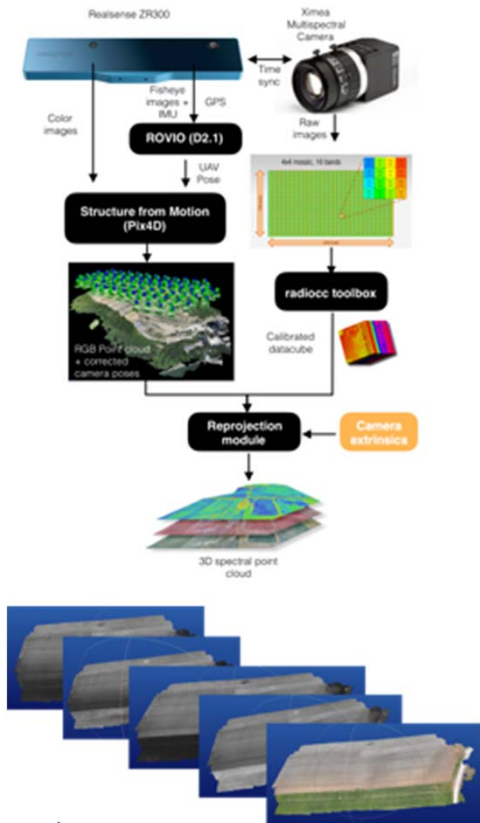
Complexity of Environment → Perception and Interaction

Autonomous Cars | a bright future without traffic jams



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

Spatio-Temporal Spectral Environment Modeling

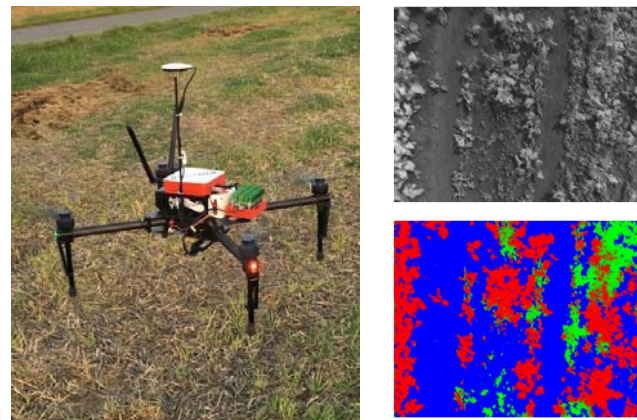


<https://youtu.be/5f1EtfW76Qc>

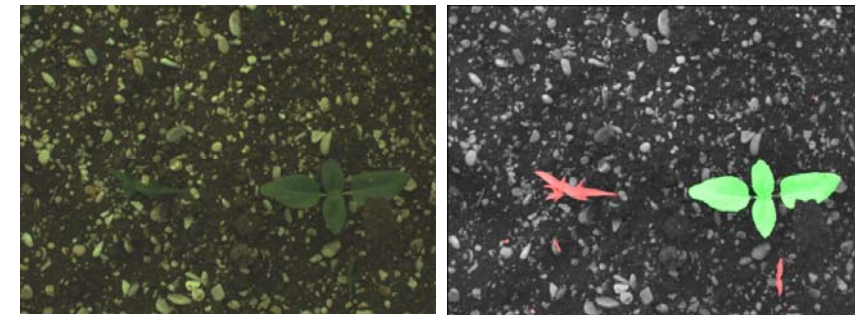
Autonomous UAV landing



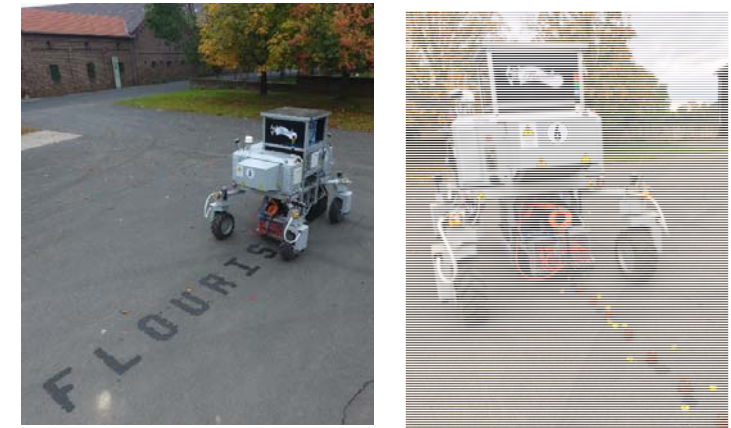
UAV onboard weed detection



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



Automated spraying and stamping



Navigation & Planning in Cluttered Environments



<https://www.youtube.com/watch?v=rAjwD2kr7c0>

Robotics Roadmap

Complexity of Services

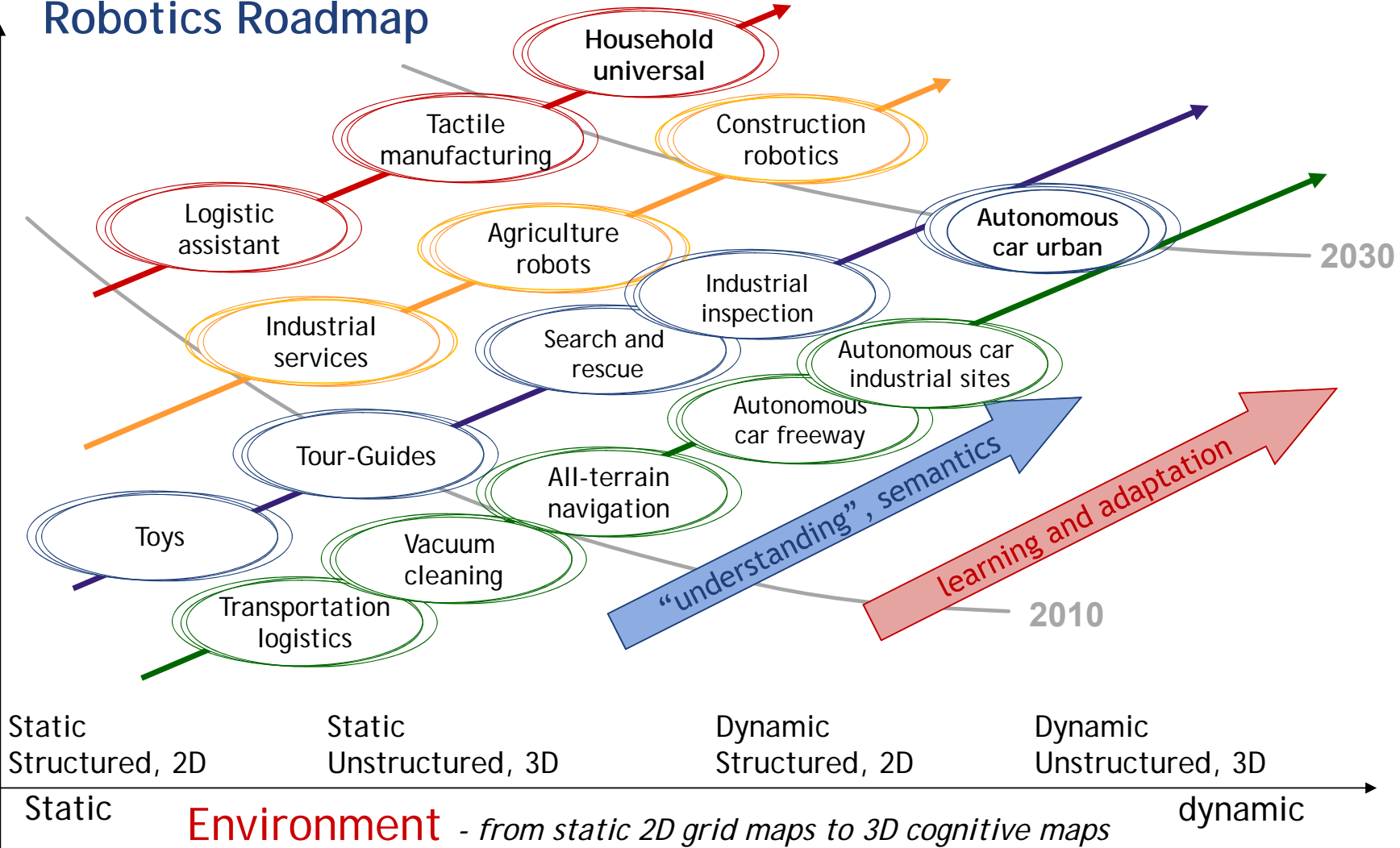
Tactile Manipulation

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

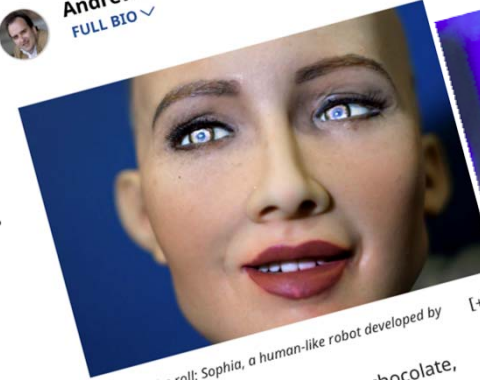
- Ja, Robotik boomte
 - ... es braucht aber noch viel F&E um diese komplexen Systeme auf den Markt zu bringen.
- Ja, Europa und speziell die Schweiz hat das Potential diesen wichtigen Markt zu erobern und somit nachhaltig Arbeitsplätze zu schaffen. Es geht um:
 - Hervorragende Forschung und grossartige 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)**

Forbes

Leadership / #CuttingEdge
SEP 26, 2017 @ 01:22 PM 16,626

How Switzerland Became The Silicon Valley Of Robotics

Andrew Cave, CONTRIBUTOR
FULL BIO



On a Swiss roll: Sophia, a human-like robot developed by

Switzerland. Mountains, lakes, chocolate, fondue and banks? Right? Only partly. The Alpine nation is now "the Silicon Valley of robotics" according to Chris Anderson, chief

THE WORLD UNIVERSITY RANKINGS

RANKING

Rank Name

1 ETH Zurich - Swiss Federal Institute of Technology Zurich
Switzerland

2 California Institute of Technology
United States

2

«Die Schweiz ist das Silicon Valley der Robotik»

Von Alain Zuccher. Aktualisiert am 04.04.2013

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

Top 10 countries for talent competitiveness

1	Switzerland	49	Argentina
2	Singapore	50	Uruguay
3	USA	51	Tanzania
4	Norway	52	Hungary
5	Sweden	53	Malaysia
6	Finland	54	Republic of Korea
7	Denmark	55	Thailand and Europe
8	UK	56	China
9	Netherlands	57	Indonesia
10	Luxembourg	58	Malaysia
11	Australia	59	Spain
12	New Zealand	60	France
13	Ireland	61	Germany
14	Canada	62	Japan
15	Belgium	63	Canada
16	Belgium	64	Canada
17	United Arab Emirates	65	Canada
18	Austria	66	Canada
19	Germany	67	Canada
20	Japan	68	Canada
21	France	69	Canada
22	Canada	70	Canada
23	Canada	71	Canada
24	Canada	72	Canada
25	Canada	73	Canada
26	Canada	74	Canada
27	Canada	75	Canada
28	Canada	76	Canada
29	Canada	77	Canada
30	Canada	78	Canada
31	Canada	79	Canada
32	Canada	80	Canada
33	Canada	81	Canada
34	Canada	82	Canada
35	Canada	83	Canada
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37	Canada	85	Canada
38	Canada	86	Canada
39	Canada	87	Canada
40	Canada	88	Canada
41	Canada	89	Canada
42	Canada	90	Canada
43	Canada	91	Canada
44	Canada	92	Canada
45	Canada	93	Canada
46	Canada	94	Canada
47	Canada	95	Canada
48	Canada	96	Canada
49	Canada	97	Canada
50	Canada	98	Canada
51	Canada	99	Canada
52	Canada	100	Canada

Top 10 cities

1	Zürich
2	Stockholm
3	Doha
4	Copenhagen
5	Helsinki
6	Washington
7	Dublin
8	San Francisco
9	Paris
10	Beijing