Trends in der Digitalisierung

Ein Blick nach Silicon Valley

Prof. Dr.-Ing. Torsten Kröger
Content

• Non-exhaustive overview of US robotics activities

• Mostly based on personal experience
Outline

(Un)related Stories from Silicon Valley

Robot Arms and Grasping

Robots in Logistics for Higher Efficiencies
Open Source Robotics Foundation (OSRF)

- Willow Garage spinoff (May 2012)
- Non-profit organization
- Maintains ROS and Gazebo
- CEO: Brian Gerkey
- Current focus on developing ROS 2.0
- No safety, no proper real-time
Open Source Robotics Corporation (OSRC)

- Taxable subsidiary of OSRF (Sep 2016)
- For-profit
- Initially funded by Toyota Research Institute
- OSRF will keep holding software copyright
- New website: http://www.openrobotics.org
Southwest Research Institute

- Initiated ROS industrial (ROS-I)
- Non-safe, non-real-time connection to COTS industrial robots
- Head of ROS-I: Shaun Edwards
RTI – Real-Time Innovations

- RTI Connext DDS
- Distributed real-time middleware

![Diagram of DDS Interoperability Protocol](image-url)
Toyota Research Institute (TRI)

- R&D in multiple robotics domains:
  - Self-driving
  - Production and manufacturing
  - Autonomous mobile manipulation
- CEO: Gil Pratt
- CTO: James Kuffner
Toyota Research Institute (TRI)

- HSR, Human Support Robot
Huawei Technologies

- Mobile robot for kids and education
- Strong emphasis on social human-robot interaction
Mayfield Robotics (Bosch)

- Kuri
- Home robot
- Announced price: $699
- Inherently safe
- Focus on social human-robot interaction
Mayfield Robotics (Bosch)
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Kuri Speaks Robot

Kuri speaks robot and only robot. It’s a purposeful language of friendly chirps and beeps that are fun to learn. The more you interact with him, the more you will understand.
Mayfield Robotics (Bosch)

Kuri Entertains

Kuri's audio capabilities lets you listen to your favorite songs, audiobooks and podcasts. You can even send her into your kids' room to tell a bedtime story. She can also connect to any entertainment hub you have in your home.
Mayfield Robotics (Bosch)

Kuri Connects
You'll always be connected with Kuri through the Kuri app. Use your favorite devices to set up and monitor tasks, review activity, or have him patrol your house when you're not home.
Savioke

- Delivery robot: Relay
- Hotels, logistics, home
- Founder and CEO: Steve Cousins
Savioke
Verb Surgical

- Founded by J&J and Alphabet
- „Surgery 4.0“: digital surgery platform
  - Robotics
  - Visualization
  - Advanced instrumentation
  - Data analytics
  - Connectivity
Auris Health (formerly Surgical Robotics)

- Founded by Fed Moll
- Monarch: Auris Robotic Endoscopy System
- Out of stealth in 2018
- Acquisition of Hansen Medical
- Device FDA approved
Intuitive Surgical

• da Vinci Surgical System is still the sole product
• „Major“ product upgrade announced
SRI International

MicroFactory Platform for Smart Manufacturing

SRI is developing new technology to reliably control thousands of micro-robots for smart manufacturing of macro-scale products in compact, integrated systems.

Pedestrian Detection from Moving Unmanned Ground Vehicles

SRI’s vision-based systems enable safe operations of moving unmanned ground vehicles around stationary and moving people in urban or cluttered environments.
SRI International

Visual Intelligence Grounded in Learning (VIGIL)

SRI’s visual intelligence system could enable a new era in unmanned robotic surveillance.

Trauma Pod

With SRI as lead integrator, DARPA collaborators demonstrated how a remotely operated trauma pod could deliver emergency first-response treatment in the battlefield to stabilize patients for transport.
openAI

- Founded by Elon Musk in 2015
- Non-profit
- Mission: „Friendly artificial intelligence“
• Learning robot motions from human demonstrations in VR
• Founder: Pieter Abbeel
Commonsense Robotics

• On-demand supply-chains that enable profitable, one-hour delivery for online grocers.
• Based in Israel
• Investors from California
Symb.io

- Machine learning for robotics
- Still in stealth mode
Magic Leap

• Augmented reality devices and eco system
• Based in FL, CA, Switzerland, and Israel
ARRAIY

• Content creation for AR and VR using computer vision and deep learning
• Still in stealth phase
• Part of the Playground Global incubator
• Deep learning for visual object recognition
Suitable Technologies

- F(o)under: Scott Hassan
- Tele-presence robots
  - Beam Pro
  - Beam Plus
(Un)related Stories from Silicon Valley

Robot Arms and Grasping

Robots in Logistics for Higher Efficiencies
Google Puts Money on Robots, Using the Man Behind Android

By JOHN MARKOFF  DEC. 4, 2013

PALO ALTO, Calif. — In an out-of-the-way Google office, two life-size humanoid robots hang suspended in a corner.

If Amazon can imagine delivering books by drones, is it too much to think that Google might be planning to one day have one of the robots hop off an automated Google Car and race to your doorstep to deliver a package?

Google executives acknowledge that robotic vision is a “moonshot.” But it appears to be more realistic than Amazon’s proposed drone delivery service, which Jeff Bezos, Amazon’s chief executive, revealed in a television interview this week.
Google Adds to Its Menagerie of Robots

By JOHN MARKOFF  DEC. 14, 2013

SAN FRANCISCO — BigDog, Cheetah, WildCat and Atlas have joined Google’s growing robot menagerie.

Google confirmed on Friday that it had completed the acquisition of Boston Dynamics, an engineering company that has designed mobile research robots for the Pentagon. The company, based in Waltham, Mass., has gained an international reputation for machines that walk with an uncanny sense of balance and even — cheetahlike — run faster than the fastest humans.
Alphabet

- Robotics acquisitions 2013 and 2014
Astro Teller, Captain of Moonshots at X, on the Future of AI, Robots, and Coffeemakers

By Erica Guizzo
Posted 8 Dec 2016 | 17:39 GMT

Interview from Dec 2016
In Buying Boston Dynamics, SoftBank Is Betting Big on Walking Robots

Can the company make a go of the automatons that never did fit in at Google?

by Jamie Condliffe  June 9, 2017

The technology conglomerate Softbank has acquired Boston Dynamics,
Learning Hand-Eye Coordination for Robotic Grasping with Deep Learning and Large-Scale Data Collection

Sergey Levine
Peter Pastor
Alex Krizhevsky
Deirdre Quillen
Google

Abstract
We describe a learning-based approach to hand-eye coordination for robotic grasping from monocular images. To learn hand-eye coordination for grasping, we trained a large convolutional neural network to predict the probability that task-space motion of the gripper will result in successful grasps, using only monocular camera images and independently of camera calibration or the current robot pose. This requires the network to observe the spatial relationship between the gripper and objects in the scene, thus learning hand-eye coordination. We then use this network to servo the gripper in real time to achieve successful grasps. To train our network, we collected over 800,000 grasp attempts over the course of two months, using between 6 and 14 robotic manipulators at any given time, with differences in camera placement and hardware. Our experimental evaluation demonstrates that our method achieves effective real-time control, can successfully grasp novel objects, and corrects mistakes by continuous servoing.

1. Introduction
When humans and animals engage in object manipulation behaviors, the interaction inherently involves a fast feedback loop between perception and action. Even complex manipulation tasks, such as extracting a single object from a cluttered bin, can be performed with hardly any advance planning, relying instead on feedback from touch and vision. In contrast, robotic manipulation often (though not always) relies more heavily on advance planning and analysis, with relatively simple feedback, such as trajectory following, to ensure stability during execution (Srinivasa et al., 2012). Part of the reason for this is that incorporating complex sensory inputs such as vision directly into a feedback controller is exceedingly challenging. Techniques such as visual servoing (Siciliano & Khatib, 2007) perform continuous feedback on visual features, but typically require the features to be specified by hand, and both open-loop perception and feedback (e.g., via visual servoing) requires manual or automatic calibration to determine the precise geometric relationship between the camera and the robot’s end-effector.

In this paper, we propose a learning-based approach to hand-eye coordination, which we demonstrate on a robotic grasping task. Our approach is data-driven and goal-centric: our method learns to servo a robotic gripper to

Figure 1. Our large-scale data collection setup, consisting of 14 robotic manipulators. We collected over 800,000 grasp attempts to train the CNN grasp prediction model.
Learning Hand-Eye Coordination

Input
512x512 pixels
Finger position

Output
Task space
gripper motion

monocular RGB camera
7 DoF robotic manipulator
2-finger gripper
object bin
Learning Hand-Eye Coordination

800,000 attempts
14 robot arms
Two months
CNNs for deep reinforcement learning
Shared models
Data Driven Robotics
Different Objects, Different Grasping Strategies
Different Objects, Different Grasping Strategies
Different Objects, Different Grasping Strategies
New (Unknown) Objects
Next Generation Arm Farm
DexNet 2.0 (UC Berkeley)

Dex-Net 2.0

99% Precision Grasping

AUTO Lab

BAIR

CITRIS People and Robots Initiative

Berkeley Engineering
Outline

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Robots in Logistics for Higher Efficiencies
RightHand Robotics

- Based in Massachusetts
- Autonomous picking for e-commerce order fulfillment
Kinema Systems

• Robot paletizing
• 3D vision using deep learning
• Founder: Sachin Chitta
Fetch Robotics

- Autonomous mobile robots for warehouses
- Founder: Melonee Wise
- ROS
(Un)related Stories from Silicon Valley

Robot Arms

Robots in Logistics for Higher Efficiencies
Thank you!

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De-hyping AI

1. Machine learning means learning from data; **AI** is a buzzword

2. Machine learning is about data and algorithms, but mostly data

3. Unless you have a lot of data, you should stick to **simple models**
Simplified: The “Four Revolutions”

1. Mechanical hardware
2. Electrical hardware
3. Software
4. Data
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