IROS 2016 Summary and Videos

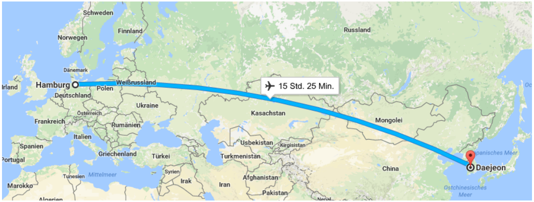
Norman Hendrich

University of Hamburg, Informatics Department
Vogt-Koelln-Str. 30, D-22527 Hamburg, Germany

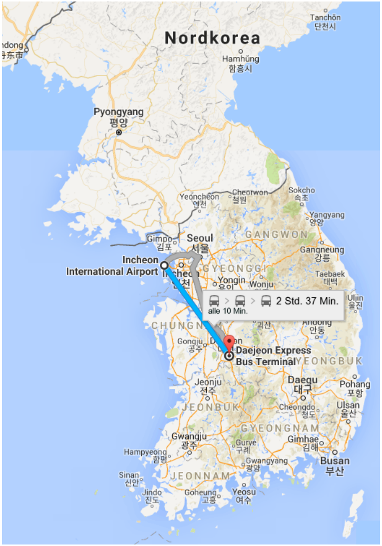
25 October 2016

- Daejeon, Korea
- IROS 2016
- Exhibition
- Workshop on Personal Robot Interaction
- Videos

Daejeon, Korea



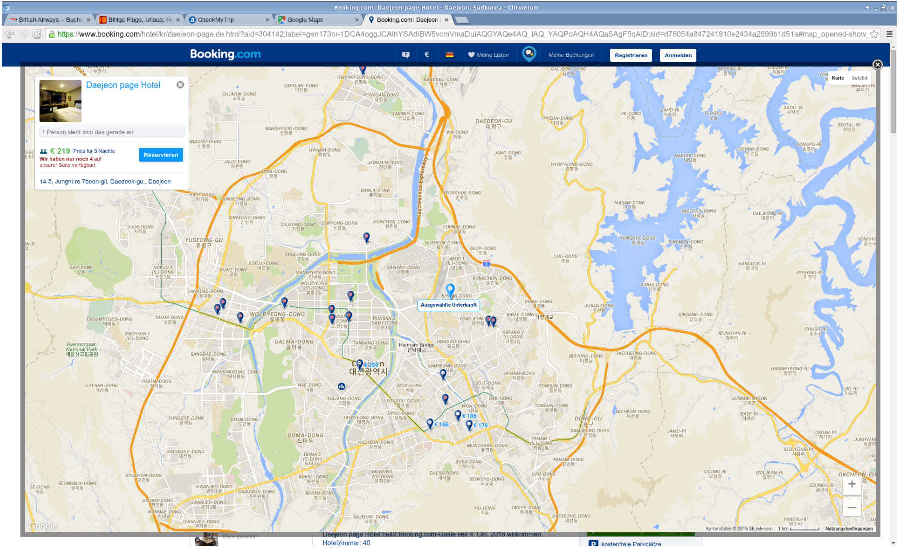
- 5th largest city in South Korea
- 1.5 M people
- modern town, no historical sights
- industry and government
- home of KAIST
- friedly people, safe; also some smog
- IROS-16 at DCC conference center
- part of EXPO 1993 site



8300 km, Hamburg - Helsinki 2 hrs, Helsinki - Incheon 10 hrs, Incheon - Daejeon 3 hrs, add transfers for 22 hrs

Selecting a hotel at last-minute. . .

. . . can go wrong



Daejeon Conference Center and Expo-93 relics

Golf…

Golf…is a big national sport

Wildlife

IROS 2016

- 10-14 Oct 2016, Daejeon Conference Center
- organizers:
  - Il Hong Suh, Hanyang Univ., General Chair
  - Dong-Soo Kwon, KAIST, Program Chair
  - Wolfram Burgard, Editor-in-Chief

- 1719 submissions, 57 countries, 832 accepted (48%)
- oral, interactive, demonstration, video, highlight presentations
- 36 workshops and tutorials
- 3 life time talks: F. Harashima, G. Hirzinger, W. J. Book
- 4 plenary talks, 9 keynotes
- 3 forums: AI/deep learning, autonomous systems, medical
- 3 challenges: drone racing, humanoid application, manipulation
- 40 exhibitors

- ROSCON-16 (8-9 Oct, Seoul), ROBOWORLD-16 (12-15 Oct, Seoul)

http://iros2016.org/

Daejeon, Korea

IROS 2016

Exhibition

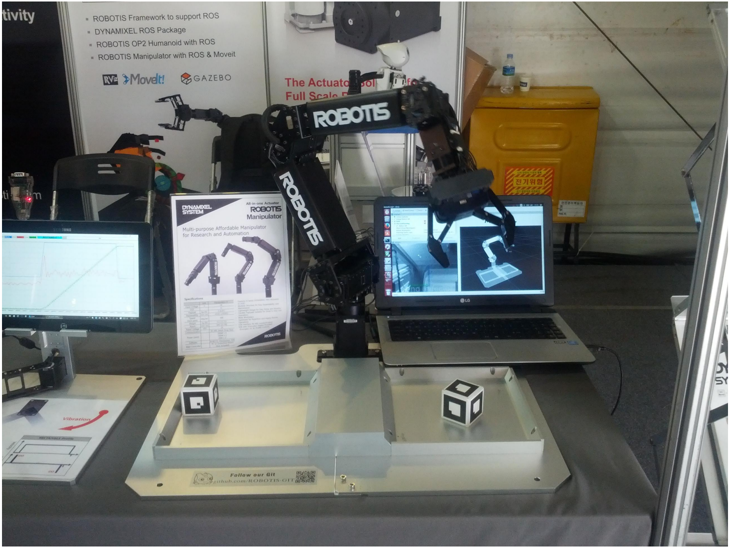
Workshop on Personal Robot Interaction

Videos

Rethink Robotics: Sawyer

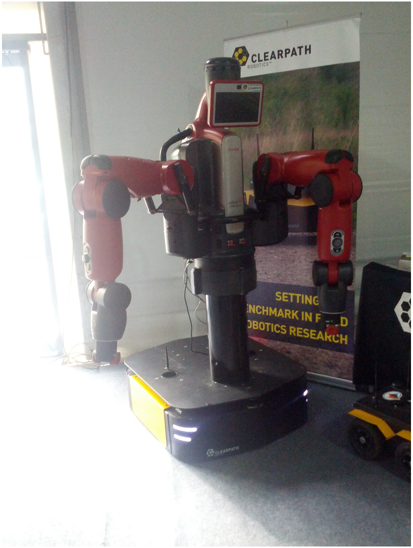
new low-cost robot arm with joint torque sensing and ROS torque control

Robotis: arm and cube demo



robot picks cube, places in the center, then brushes it away again

Clearpath Robotics: mobile platforms

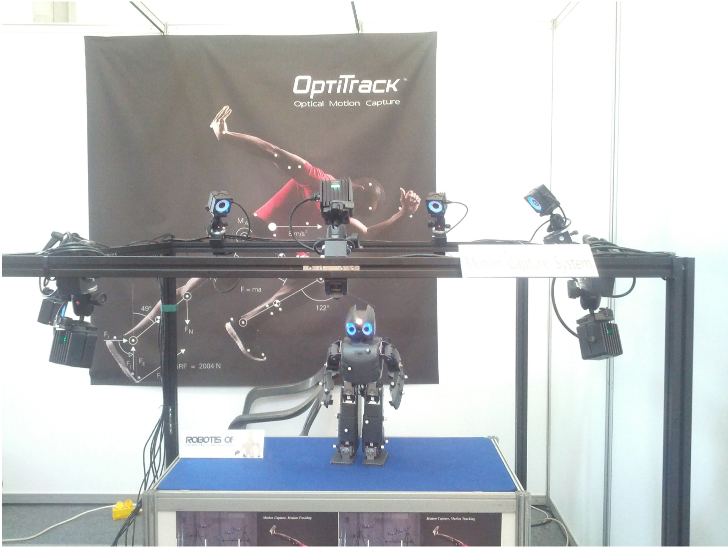


Ridgeback+Baxter and Otto mobile platforms

Long Endurance UAV

North-South Korean border control: 3 kg payload, 24 hrs flight time, tethered via car battery

OptiTrack: demo



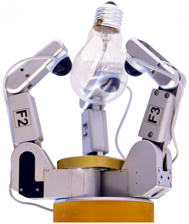
note: data looked smooth, stable and precise

OptiTrack: data

note: upper body has two markers in front, two in rear

Optoforce

- half-sphere rubber 3-DOF force sensor
  - camera measures surface deflection
  - two sizes, 20 mm or 10 mm diameter
  - nominally 16-bit and 12-bit resolution
  - live demo of the 20 mm sensor, worked well
  - we should get one or two of these…
- new 6-axis F/T sensor, 200 N
  - industrial casing, size similar to Sunrise/ATi
  - built-in electronics (CAN bus, external EtherCAT adapter)
- hand-contour following demo
  - UR5 and 6-axis F/T



optoforce.com

i2A Systems optical sensors

- i2asys.com, spin-off from KAIST
- 1-DOF, 2-DOF, 3-DOF force sensors
  - optical proximity sensing principle
  - "convenient use without amplifier"
  - 30 kg .. 200 kg max load
  - industrial grade housings
  - torque sensor for harmonic drive (not shown at IROS exhibition)
- Batuino board: Arduino compatible
  - ATmega 328P (16 MHz, 32 kB Flash, 2 kB RAM, 1 kB EEPROM)
  - versatile power supply: BAT1 0.9-5.5 V
  - LiPo compatible with on-board charger: BAT2 3.7 V

Daejeon, Korea

IROS 2016

Exhibition

Workshop on Personal Robot Interaction

Videos

Workshop on Personal Robot Interaction

http://rccnc.ustc.edu.cn/iros2016/IROS2016-Workshop-Personal-Robot-Interaction.html

Workshop on Personal Robot Interaction

- organizers
  - Yimin Zhang, Intel Labs China, yimin.zhang@intel.com
  - Jiqiang Song, Intel Labs China, jiqiang.song@intel.com
  - Prof. Xiaoping Chen, University of Science and Technology of China (USTC), xpchen@ustc.edu.cn
- cosponsored by RAS TC on Human-Robot Interaction

- 8 invited talks
- 15 posters
- about 50 participants

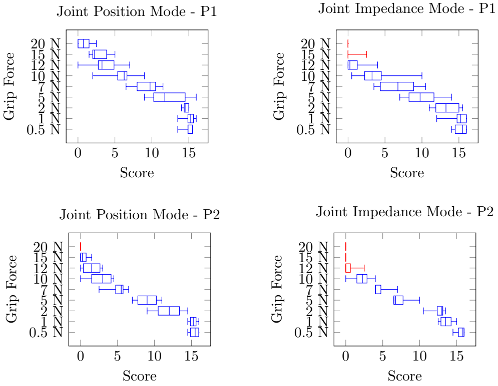
- Intel exhibits:
  - Realsense SDK demos
  - telepresence robot: mobile base, tablet, realsense, 1.60 m
  - turtlebot style low-cost robots
  - JEDI1: omni-wheel two-arm mobile robot

http://rccnc.ustc.edu.cn/iros2016/IROS2016-Workshop-Personal-Robot-Interaction.html

Dexterous manipulation and robot service

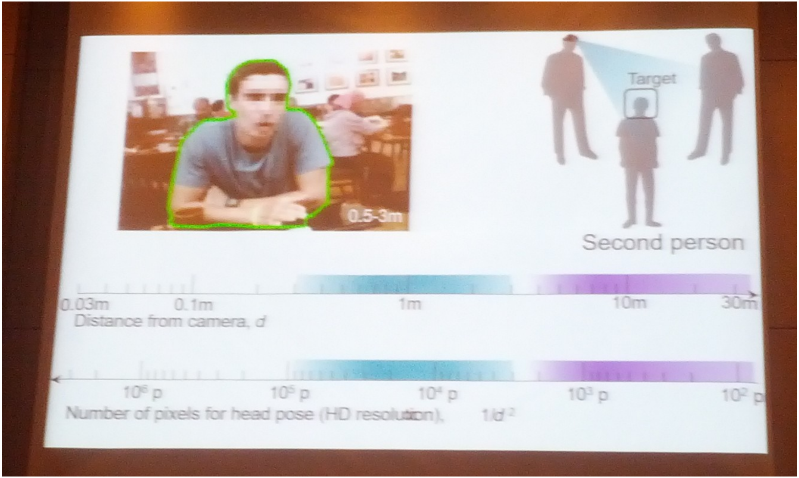
Norman Hendrich, Univ. Hamburg

- case study: object handover
- preferred handover force thresholds
- stiff and compliant robot, horizontal and vertical gripper



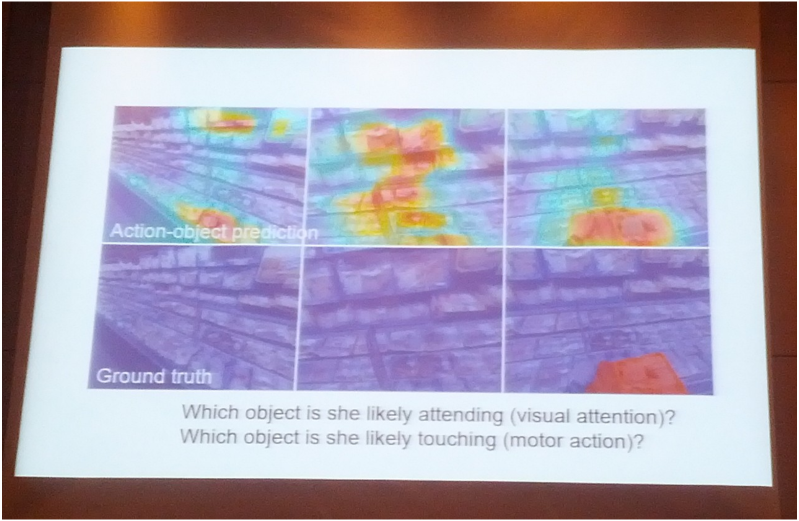
Personalized AI with first person vision

Prof. Jianbo Shi, UPenn



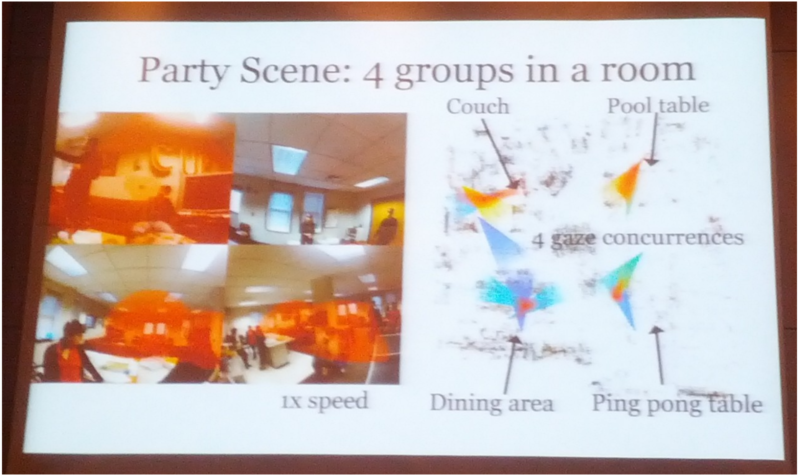
head camera evolution: third person ▷ second person ▷ full immersive experience

Head camera: supermarket attention analysis



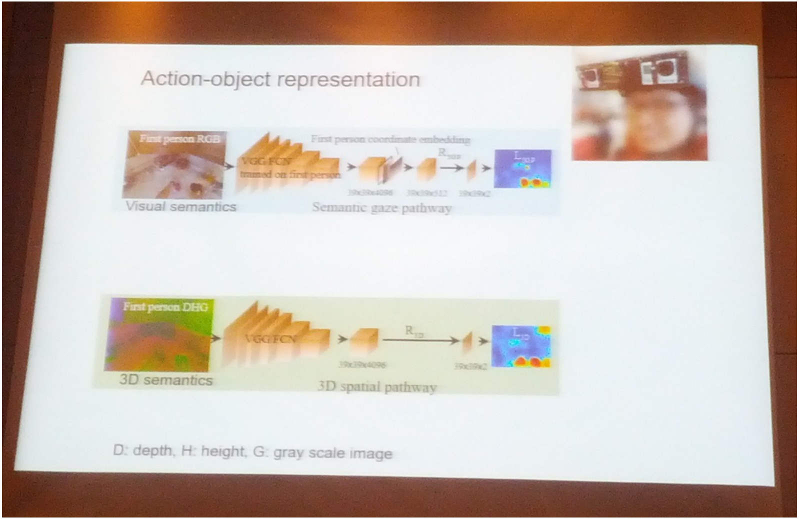
GoPro camera plus head tracking, no eye tracking

Head camera: party scene analysis

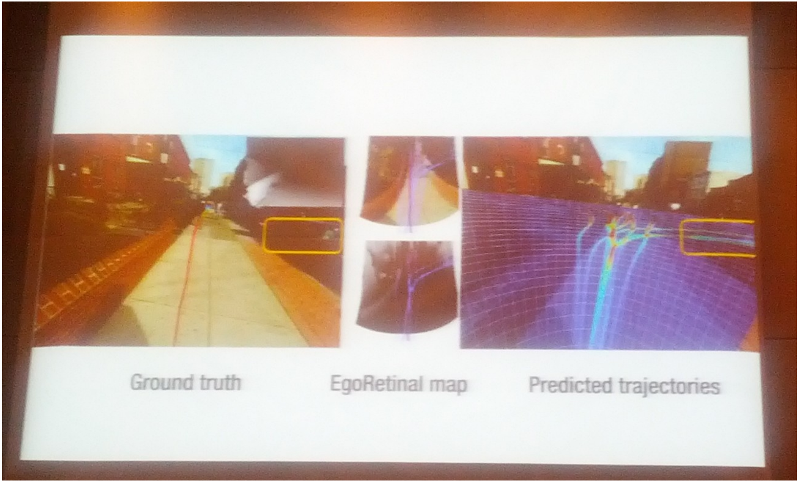


reliable attention localization from fusion of multiple persons' cameras

EgoNet: Deep learning for motion prediction

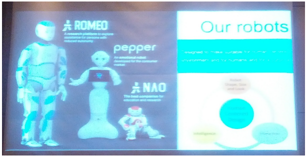


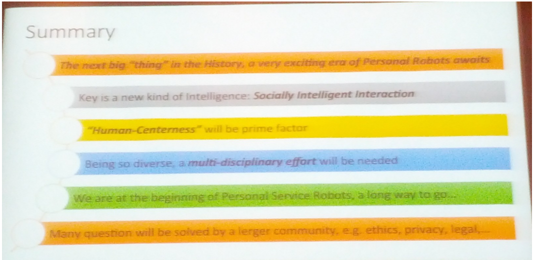
EgoNet: motion prediction



A personal robot for me? Socially intelligent interaction is the key

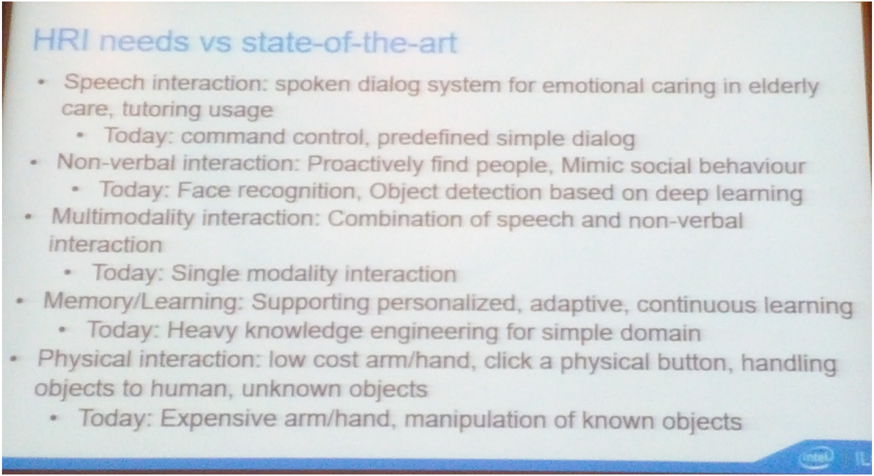
Dr. Amit Kumar Paney, Softbank Robotics



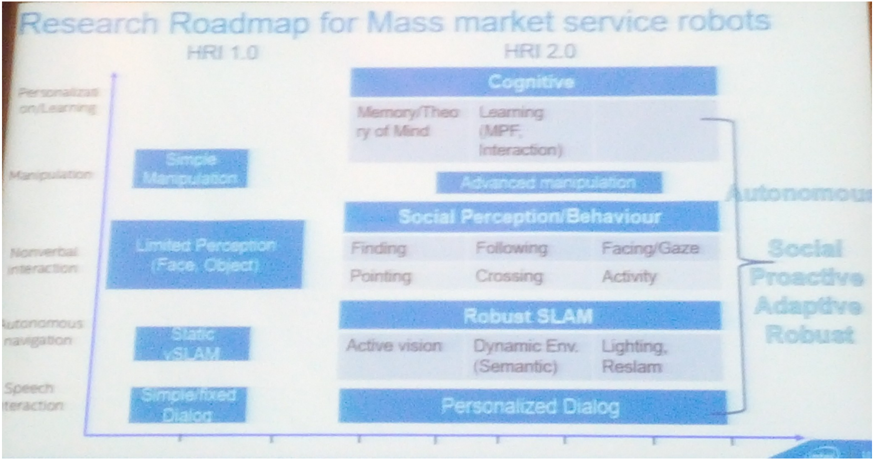


Human-Robot Interaction on Service Robot

Dr. Jiqiang Song, Dr. Yimin Zhang, Intel Labs China

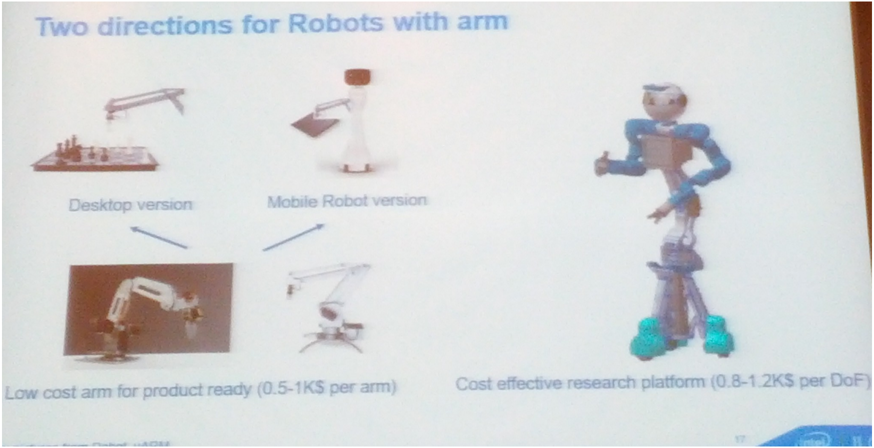


Mass market service robots



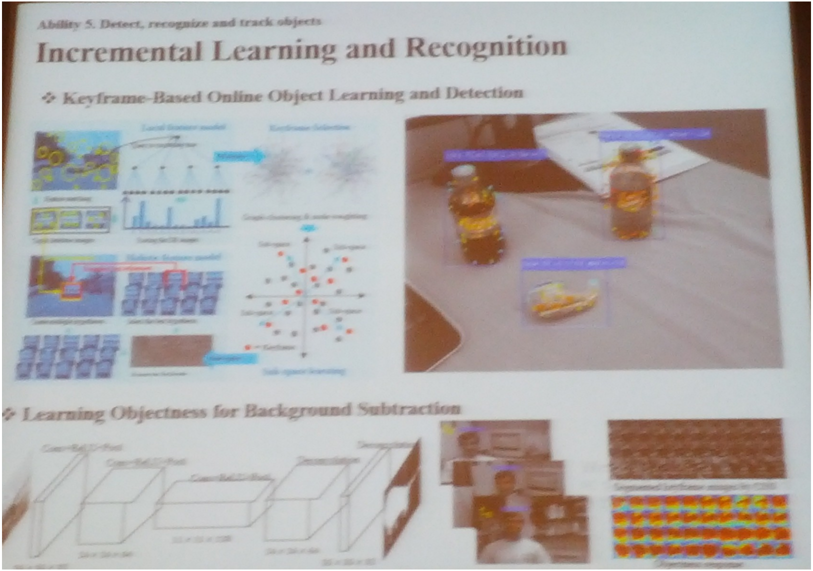
Low-cost service robot use cases

Low-cost robot arms



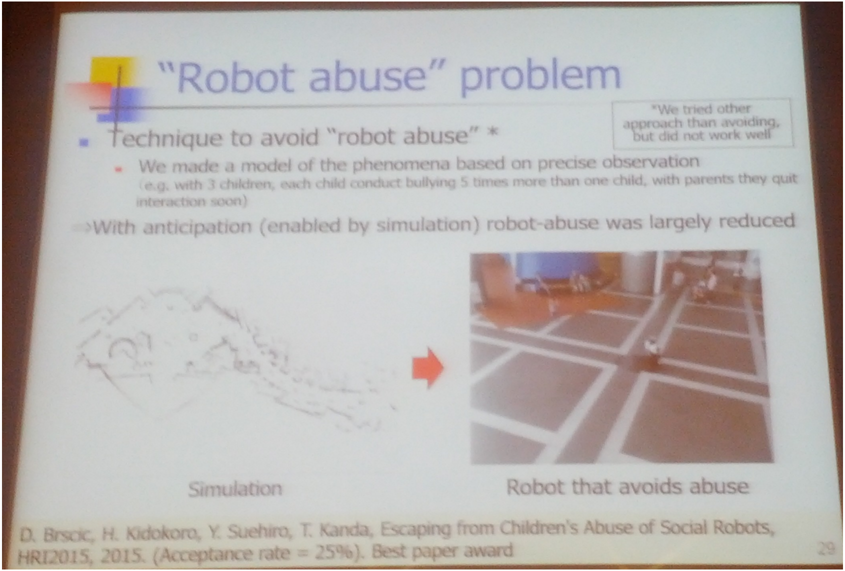
Cognitive X-ability for Social HRI

Prof. Il Hong Suh, Hanyang Univ



Enabling HRI - Real World Approach

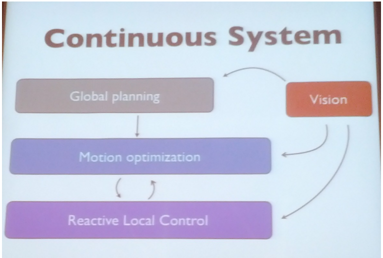
Dr. Takayuki Kanda, ATR

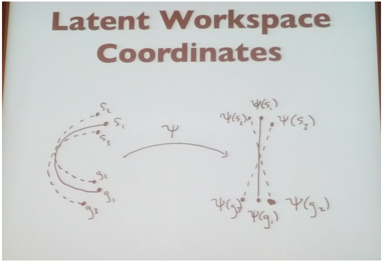


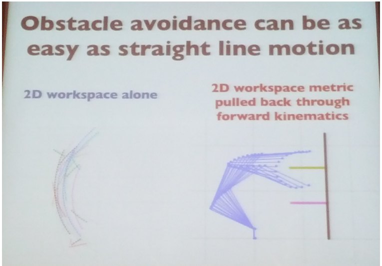
Designing motion with an expectation of change

Continuous motion adaptation for dynamic interaction in human environments

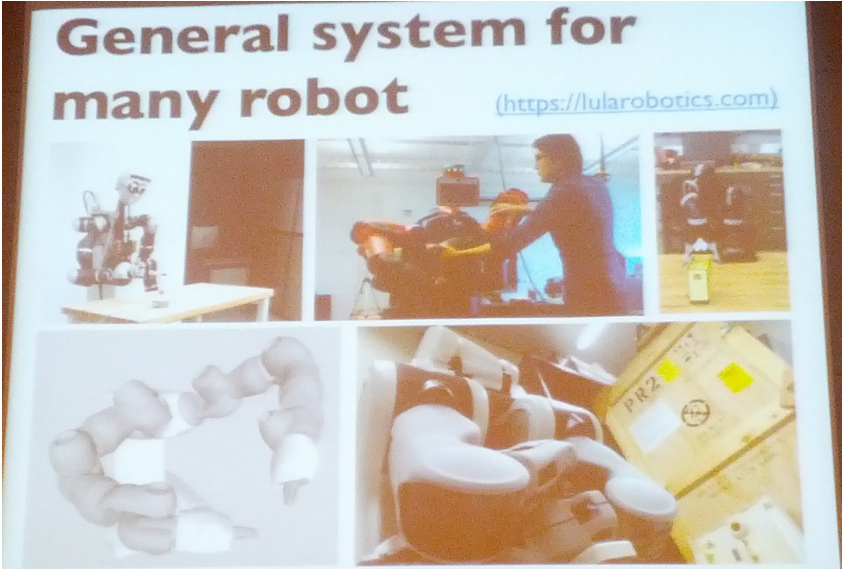
Dr. Nathan Ratliff, Lula Robotics





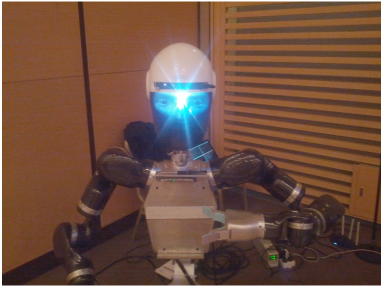


Continous Motion Adaptation



lularobotics.com

Intel JEDI1 robot



Intel JEDI1 robot

Mechanical Components	Computing and Interaction Components	Software Development Kit Components
2-DOF Head	Intel Core i7 CPU, Intel Core i5 CPU	Intel RealSense SDK
Dual 7-DOF Arms with Grippers	Intel RealSense Camera	Human-robot Interaction Development Kit
Elevatable Body	3D Face Projection	Motion Navigation Development Kit
Extendable Omni-directional Mobile Base	Microphone Array	3D Operation Development Kit

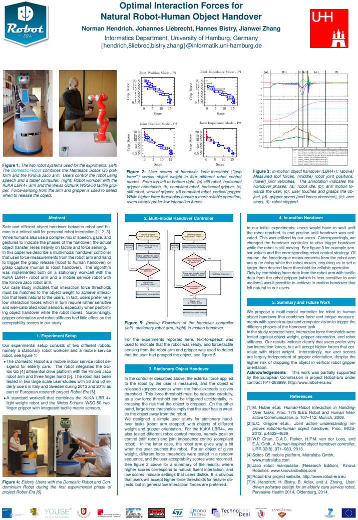
With Intel's cost-effective intelligent perception and computing technology and the robot motion module independently developed by AUBO, we will provide cognate multi-configuration robot platform at a competitive price to individuals, corporations, universities and scientific research institutes that are dedicated to the research and development of intelligent robot interaction. Based on our platform, they can conduct secondary development, algorithm verification, function test, etc.

Through competition, training and other channels, this platform will be promoted to more than 100 universities, research institutes and corporations at home and abroad, so as to improve intelligent robot development community and accelerate the enhancement of core technologies and the industrialization of service robot.

Contact: patricia.p.wang@intel.com

AUBO harmonic-drive actuators, ca. 1500 USD apiece, spindle driven torso lift, ca. 1.40..1.80 m, 3x NUCs on board

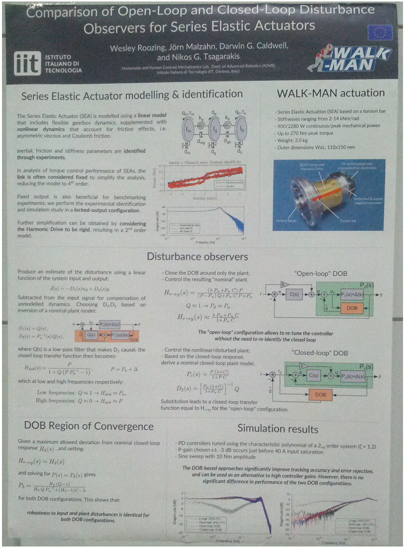
Posters…



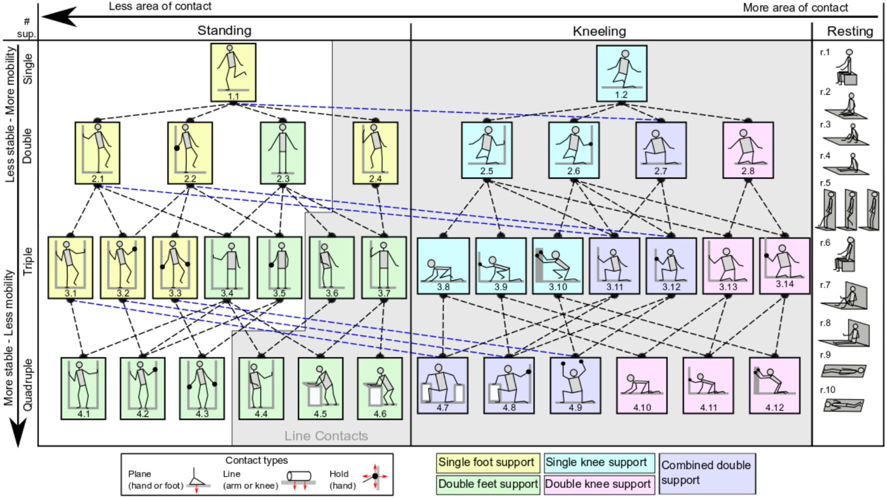
Optimal Interaction Forces for
Natural Robot-Human Object Handover
Norman Hendrich, Johannes Liebrecht, Hannes Bistry, Jianwei Zhang
Informatics Department, University of Hamburg, Germany
{hendrich,8liebrec,bistry,zhang}@informatik.uni-hamburg.de
Joint Position Mode - P1
Joint Impedance Mode - P1
Joint Position Mode - P2
Joint Impedance Mode - P2
Grip Force
Score
Figure 1: The two robot systems used for the experiments. (left) The Domestic Robot combines the Metralabs Scitos G5 platform and the Kinova Jaco arm. Users control the robot using speech and a tablet computer. (right) Robot workcell with the KuKA LBR 4+ arm and the Weiss-Schunk WSG-50 tactile gripper. Force-sensing from the arm and gripper is used to detect when to release the object.
Figure 2: User scores of handover force-threshold ("grip force") versus object weight in four different robot control modes. From top-left to bottom right: (a) stiff robot, horizontal gripper orientation, (b) compliant robot, horizontal gripper, (c) stiff robot, vertical gripper, (d) compliant robot, vertical gripper. While higher force thresholds ensure a more reliable operation, users clearly prefer low interaction forces.
Figure 3: In-motion object handover (LBR4+): (above) Measured tool forces, (middle) robot joint positions, (lower) joint velocities. The annotation indicates the Handover phases: (a): robot idle, (b): arm motion towards the user, (c): user touches and grasps the object, (d): gripper opens (and forces decrease), (e): arm stops, (f): robot stopped.
Abstract
Safe and efficient object handover between robot and human is a critical skill for personal robot interaction [1, 2, 3]. While humans also use a complex mix of speech, gaze, and gestures to indicate the phases of the handover, the actual object transfer relies heavily on tactile and force sensing.
In this paper we describe a multi-modal handover controller that uses force-measurements from the robot arm and hand to trigger the grasp release (robot to human handover) or grasp capture (human to robot handover). The algorithm was implemented both on a stationary workcell with the KuKA LBR4+ robot arm and a mobile service robot with the Kinova Jaco robot arm.
Our case study indicates that interaction force thresholds must be matched to the object weight to achieve interaction that feels natural to the users. In fact, users prefer very low interaction forces which in turn require rather sensitive and well-calibrated robot sensors, especially when performing object handover while the robot moves. Surprinsingly, gripper orientation and robot stiffness had little effect on the acceptability scores in our study.
1. Experiment Setup
Our experimental setup consists of two different robots, namely a stationary robot workcell and a mobile service robot, see figure 1:
• The Domestic Robot is a mobile indoor service robot designed for elderly care. The robot integrates the Scitos G5 [4] differential drive platform with the Kinova Jaco robot arm and three finger hand [5]. The robot has been tested in two large scale user-studies with 56 and 50 elderly users in Italy and Sweden during 2013 and 2015 as part of European research project Robot-Era [6].
• A standard workcell that combines the KuKA LBR 4+ light-weight robot and the Weiss-Schunk WSG-50 two-finger gripper with integrated tactile matrix sensors.
Figure 4: Elderly Users with the Domestic Robot and Condominium Robot during the first experimental phase of project Robot-Era [6].
2. Multi-modal Handover Controller
Figure 5: (below) Flowchart of the handover controller (left): stationary robot arm, (right) in-motion handover.
For the experiments reported here, text-to-speech was used to indicate that the robot was ready, and force/tactile sensing from the robot arm and gripper was used to detect that the user had grasped the object, see figure 5.
3. Stationary Object Handover
In the controller described above, the external force applied to the robot by the user is measured, and the object is released (gripper opens) when the force exceeds a given threshold. This force threshold must be selected carefully, as a low force threshold can be triggered accidentally, increasing the risk that the object is dropped. On the other hand, large force thresholds imply that the user has to wrestle the object away from the robot.
We designed a simple user study for stationary handover tasks (robot arm stopped) with objects of different weight and gripper orientation. For the KuKA LBR4+, we also tested different robot control modes, namely position control (stiff robot) and joint impedence control (compliant robot). In the latter case, the robot arm gives way a bit when the user touches the robot. For an object of given weight, different force thresholds were tested in a random sequence, and the user acceptability scores were recorded. See figure 2 above for a summary of the results, where higher scores correspond to natural fluent interaction, and low scores indicate settings that users dislike. It is obvious that users will accept higher force thresholds for heavier objects, but in general low interaction forces are preferred.
4. In-motion Handover
In our initial experiments, users would have to wait until the robot reached its end position until handover was activated. This was critized by our users. Correspondingly, we changed the handover controller to also trigger handover while the robot is still moving. See figure 3 for example sensor values and the corresponding robot control strategy. Of course, the force/torque measurements from the robot arm are quite noisy while the robot moves, requiring us to set a larger than desired force threshold for reliable operation. Only by combining force data from the robot arm with tactile data from the robot gripper (which is less sensitive to arm motions) was it possible to achieve in-motion handover that felt natural to our users.
5. Summary and Future Work
We propose a multi-modal controller for robot to human object handover that combines force and torque measurements with speech output and computer vision to trigger the different phases of the handover task.
In the study reported here, interaction force thresholds were tested against object weight, gripper orientation, and robot stiffness. Our results indicate clearly that users prefer very low interaction forces, but will accept higher force thresholds for heavy objects. Our user scores correlate with object weight. Interestingly, our user scores are largely independent of gripper orientation, despite the higher risk of dropping the object in vertical robot gripper orientation.
Acknowledgements This work was partially supported by the European Commission in project Robot-Era under contract FP7-288899, http://www.robot-era.eu
References
[1] M. Huber et.al, Human-Robot Interaction in Handing-Over Tasks, Proc. 17th IEEE Robot and Human Interactive Communication, p. 107–112, Munich, 2008.
[2] E.C. Grigore et.al., Joint action understanding improves robot-to-human object handover, Proc. IROS-2013, p.4622–4629
[3] W.P. Chan, C.A.C. Parker, H.F.M. van der Loos, and E.A. Croft, A human-inspired object handover controller, IJRR 32(8), 971–983, 2013.
[4] Scitos G5 mobile platform, Metralabs Gmbh, www.metralabs.com
[5] Jaco robot manipulator (Research Edition), Kinova Robotics, www.kinovarobotics.com
[6] Robot-Era project website, http://www.robot-era.eu
[7] N. Hendrich, H. Bistry, B. Adler, and J. Zhang, User-driven software design for an elderly care service robot, Pervasive-Health 2014, Oldenburg, 2014.

High Efficient Dynamic Walking Robot XINGZHE
and Its Application in Walking Aid
CHONGQING UNIVERSITY OF POSTS AND TELECOMMUNICATIONS
UNIVERSITY OF HAMBURG
CHONGQING ZUBU TECHNOLOGY CO., LTD.
(Leading by Prof. Qingdu Li, liqd@cqupt.edu.cn, phone +8618623556969)
Xingzhe is one of the most energy efficient robots in the world. It set a new record walking 340936 steps over 134 km in 54 hours with in-body 0.8kWh batteries without refuel or falling (COT<0.214).
Most advanced robots walk via the ZMP approach with static balance, which cost complex design, slow motion, more energy and money. However, Xingzhe mimics the walking mechanism of human with dynamical balance and natural gaits.
Features Xingzhe:
Energy efficiency: COT=0.21, human is 0.2
Walking distance: >130km
Endurance: >50 hours;
Weight: 4kg (According to battery)
Walking gaits: Natural & Comfortable
Walking speed: 0 ~ 4 km/h
Carry load: up to 75kg on upper-body
Xingzhe walking assist:
Help walking and excising for old/disabled
Intelligent friend for the
Customizable home assist for family
Make a better life

WS Torque-Controlled Robots: IIT Walk-Man



WS Manipulation: KIT humanoid pose taxonomy



The proposed taxonomy has 46 classes, including 18 standing poses, 18 kneeling poses and 10 resting configurations. Sketches represent all the ranges of poses with the same number of supports and type of contact. Each class includes the symmetric cases when applicable. The lines provide possible road maps to transfer from one pose to another, assuming we can just perform one contact change at a time. Lines also provide a hierarchy among the poses. Blue lines represent transitions to different categories (from standing to kneeling).

https://arxiv.org/pdf/1503.06839v2.pdf

IROS Videos selection

- my personal selection from 423 submitted videos
  - grasping and manipulation
  - sensing
  - human-robot interaction
  - fun

- full proceedings: on our server, and on IEEExplore
- /informatik2/tams/intern/proceedings/iros/2016/

Gyeongbokgung palace at night