IROS参加報告

原田　研介（大阪大学）

IROS（IEEE/RSJ Int. Conf. Intelligent Robots and Systems）とは

- ICRA (Int. Conf. on Robotics and Automation)に次ぐ規模のIEEEのロボティクス関連の国際会議
- 1988年に第一回が東京で開催された日本発の国際会議（当時名古屋大学の福田先生と東大の原島先生とで企画）


- アメリカ，アジア，ヨーロッパで順番での開催で，今年はアジアでの開催
- 元々はシステム系の論文が多かったが，現在はICRAと論文の傾向は似てきている

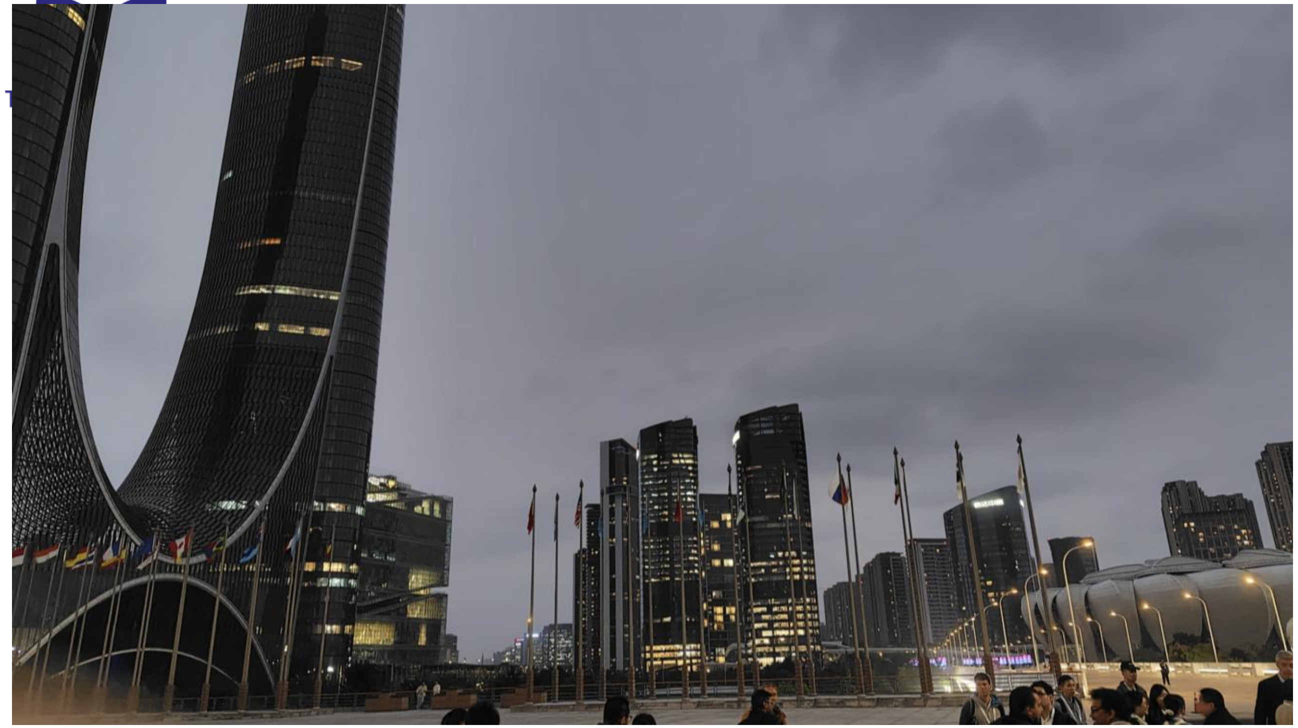

IROS
HANGZHOU 2025
The 2025 IEEE/RSJ International Conference on Intelligent Robots and Systems
IROS HISTORY
October 19–25, 2025
Hangzhou · CHINA
1988 Tokyo, Japan
1989 Tsukuba, Japan
1990 Ibaraki, Japan
1991 Osaka, Japan
1992 Raleigh (NC), USA
1993 Tokyo, Japan
1994 Munich, Germany
1995 Pittsburgh (PA), USA
1996 Osaka, Japan
1997 Grenoble, France
1998 Victoria, Canada
1999 Kyongju, Korea
2000 Takamatsu, Japan
2001 Maui (HI), USA
2002 Lausanne, Switzerland
2003 Las Vegas (NV), USA
2004 Sendai, Japan
2005 Edmonton, Canada
2006 Beijing, China
2007 San Diego (CA), USA
2008 Nice, France
2009 St. Louis (MO), USA
2010 Taipei, Taiwan, China
2011 San Francisco (CA), USA
2012 Vilamoura, Algarve, Portugal
2013 Tokyo, Japan
2014 Chicago (IL), USA
2015 Hamburg, Germany
2016 Daejon, South Korea
2017 Vancouver, Canada
2018 Madrid, Spain
2019 Macau, China
2020 Las Vegas (NV), USA
2021 Prague, Czech Republic
2022 Kyoto, Japan
2023 Detroit (MI), USA
2024 Abu Dhabi, UAE
2025 Hangzhou, China

温故知新

- 1990年代
  - アジアからの発表は日本が中心
  - 研究の競争率はそれほど高くなく，レベルが低めの研究も多く発表
- 2000年代
  - アメリカを中心としたコンピュータ科学系の研究と日本を中心とした機械工学系の研究に２分される.
  - 徐々に研究人口が増えだし，研究の競争率が少しずつ上がってくる
  - 中国など新興国の学生が欧米の有名大学に留学し，発表する機会が増えてくる
- 2010年代
  - 様々な研究ツールが整備されてきたことで，コンピュータ科学系の研究の垣根が下がり，一気にコンピュータ科学系の研究の割合が増えだす.
  - 中国本国からの発表が増えだす
  - 深層学習ブームの到来
- 2020年代
  - 競争率の更なる激化
  - 中国本国からの研究レベルが高くなる

IROS 2025 in Hangzhou

会場付近：会場はG20やアジア大会の会場になったエリアで，この１０年で重点的に開発されてきた．目覚ましい発展を遂げている．



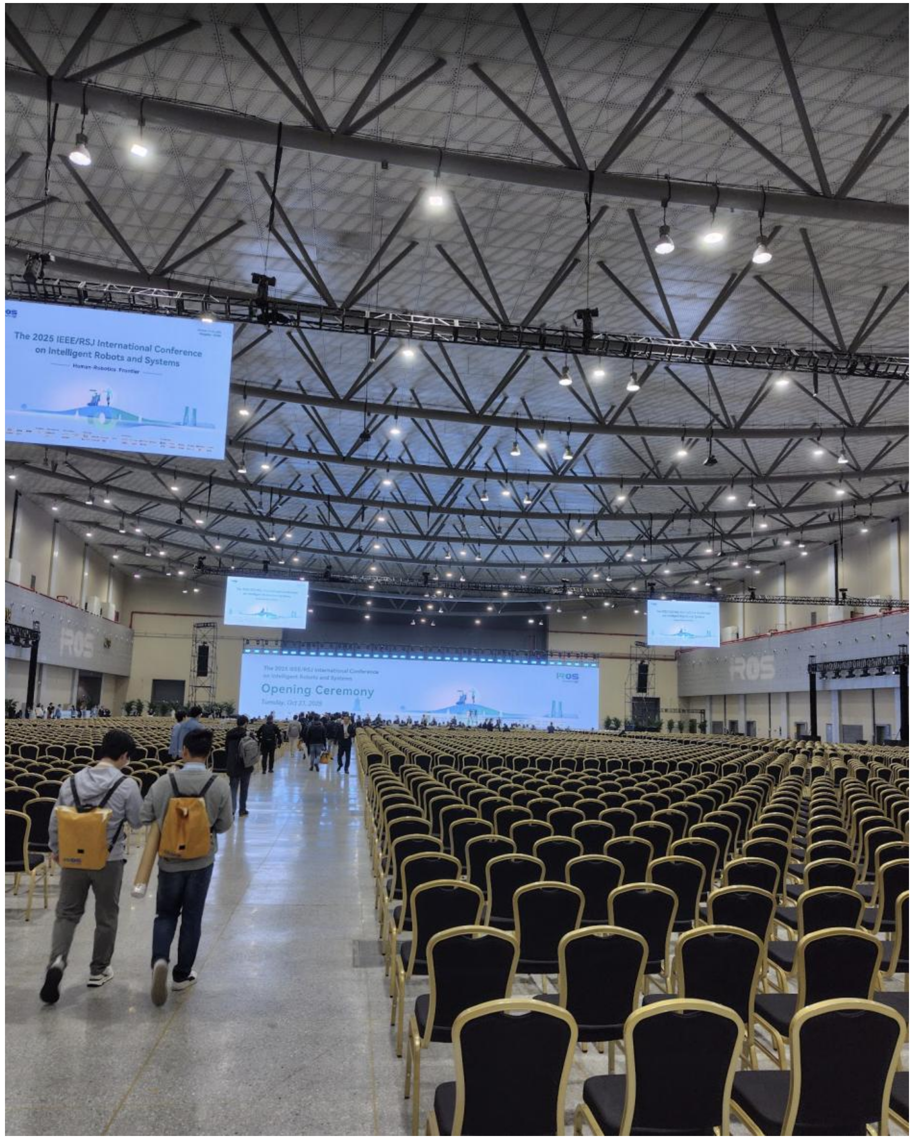
杭州の街並み

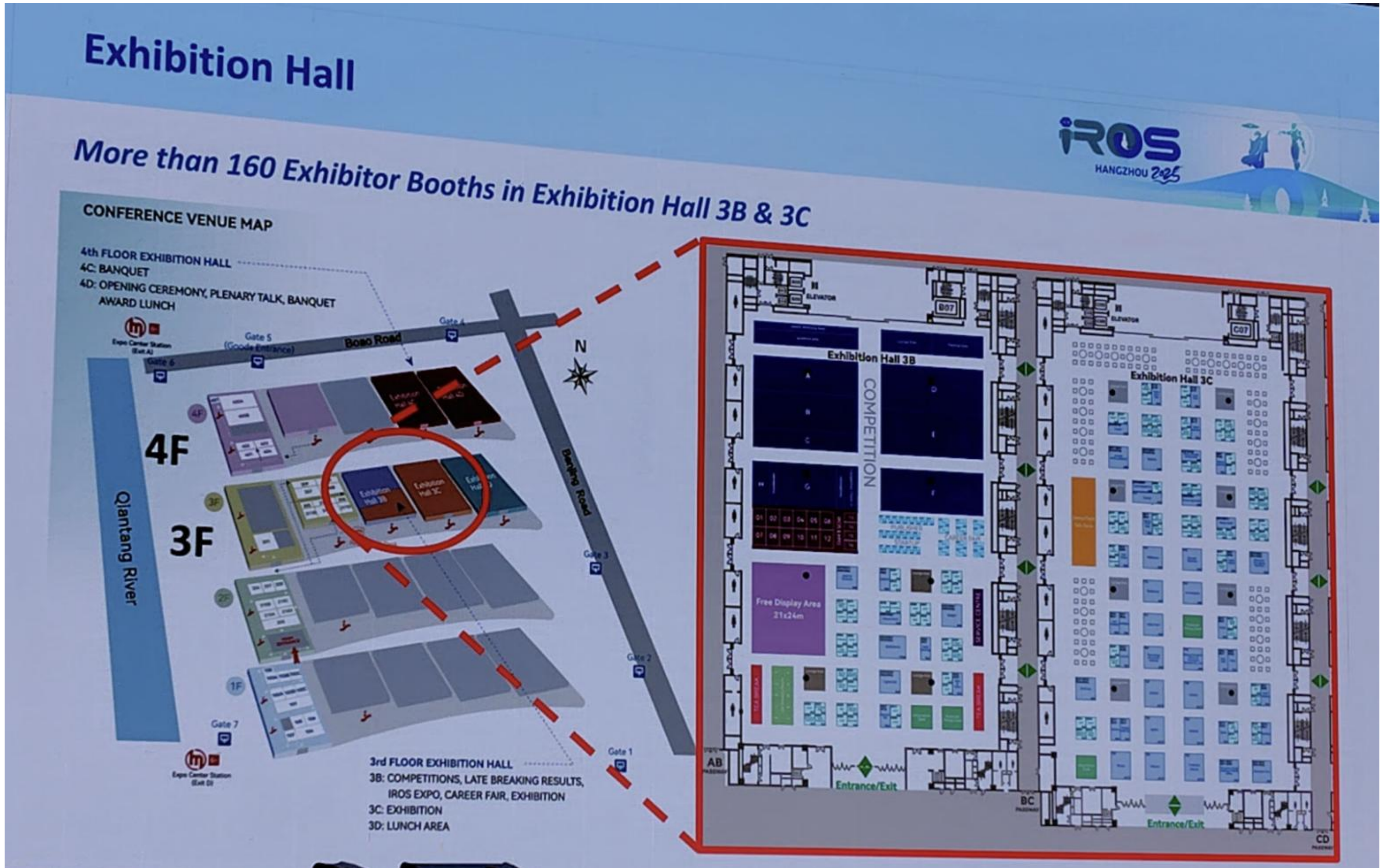
漫画のAKIRAの設定が2019年の東京で，これが東京ではなくて中国で実現した感じ

会場：杭州国際博覧会場

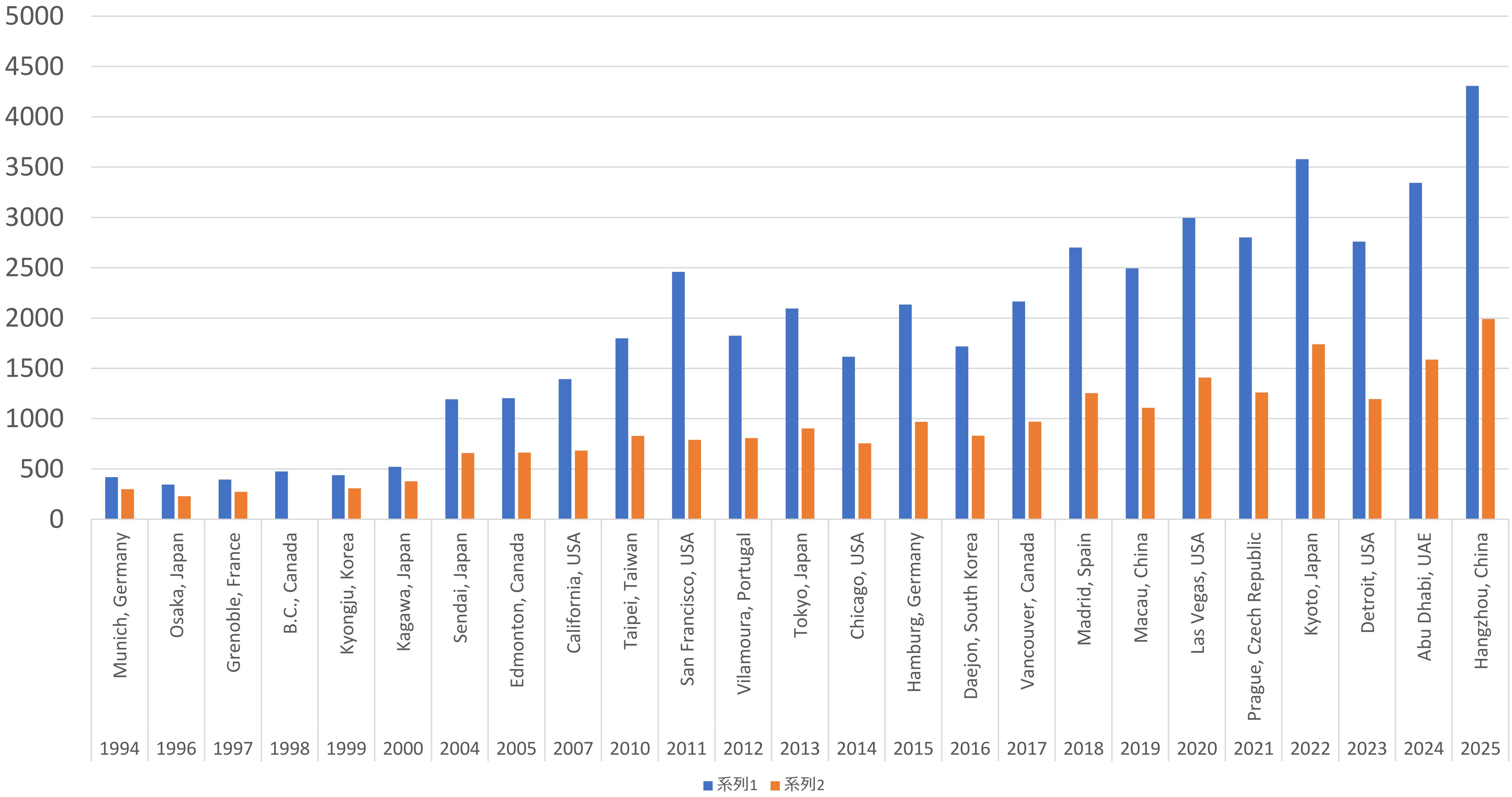
４階建の展示会場＋４階建の会議棟

３階：レジストレーション＋展示
４階：プレナリ+バンケット
会議棟：講演会





投稿論文数－採択論文数



ほぼ１０年で倍の規模で論文数が増加している

国別登録者数

中国での開催もあり，参加はほぼ中国からであった

約2500件の発表のうち，論文誌からのトランスファーが600件程度

82件のワークショップ！

Submission Statistics

IROS Conference Papers

- Total number of IROS submissions: 4381
- Withdrawn: 75
- Returned w/out review: 44
- Reviewed Papers: 4262
- Accepted conference submissions: 1991
- Rejected conference submissions: 2271

➤ **Acceptance rate = 46.2%**

Accepted /(Reviewed + Returned w/out review)

Workshops & Tutorials

- Submitted Workshop Proposals: 112, Accepted: 82
- Submitted Tutorial Proposals: 6, Accepted: 3

Competitions:

- Submissions: 19, Accepted: 8

Journal Papers transferred to IROS: 686

➤ RA-L: 366

➤ T-RO: 65

➤ T-FR: 3

➤ T-ASE: 109

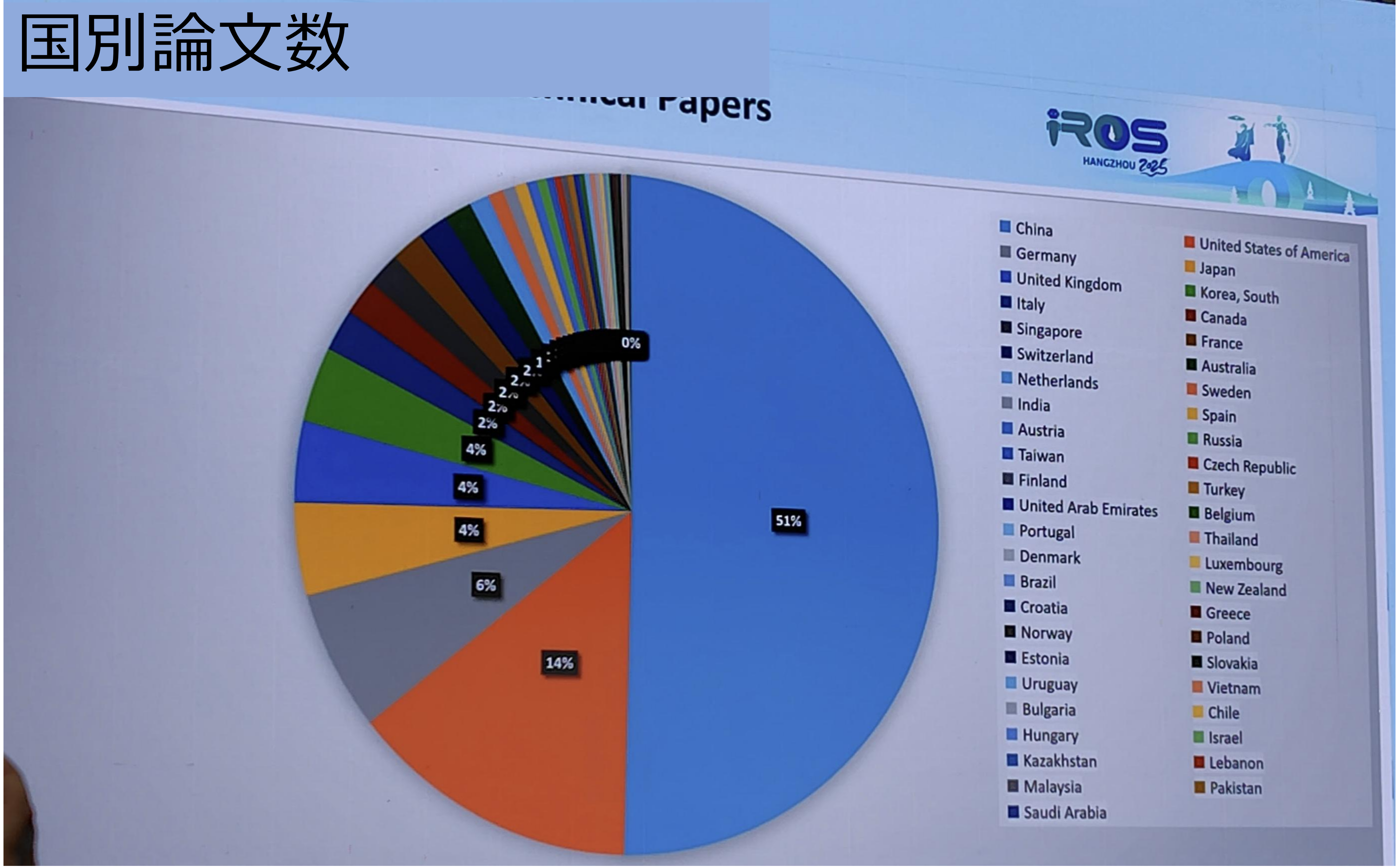
➤ RA-M: 9

➤ T-IE: 35

➤ T-II: 11

➤ T-MECH: 88

国別論文数



論文も半分が中国からの投稿，以下，アメリカ，ドイツ，日本の順
日本発の国際会議として，何とも寂しい数

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ENGINEERING SCIENCE

キーワードカウント

IROS HANGZHOU 2025

Keyword	Total count
Reinforcement Learning*	463
Deep Learning Methods*	422
Motion and Path Planning*	385
Deep Learning for Visual Perception*	349
Localization*	272
Multi-Robot Systems*	259
AI-Based Methods*	231
SLAM*	228
Machine Learning for Robot Control*	225
Autonomous Vehicle Navigation*	218
Sensor Fusion*	212
Legged Robots*	211
Mapping*	208
Optimization and Optimal Control*	201
Computer Vision for Automation*	197
Motion Control*	188
Vision-Based Navigation*	187
Medical Robots and Systems*	183
Object Detection, Segmentation and Categorization*	178
Imitation Learning*	177
RGB-D Perception*	170
Semantic Scene Understanding*	160
Deep Learning in Grasping and Manipulation*	158
Collision Avoidance*	155
AI-Enabled Robotics*	153
Perception for Grasping and Manipulation*	152
Learning from Demonstration*	143
Force and Tactile Sensing*	141
Intelligent Transportation Systems*	139

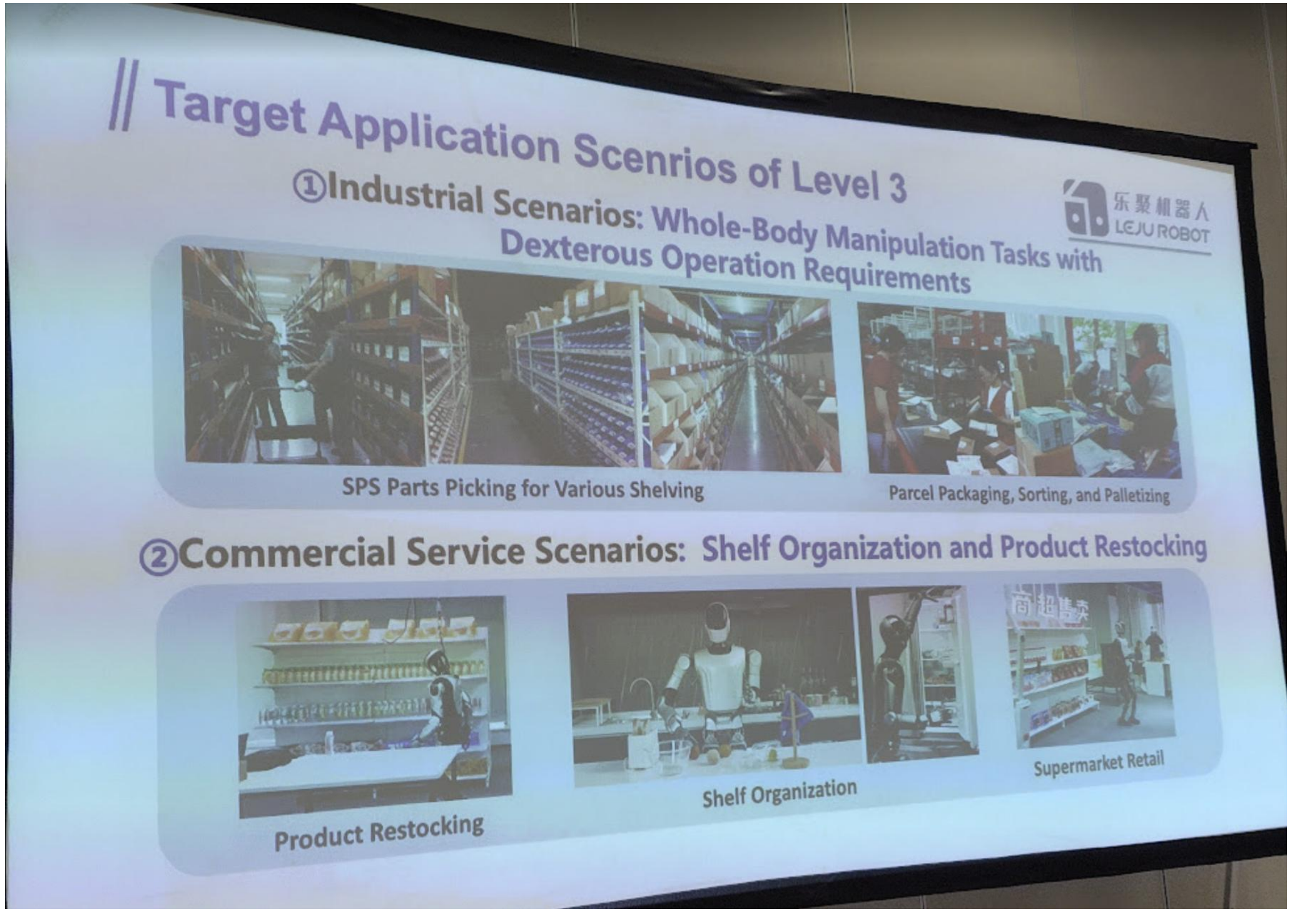
Keyword	Total count
Human-Robot Collaboration*	136
Marine Robotics*	134
Task and Motion Planning*	131
Aerial Systems: Applications*	130
Mechanism Design*	127
Biologically-Inspired Robots*	118
Computer Vision for Transportation*	115
Grasping*	113
Robust/Adaptive Control*	112
Manipulation Planning*	109
Telerobotics and Teleoperation*	107
Field Robots*	106
Soft Robot Applications*	104
Recognition*	104
Path Planning for Multiple Mobile Robots or Agents*	103
Task Planning*	102
Visual Learning*	102
Physical Human-Robot Interaction*	101
Aerial Systems: Mechanics and Control*	101
Autonomous Agents*	96
Soft Sensors and Actuators*	94
Micro/Nano Robots*	91
Aerial Systems: Perception and Autonomy*	90
Robot Safety*	89
Representation Learning*	88
Dexterous Manipulation*	84
Data Sets for Robotic Vision*	84
Dynamics*	83
Soft Robot Materials and Design*	83

トピックは学習系が多いが，それ以外にも計画や自己位置推定など広い領域をカバーしている

今年のIROS

- 直前にCoRL(Conference on Robot Learning)が韓国で開催され，機械学習系の優秀な論文はCoRLなどに流れたと思われる．結果的に論文のレベルは期待したほどは高くはなかった．
- アメリカは州によって中国への渡航が制限された．欧米のボイコットがあり世界の分断を感じさせられた．
- プレゼンテーションが上手ではない発表が多く，ストレスが溜まることが多かった

Workshop



すごい勢いで現場にヒューマノイドを導入しようとしている

模倣学習のトレーニングセンターを建てて大規模に訓練を行っている

Debate : Humanoids will soon replace most human workers: True or False

Moderator: Ken Goldberg

True: T.Asfour, CEO Unitree, S.Sugano
False: Y. Sun, +2

False：まだヒューマノイドの技術が人と置き換えられるほど成熟していない

True：技術の進展は早いので，数年後どうなっているかは予想できない(Unitree)
2050年にはTrueになっているのでは（Sugano，Tamim）

会場もFalseが優勢(事前は80%，事後は90%)

Plenary Sessions

Songchun Zhu
Chair Professor of Peking University & Tsinghua University

TongBrain: Bridging Physical Robots and AGI Agents

Marco Hutter
Professor of ETH Zurich

The New Era of Mobility: Humanoids and Quadrupeds Enter the Real World

Hyoun JIN Kim
Professor of Seoul National University

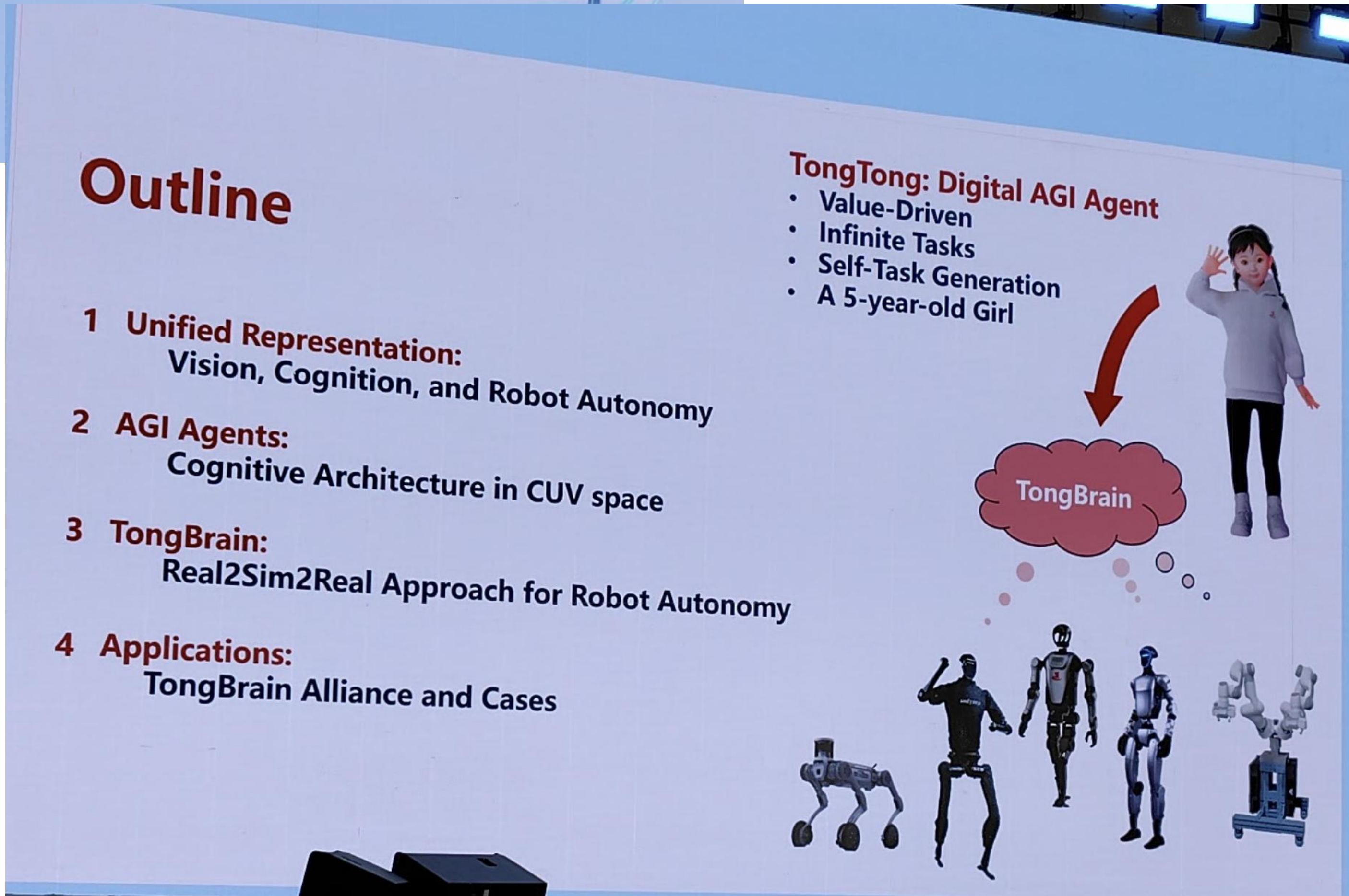
Autonomous Aerial Manipulation: Toward Physically Intelligent Robots in Flight

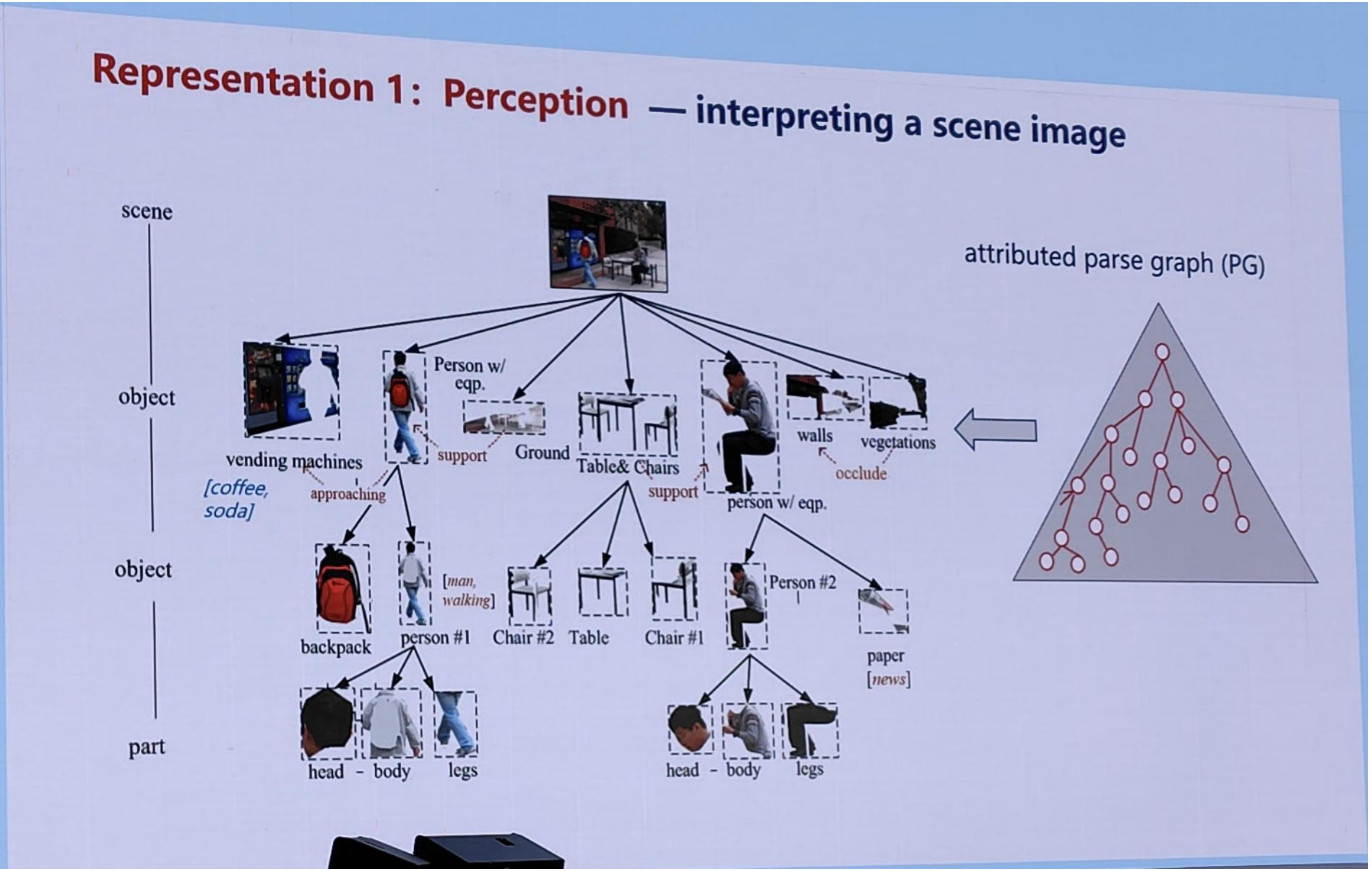
Oct 21, 22, 23, 9:00-10:00 AM, Exhibition Hall 4D

機械学習はデータをひたすらデータを集めるだけではだめである（今のデータドリブンの機械学習を批判）

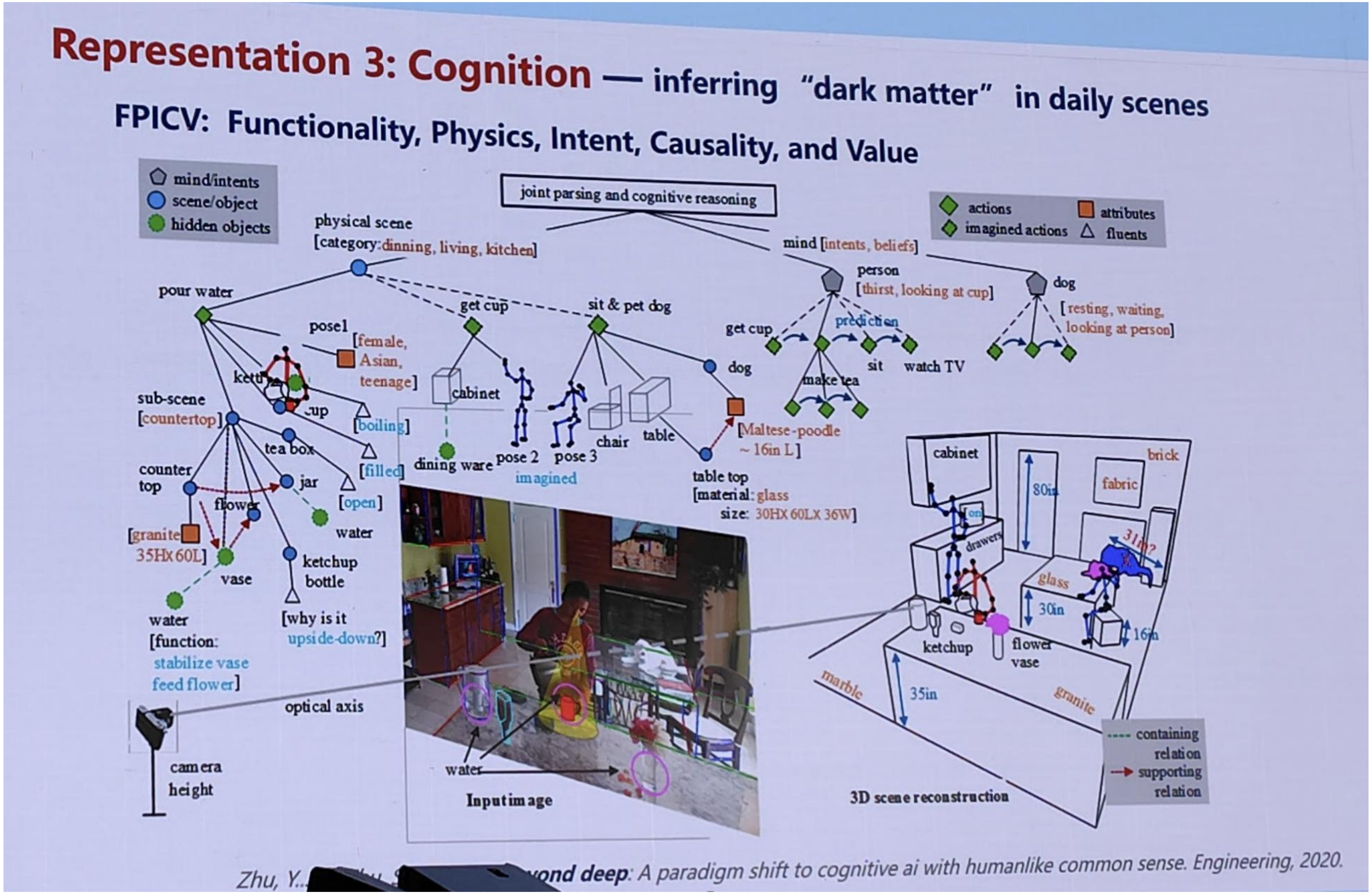
物事のCausalityを考える必要がある

手法を間違うととんでもない回り道をする





家庭環境を理解する際でも
階層性を考慮する


Representation 3: Cognition — inferring "dark matter" in daily scenes
FPICV: Functionality, Physics, Intent, Causality, and Value
mind/intents
scene/object
hidden objects
joint parsing and cognitive reasoning
actions
imagined actions
attributes
fluents
physical scene
[category: dinning, living, kitchen]
mind [intents, beliefs]
person
[thirst, looking at cup]
dog
[resting, waiting, looking at person]
pour water
get cup
sit & pet dog
pose1
[female, Asian, teenage]
get cup
prediction
sit
watch TV
make tea
dog
cabinet
dining ware
pose 2
pose 3
imagined
chair
table
[Maltese-poodle ~ 16in L]
table top
[material: glass
size: 30HX 60LX 36W]
sub-scene
[countertop]
cup
[boiling]
tea box
[filled]
counter top
jar
[open]
flower
water
[granite
35Hx 60L]
vase
ketchup bottle
water
[function:
stabilize vase
feed flower]
[why is it upside-down?]
optical axis
camera height
water
Input image
cabinet
brick
80in
fabric
drawers
glass
30in
16in
ketchup
flower vase
marble
35in
granite
containing relation
supporting relation
3D scene reconstruction
Zhu, Y.
ond deep: A paradigm shift to cognitive ai with humanlike common sense. Engineering, 2020.

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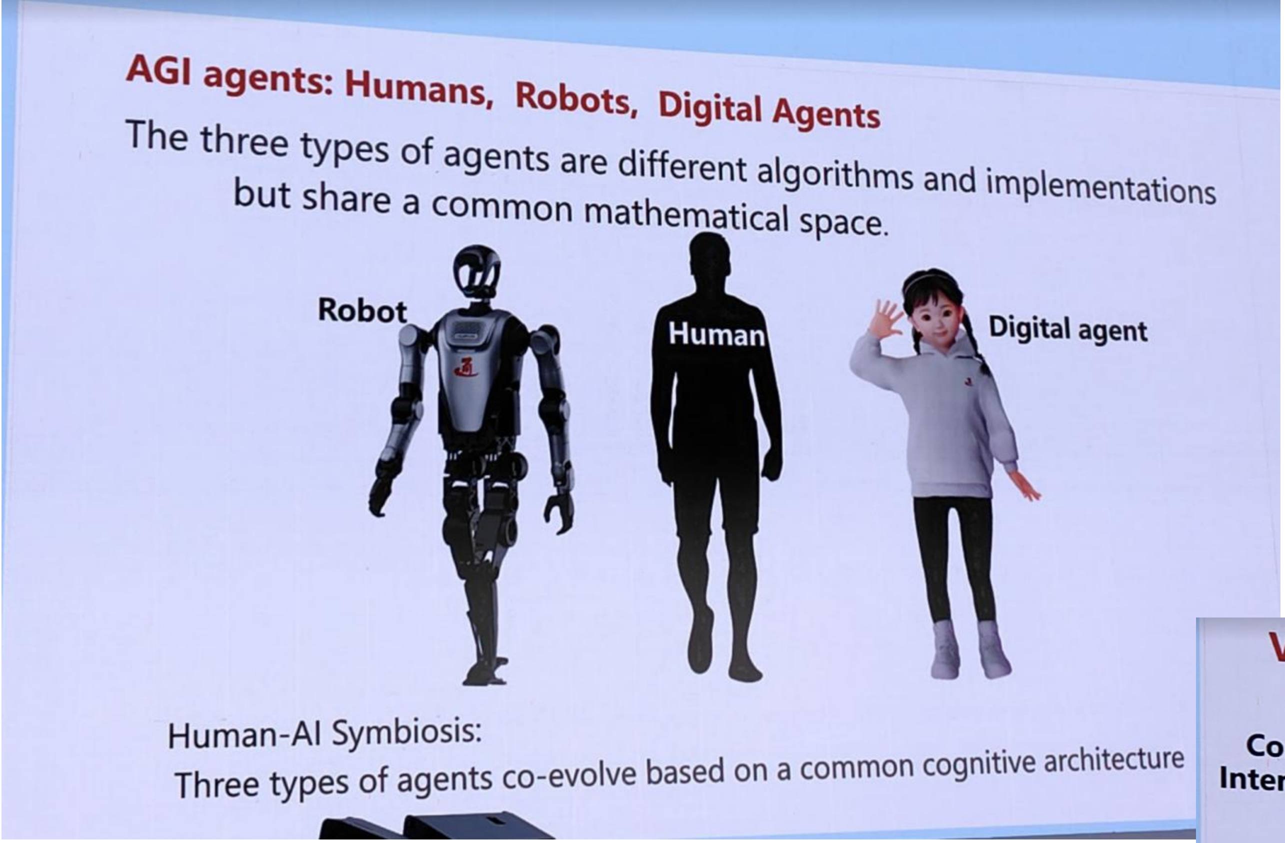
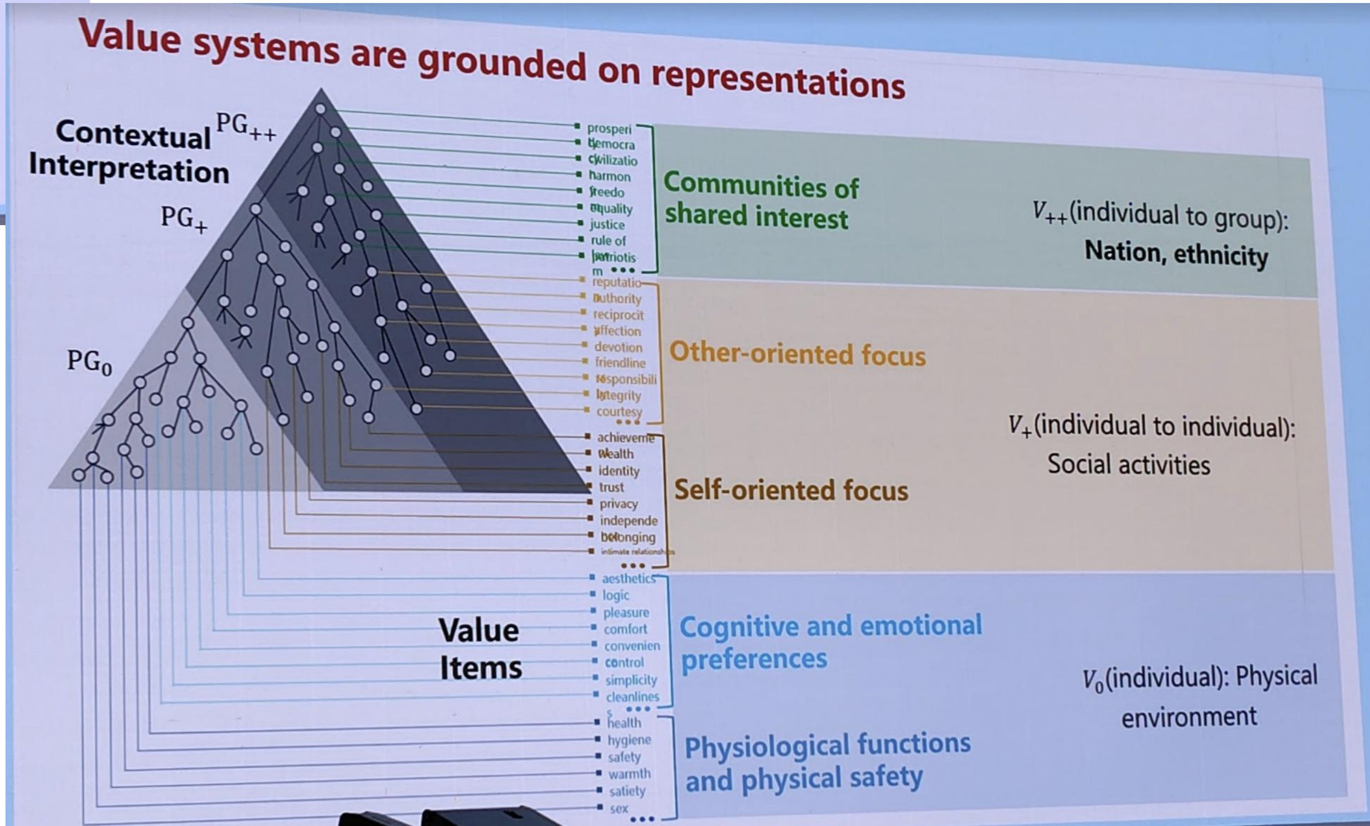
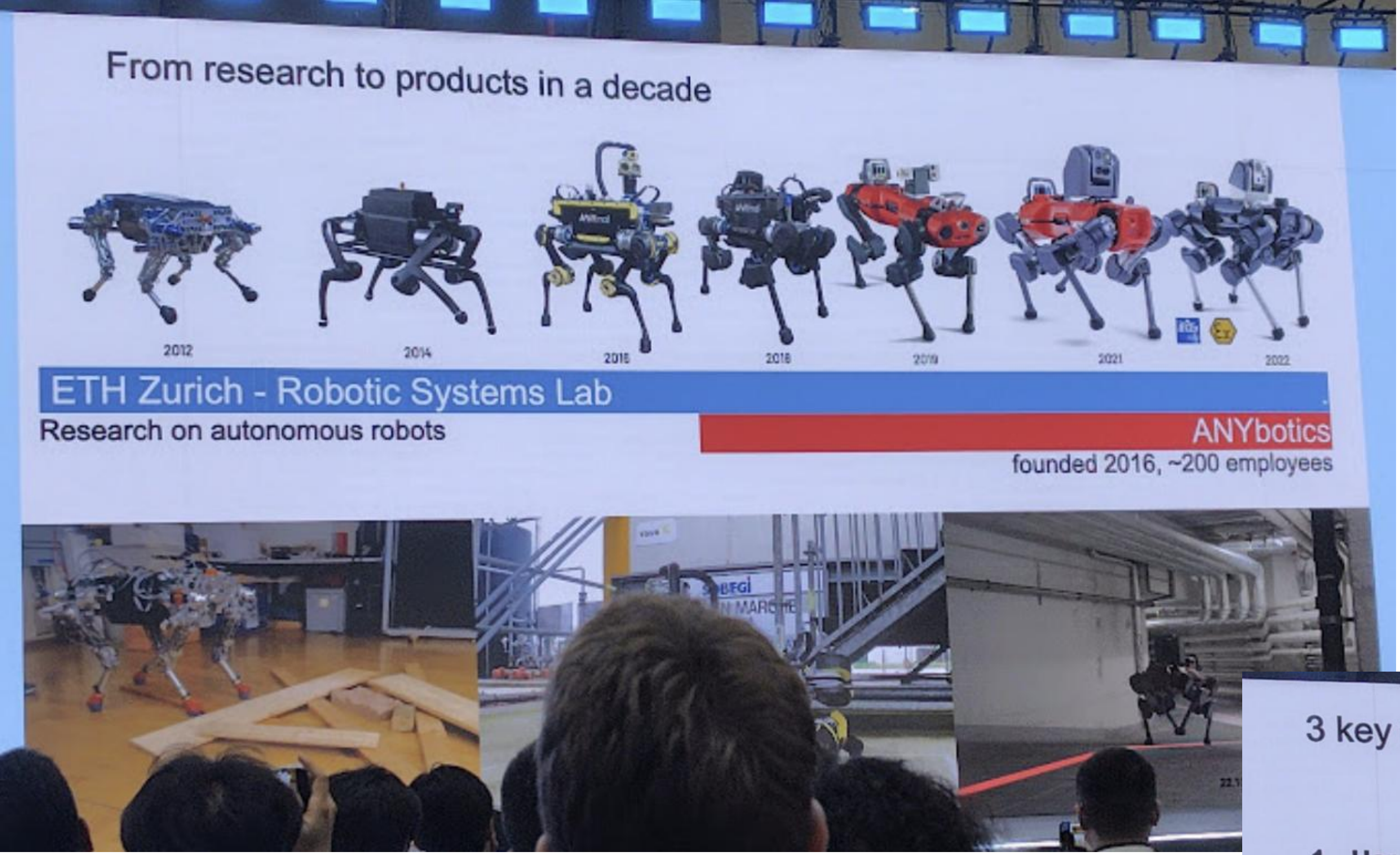


階層関係を利用すると、ロボットの種類に応じて、
ロボットに非依存の部分を再利用できる



近年の４足歩行や２足歩行ロボットの進化は全て，彼から始まっているといっても過言ではない



Hutterらが開発してきたロボット

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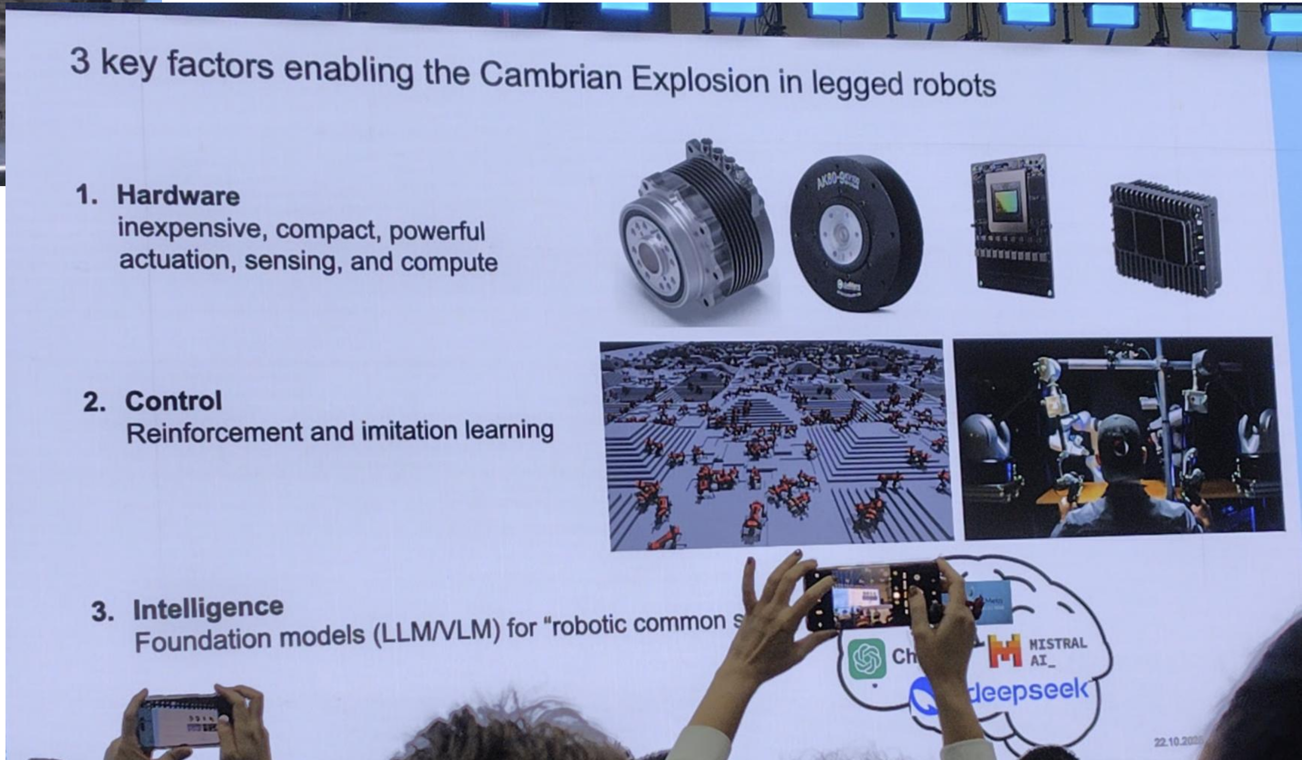
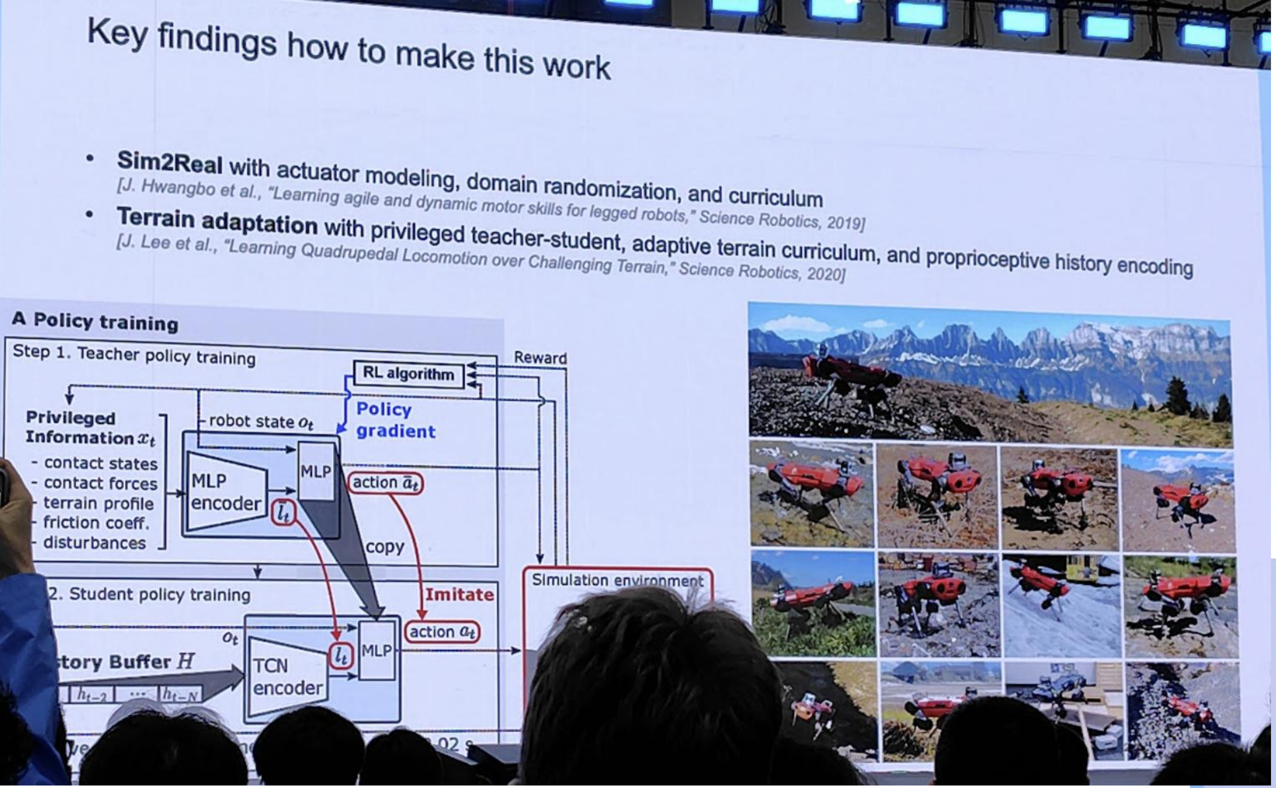
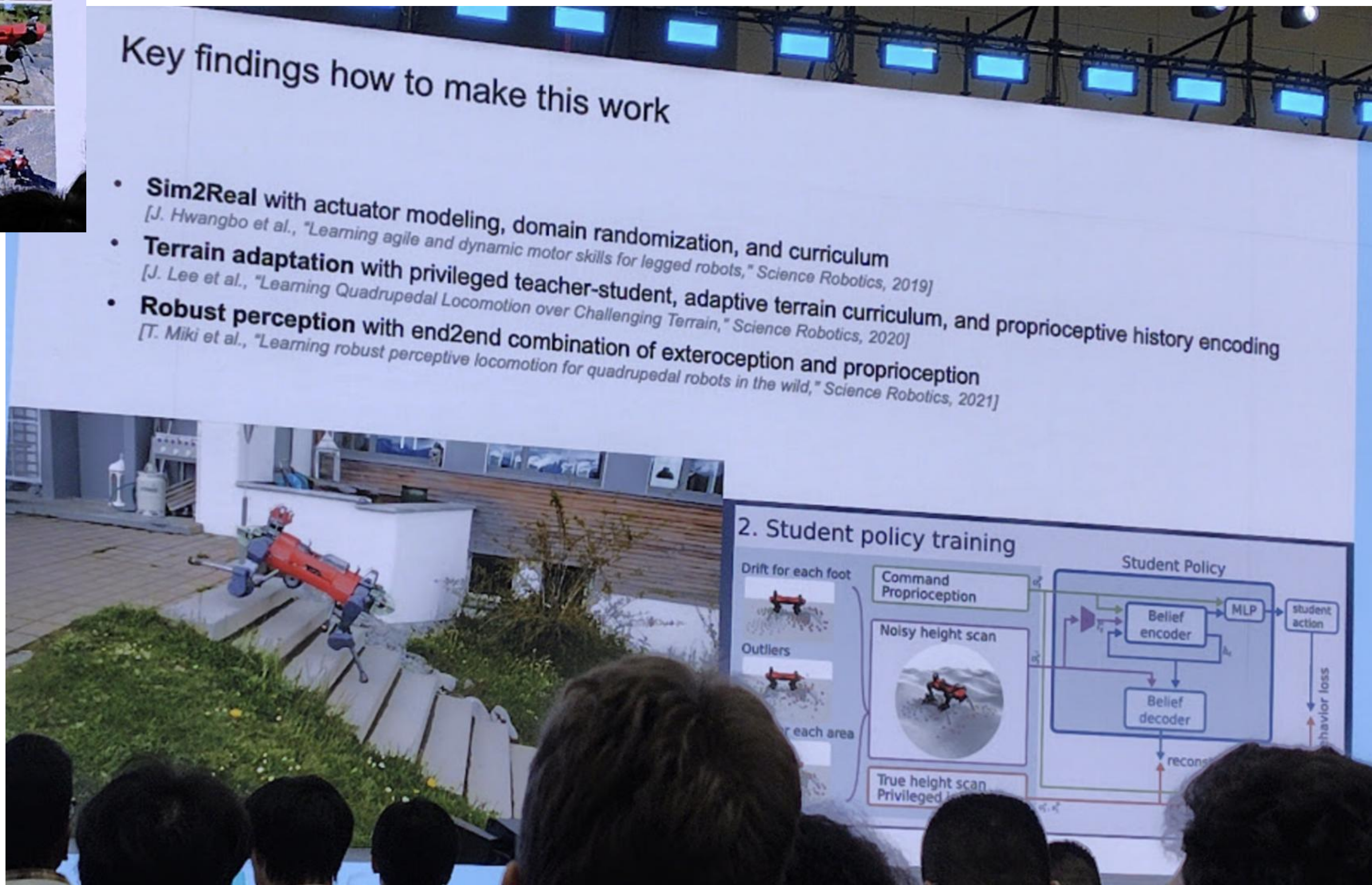
近年の４足飛行ロボットのカンブリアン爆発を招いた三つの要因




Key findings how to make this work
Sim2Real with actuator modeling, domain randomization, and curriculum
[J. Hwangbo et al., "Learning agile and dynamic motor skills for legged robots," Science Robotics, 2019]
Terrain adaptation with privileged teacher-student, adaptive terrain curriculum, and proprioceptive history encoding
[J. Lee et al., "Learning Quadrupedal Locomotion over Challenging Terrain," Science Robotics, 2020]
A Policy training
Step 1. Teacher policy training
RL algorithm
Reward
Privileged Information x_t
- contact states
- contact forces
- terrain profile
- friction coeff.
- disturbances
robot state o_t
Policy gradient
MLP encoder
MLP
action $\bar{a}_t$
l_t
copy
2. Student policy training
Imitate
Simulation environment
o_t
action a_t
TCN encoder
MLP
h_{t-2}
h_{t-N}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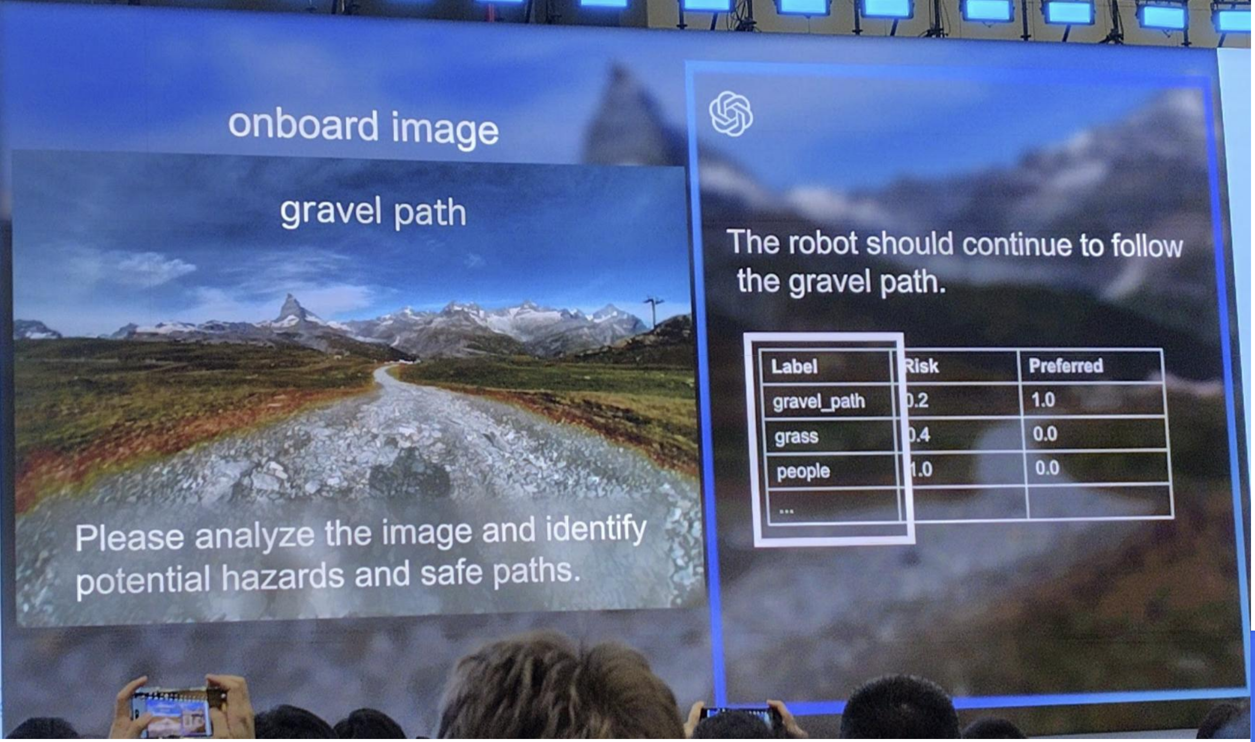
Terrain adaptation with privileged teacher-student, adaptive terrain curriculum, and proprioceptive history encoding
[J. Lee et al., "Learning Quadrupedal Locomotion over Challenging Terrain," Science Robotics, 2020]
Robust perception with end2end combination of exteroception and proprioception
[T. Miki et al., "Learning robust perceptive locomotion for quadrupedal robots in the wild," Science Robotics, 2021]
2. Student policy training
Drift for each foot
Outliers
Command Proprioception
Noisy height scan
True height scan
Student Policy
Belief encoder
Belief decoder
MLP
student action



Engineering Science

Award Papers

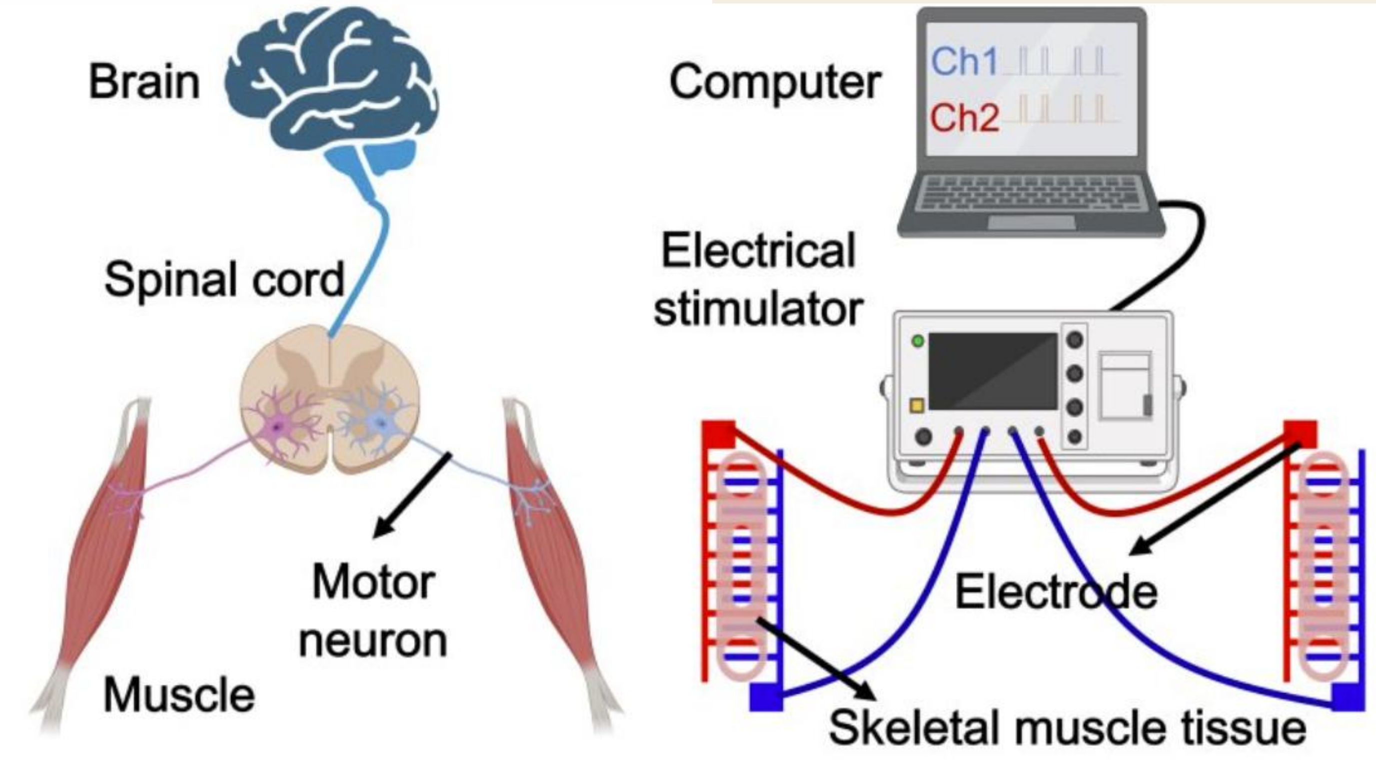
会議としては機械学習が多いが，IROSらしく，手法の組み合わせや実装のような研究が多く優秀論文の候補に選ばれている

Best Paper Award

Interdigitated Electrodes for Selective Stimulation of Skeletal Muscle Actuators in Biosyncretic Robots

Lianchao Yang[1], Chuang Zhang[2], Qi Zhang[3], Yiwei Zhang[4], Hengshen Qin[5], Lianqing Liu[1]

[1]Shenyang Institute of Automation, Chinese Academy of Sciences, [2]Shenyang Institute of Automation Chinese Academy of Sciences, [3]SHENYANG INSTITUTE OF AUTOMATION, CHINESE ACADEMY OF SCIENCES, [4]Chinese Academy of Sciences, [5]Shenyang Institute of Automation



Selective Stimulation of Muscle Tissue—A Novel Approach to Enhancing Controllability in Biohybrid / Biosyncretic Robots

人の筋肉のように選択的に筋肉を刺激する仕組みを，Thin-film Interdigitated electrodes (IDEs)を用いた３D Skeletal Muscle Tissue (SMT)で実現した

Best Paper Award Finalist

FruitNeRF++: A Generalized Multi-Fruit Counting Method Utilizing Contrastive Learning and Neural Radiance Fields

Lukas Meyer[1], Andrei-timotei Ardelean[1], Tim Weyrich[1], Marc Stamminger[2]

[1]Friedrich-Alexander-Universität Erlangen-Nürnberg, [2]Universität Erlangen-Nürnberg

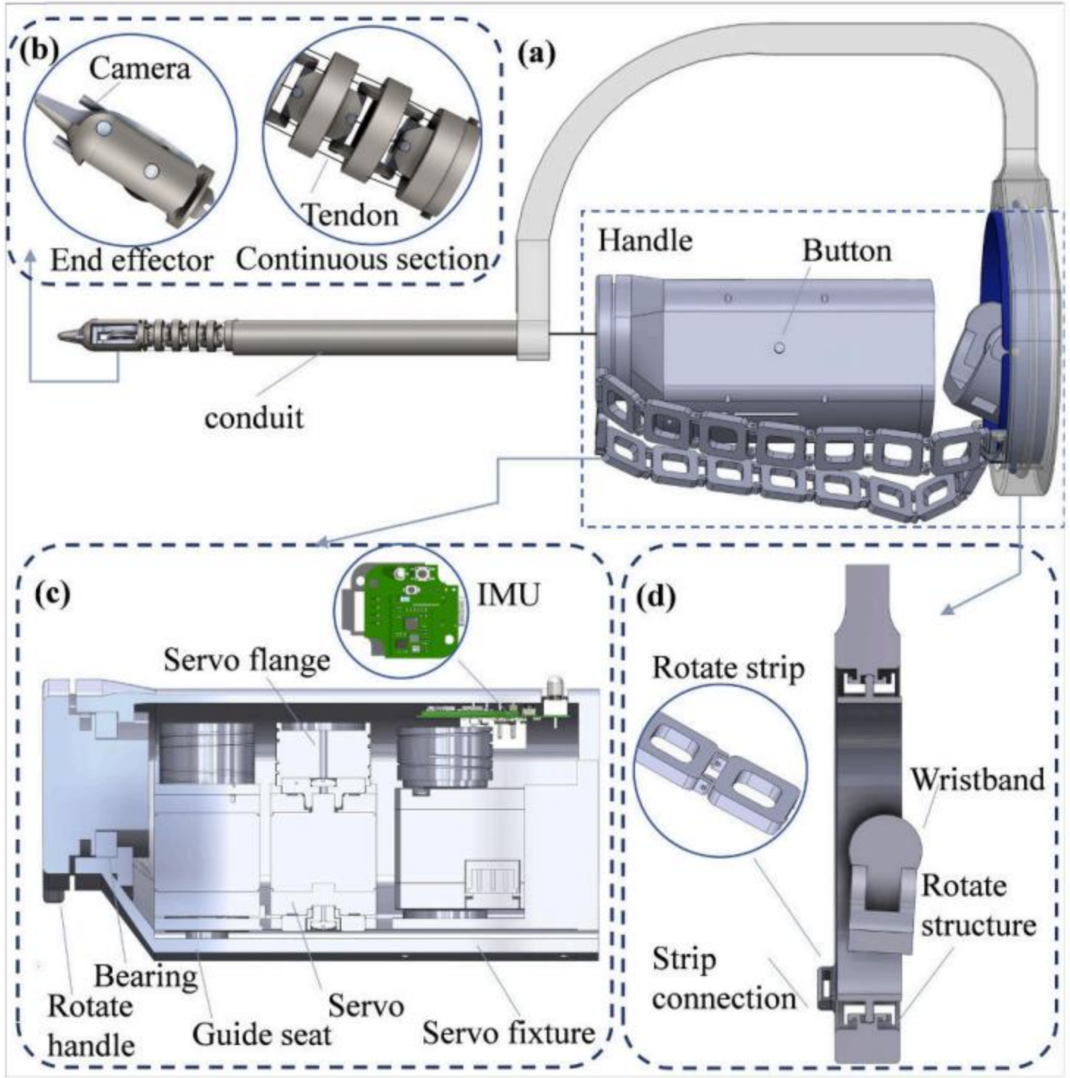
NeRFを利用して，木に成った果実の位置と形を推定

Best Paper Award Finalist

Human-Guided Robotic-Assistance Handheld Continuum Medical Robot System

Fei Wang[1], Changhao Luo[1], Zexi Zhao[2], Pingyu Xiang[2], Ke Qiu[2], Yufei Wei[2], Yue Wang[2], Rong Xiong[2], Haojian Lu[2]

[1]ZheJiang University, [2]Zhejiang University



Continuum robotを応用した手術支援デバイスの提案

Best Student Paper Award

Neural MP: A Neural Motion Planner

Murtaza Dalal[1], Jiahui Yang[1], Russell Mendonca[1], Youssef Khaky[1], Ruslan Salakhutdinov[2], Deepak Pathak[1]

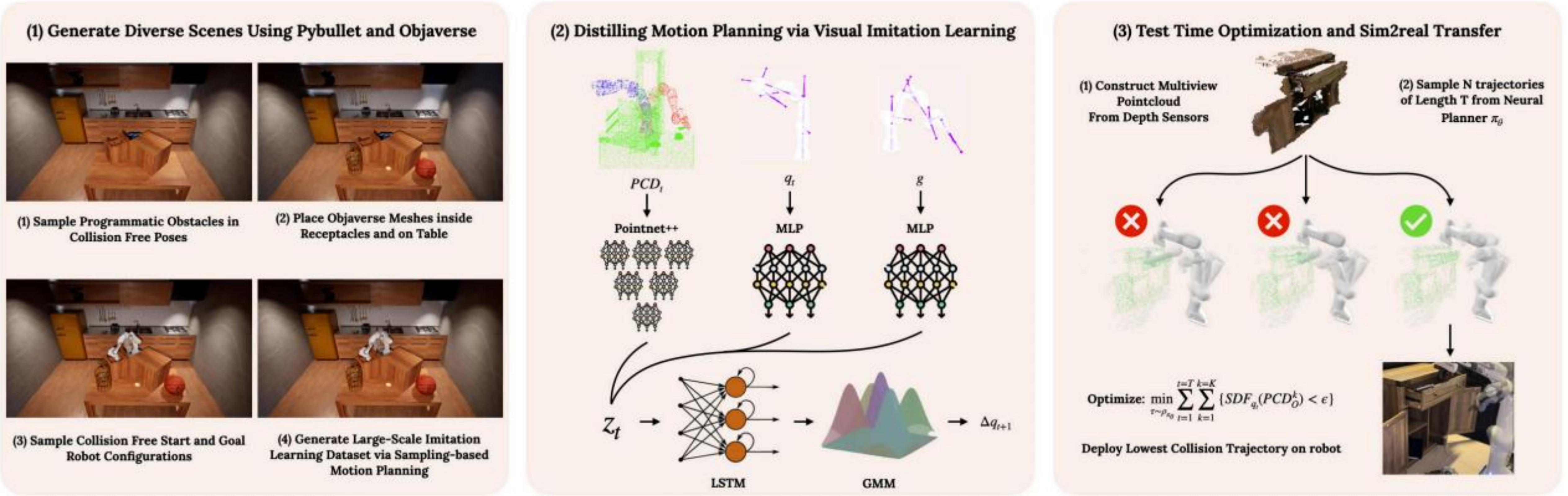


Fig. 3: **Method Overview**: We present Neural Motion Planners, which consists of 3 main components. **Left**: Large Scale data generation in simulation using expert planners **Middle**: Training deep network models to perform fast reactive motion planning **Right**: Test-time optimization at inference time to improve performance.

Exhibition

びっくりするくらいの量のヒューマノイドの展示があった

2足歩行ロボットの一部

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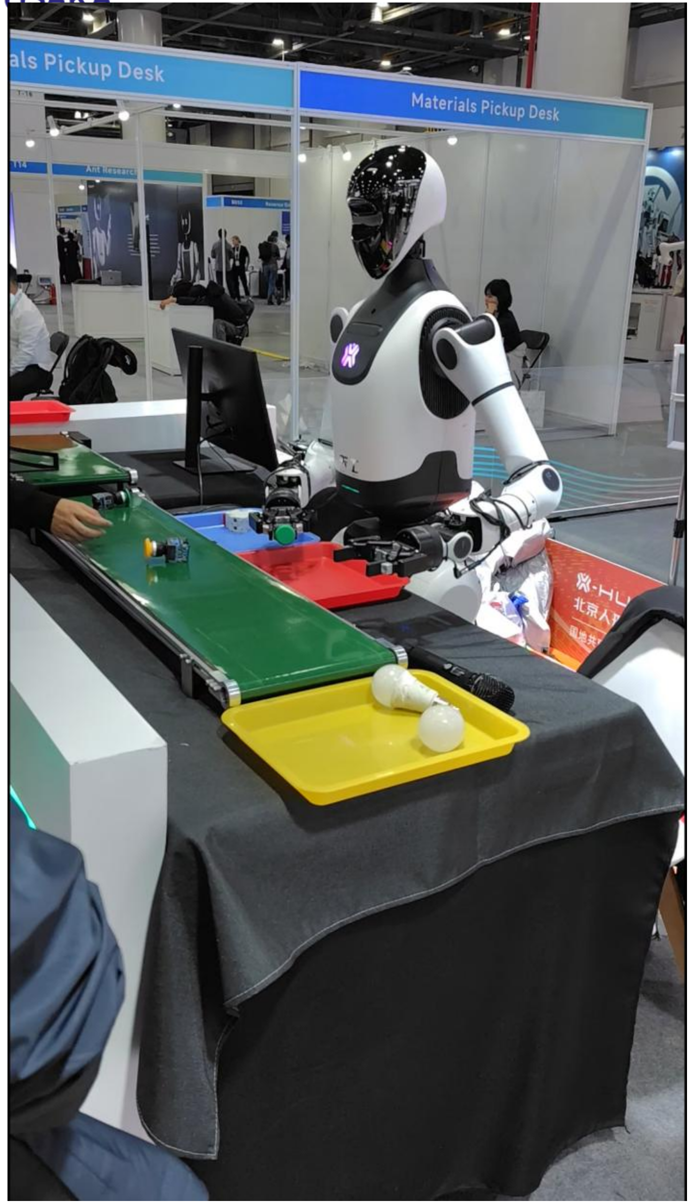
上半身型も非常に多い
模倣学習もあたりまえのように実演




3B11
C03
企业概述
OVERVIEW
那儿有脸

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ENGINEERING SCIENCE

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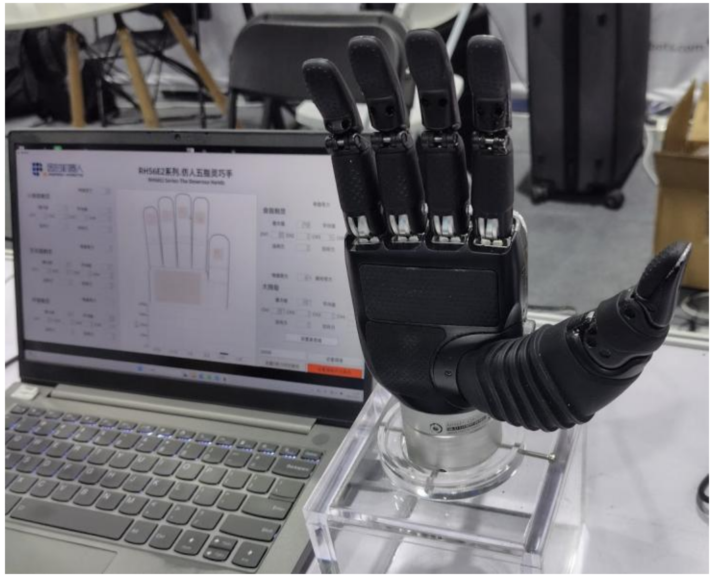
多指ハンドも多くの種類のものが展示された

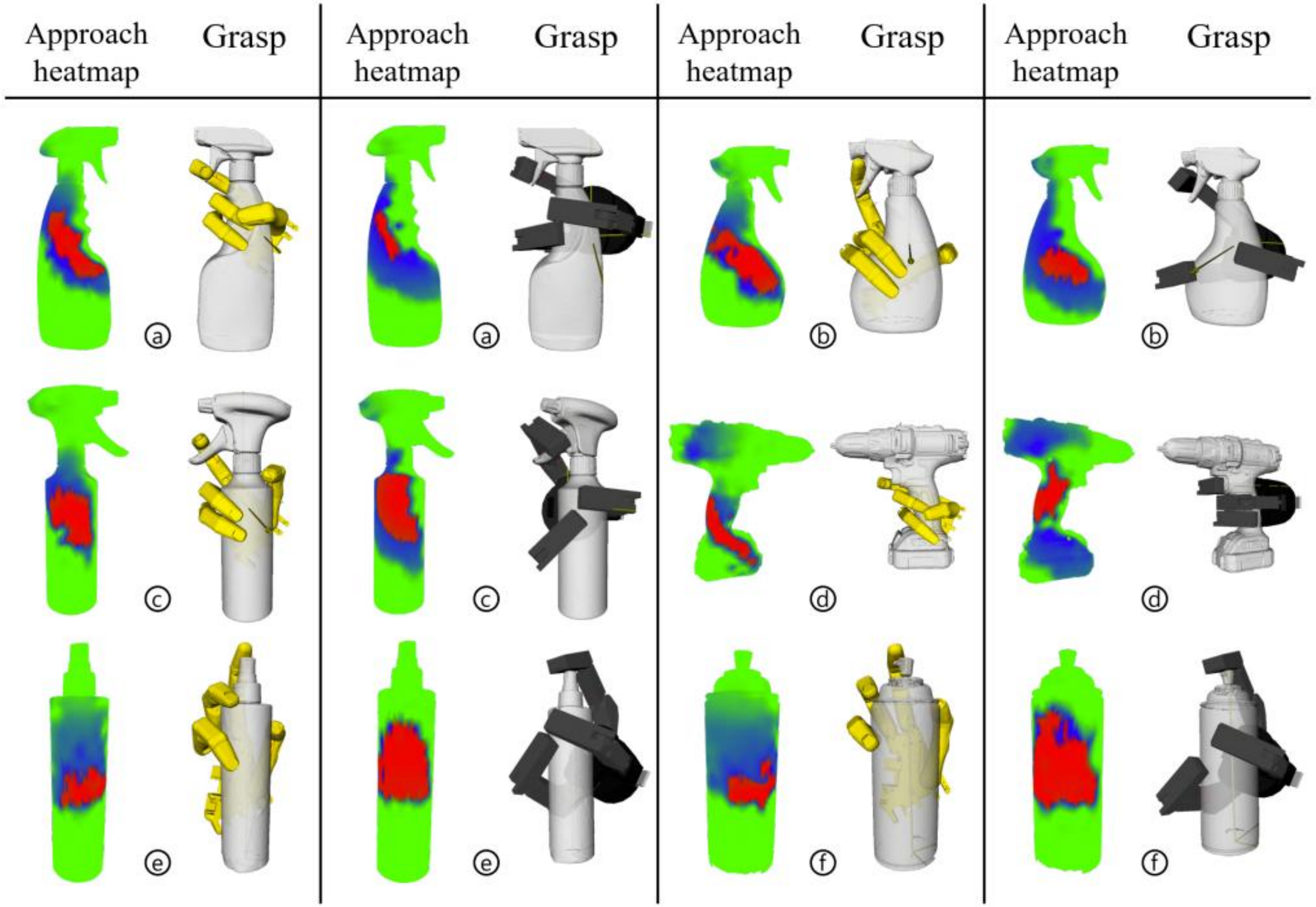


ロボット用のモータも数社の展示があった

Functional Eigen-Grasping Using Approach Heatmaps

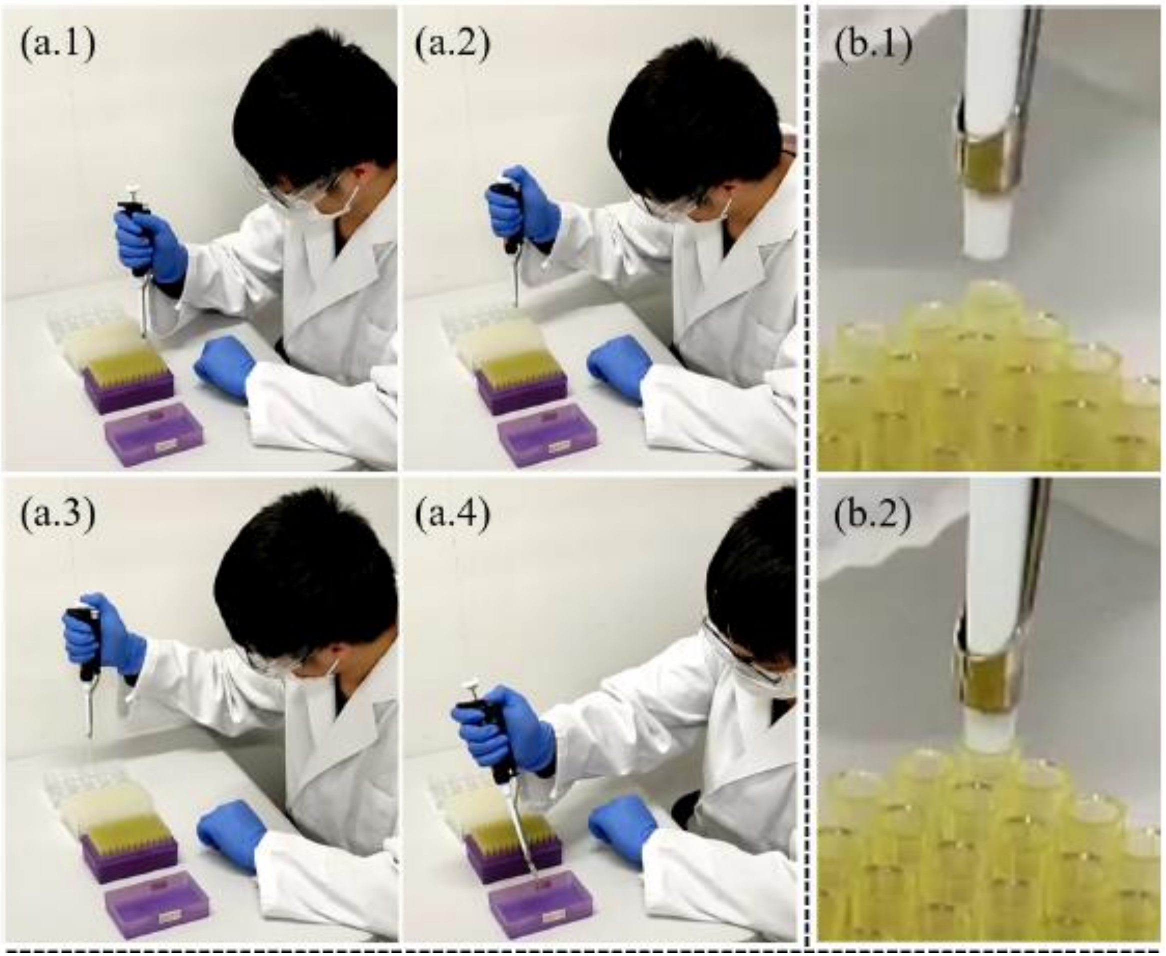
Malek Aburub[1], Kazuki Higashi[2], Weiwei Wan[1], Kensuke Harada[1]

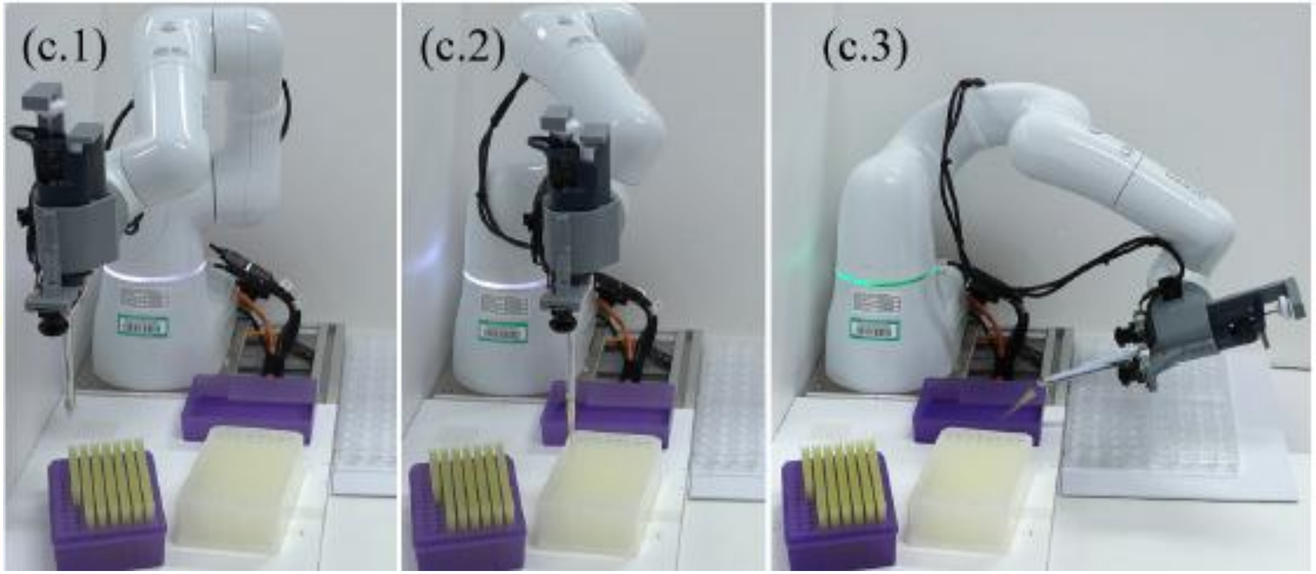
[1]The University of Osaka, [2]Osaka University



Integrating a Pipette into a Robot Manipulator with Uncalibrated Vision and TCP for Liquid Handling

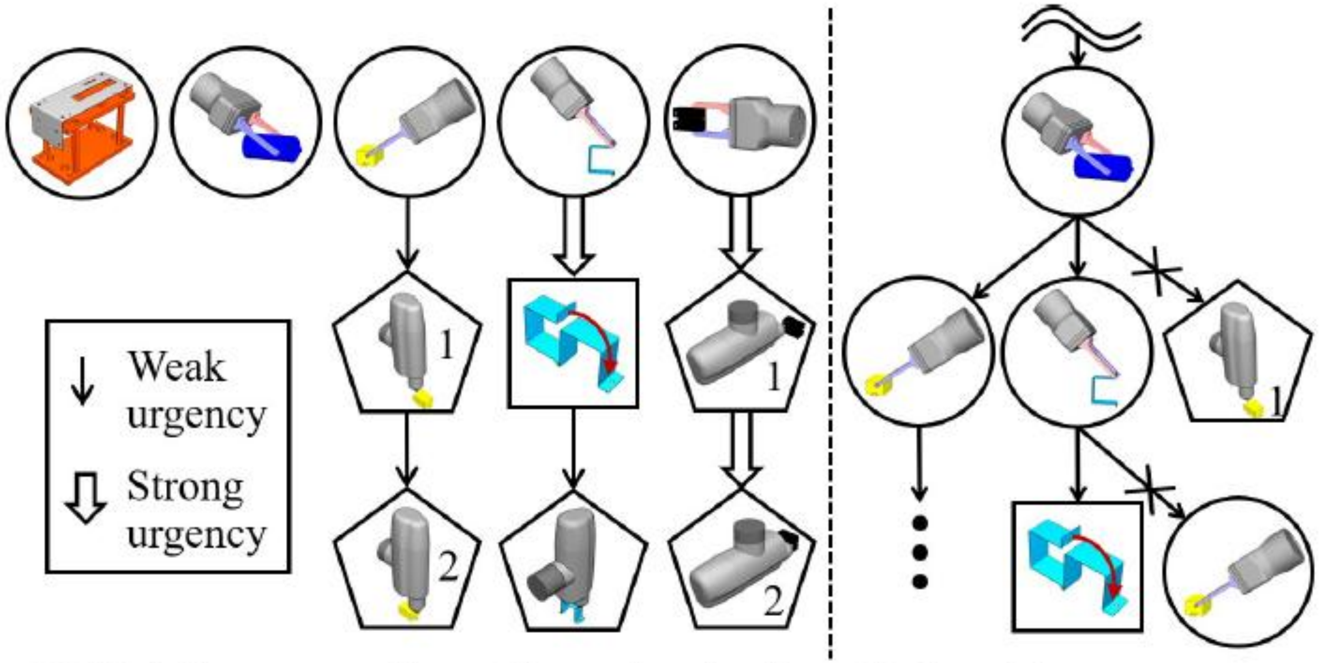
Junbo Zhang[1,2], Weiwei Wan[1,2,*], Nobuyuki Tanaka[2], Miki Fujita[3], Koichi Takahashi[2] and Kensuke Harada[1]





Assembly Sequence Planning Considering Robotic Motion Costs and Multi-Operation Constraints

Haruto Nagai[1], Weiwei Wan*[1], Hiroki Suemoto[2], Kouichi Masaoka[2], Kensuke Harada[1]



(a) Workflow-constraints with motion details (b) Searching tree