

Co-experience Knowledge and Wisdom with Human-Machine Harmonious Collaboration

July 11th, 2018

Norihiro Hagita, Board Director, Director,
Intelligent Robotics and Communication Laboratories,
Advanced Telecommunications Research Institute
International(ATR)

CREST Programs on Big Data



Human-Machine
Harmonious
Collaboration

[1] Research Area: Advanced Core Technologies for **Big Data** Integration

Research Supervisor:

Masaru Kitsuregawa

(Director General, National Institute of Informatics,
Professor, Institute of Industrial Science,
the University of Tokyo)

& **Etsuya Shibayama**

(Professor, The University of Tokyo)

[2] Research Area: Advanced Application Technologies to Boost **Big Data** Utilization for Multiple-Field Scientific Discovery and Social Problem Solving

Research Supervisor: **Yuzuru Tanaka**

(Professor Emeritus, Hokkaido University)

Call 1	2013	2014	2015	2016	2017	2018		
Call 2		2014	2015	2016	2017	2018	2019	
Call 3			2015	2016	2017	2018	2019	2020

Mid-term evaluation

Final evaluation

CREST Programs on Harmonious Interaction and Augmented Intelligence (HIAI)



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[3] Research Area:

**Intelligent Information Processing Systems Creating Co-Experience
Knowledge and Wisdom with Human-Machine Harmonious Collaboration**

Research Supervisor: **Norihiro Hagita (ATR)**

Call 1	2014	2015	2016	2017	2018	2019			
Call 2		2015	2016	2017	2018	2019	2020		
Call 3			2016	2017	2018	2019	2020	2021	

Mid-term evaluation
Final evaluation

[4] Research Area:

**Development and Integration of Artificial Intelligence Technologies for
Innovation Acceleration**

Research Supervisor: **Minoru Etoh (Professor, Open and Transdisciplinary
Research Initiatives, Osaka University)**

Call 1	2016	2017	2018	2019	2020	2021		
Call 2		2017	2018	2019	2020	2021	2022	
Call 3			2018	2019	2020	2021	2022	2023

Stage-Gate Screening
Final evaluation

[5] Research Area:

**Symbiotic Interaction: Creation and Development of Core Technologies
Interfacing Human and Information Environments**

Research Supervisor: **Kenji Mase (Professor,
Graduate School of Informatics, Nagoya University)**

Call 1	2017	2018	2019	2020	2021	2022		
Call 2		2018	2019	2020	2021	2022	2023	
Call 3			2019	2020	2021	2022	2023	2024

Mid-term evaluation
Final evaluation

JST's Strategic Research Program in Human-Machine Harmonious Collaboration (FY2014 - FY2021)



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Research Area : Intelligent Information Processing Systems
Creating Co-Experience Knowledge and Wisdom
with Human-Machine Harmonious Collaboration

- 11 team projects (CREST)
- Aims to create “*Situated Services*” using Co-Experience Knowledge and Wisdom with Human-Machine Harmonious Collaboration
- Considers *ELSI* (Ethical, Legal and Social Issues)



Application Domains

2014

2015

2016

Co-Experience Sharing Services

Ambient Assisted Living

Research & Development & Innovation Acceleration

**Sharing Services among athletes and/or coaches
(K. Watanabe)**

**Visualizing Social Attitude and Stress
(M. Haruno)**

**Common Platform for Co-Experience Knowledge and Wisdom
(T. Yamaguchi)**

**Sharing Services among Medical operators, Pedestrians, etc.
(Y. Sato)**

**Social Symbol Grounding with Human Robot Interaction
(T. Nagai)**

Election, Debating etc. in Cyber Physical System

**Sharing Services among enhanced children, parents, caregivers
(K. Suzuki)**

**Living with Artificial Consciousness
(R. Kanai)**

**Knowledge and Wisdom for Social Consensus
(T. Itoh)**

**Sharing Services among enhanced children, parents, caregivers
(Y. Nagai)**

Employment Creation

**Sharing Services with Experiential Supplements
(K. Kise)**

**Knowledge and Wisdom for Facilitating Crowdsourcing
(A. Morishima)**

Social Impact



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Situated Services

Using Co-Experience Knowledge and Wisdom
with Human-Machine Harmonious Collaboration

The Readiness



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Human-Machine Harmonious Collaboration Considering ELSI (Ethical, Legal and Social Issues) :

- Targeting Human(s):
Not only users but also human society (the others)
may feel the services acceptable
- Machine(s):
Should be designed to satisfy with at least
two criterions:
maximizing the user comfort(satisfaction)
while minimizing the discomfort of the others



Human-Robot "Harmonious" Interaction (ATR recent work)

Congestion Coming from Robotic Services in Human Populated Environment



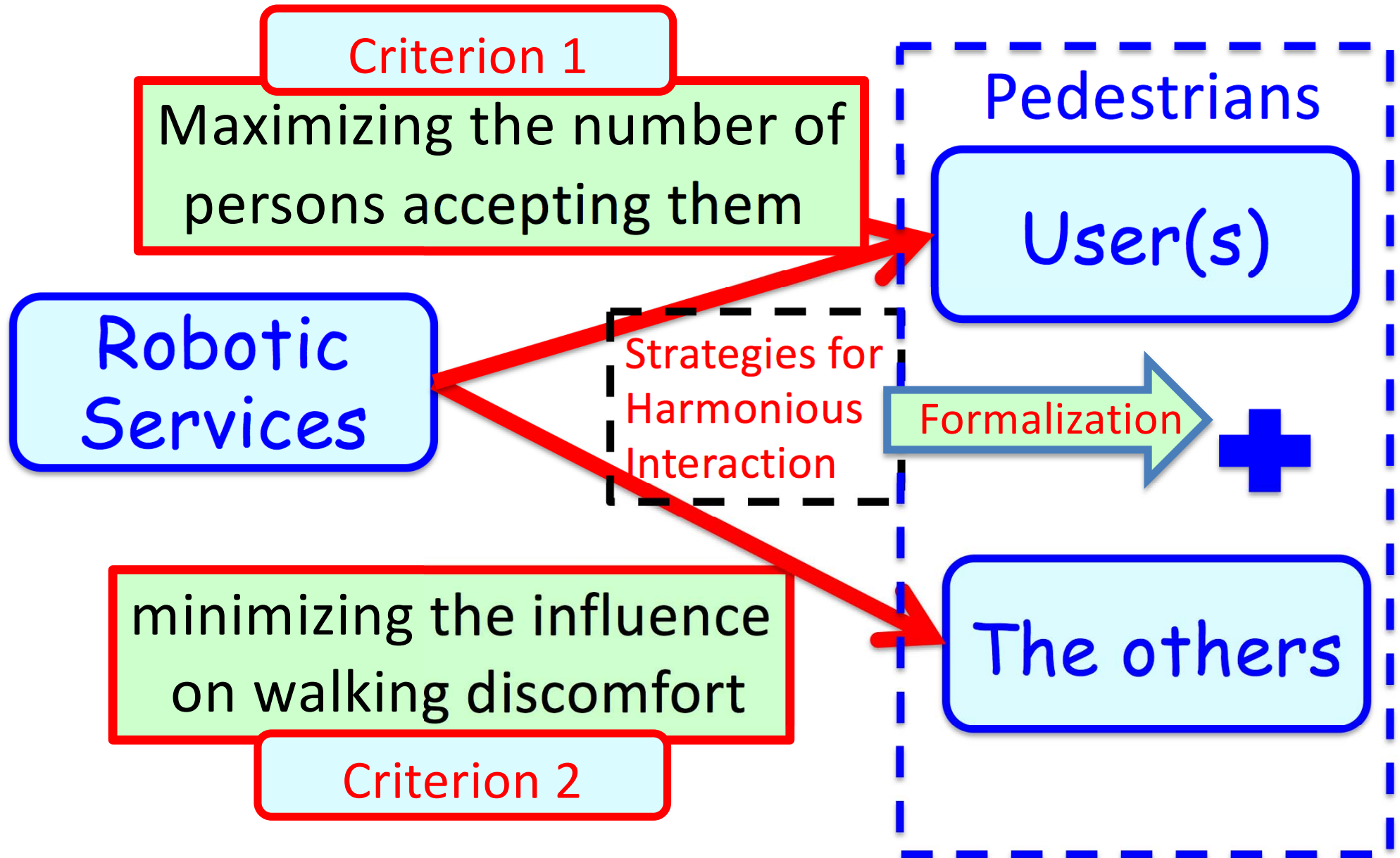
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Collaboration





**"Situated" Robotic Services with
Human-Robot "Harmonious" Interaction
From CREST on Human-harmonized IT
& Symbiotic Interaction
(by Takayuki Kanda from ATR)**

Human-Robot "Harmonious" Interaction In Human Populated Environments



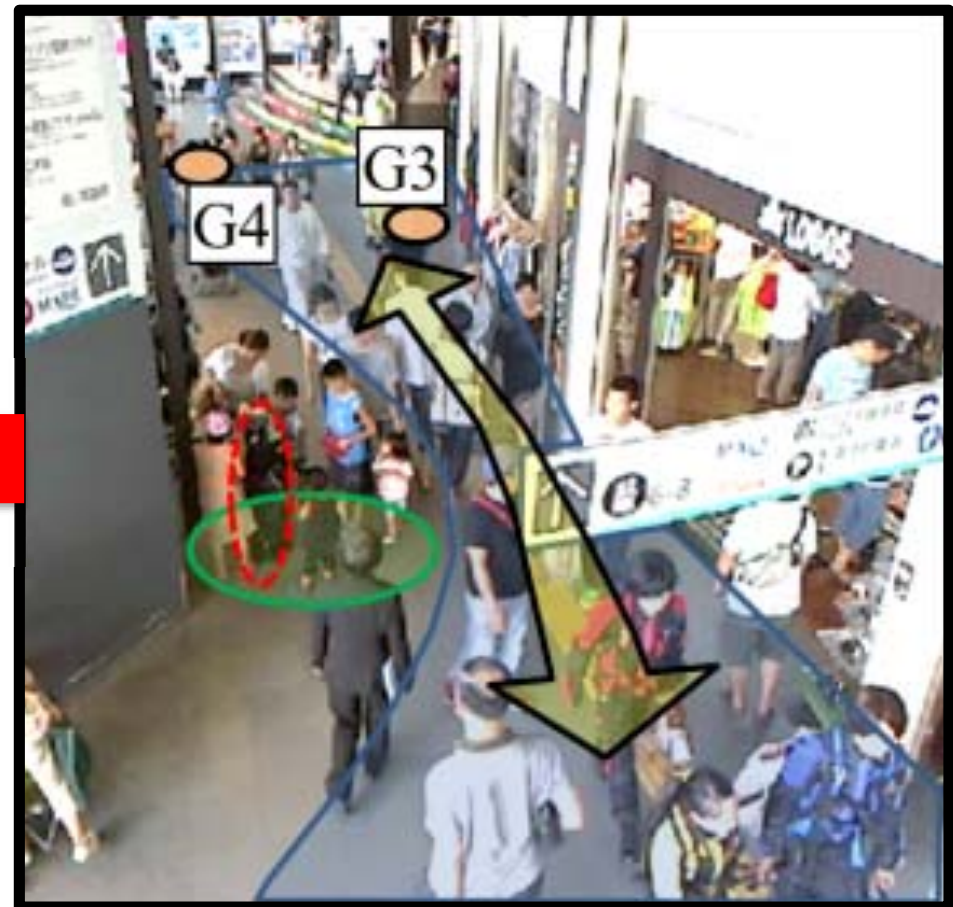
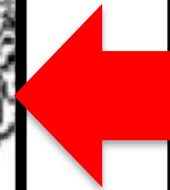
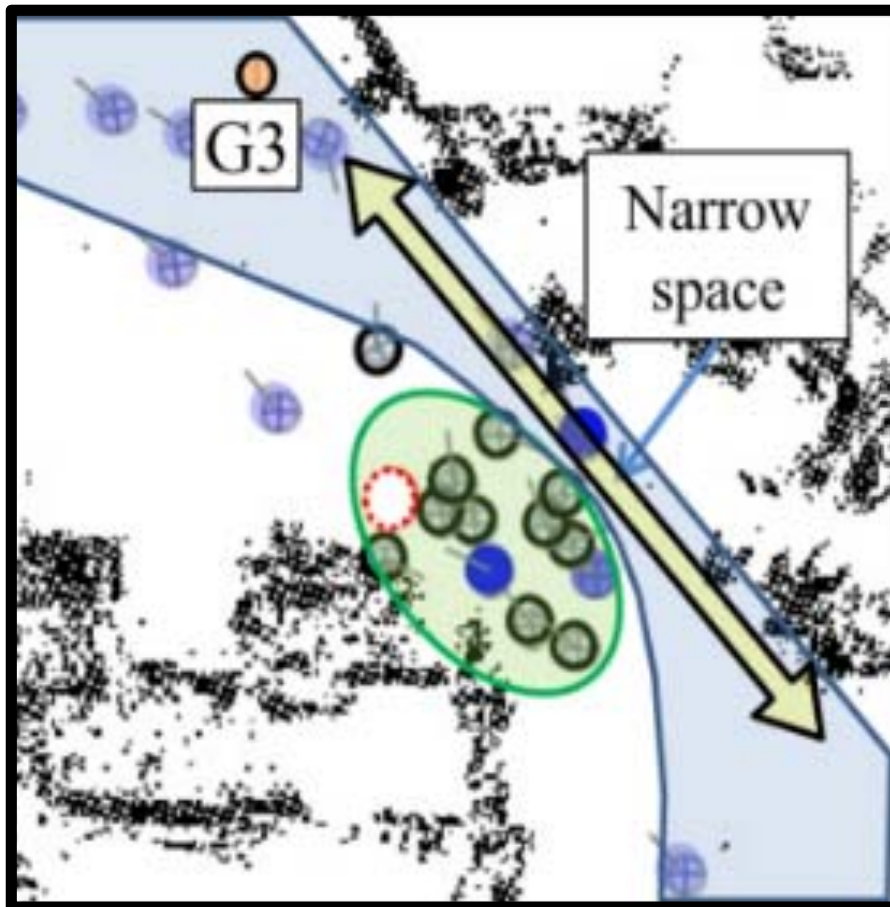
Congestion Avoidance with *Criteria* 1 & 2



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Congestion Simulation

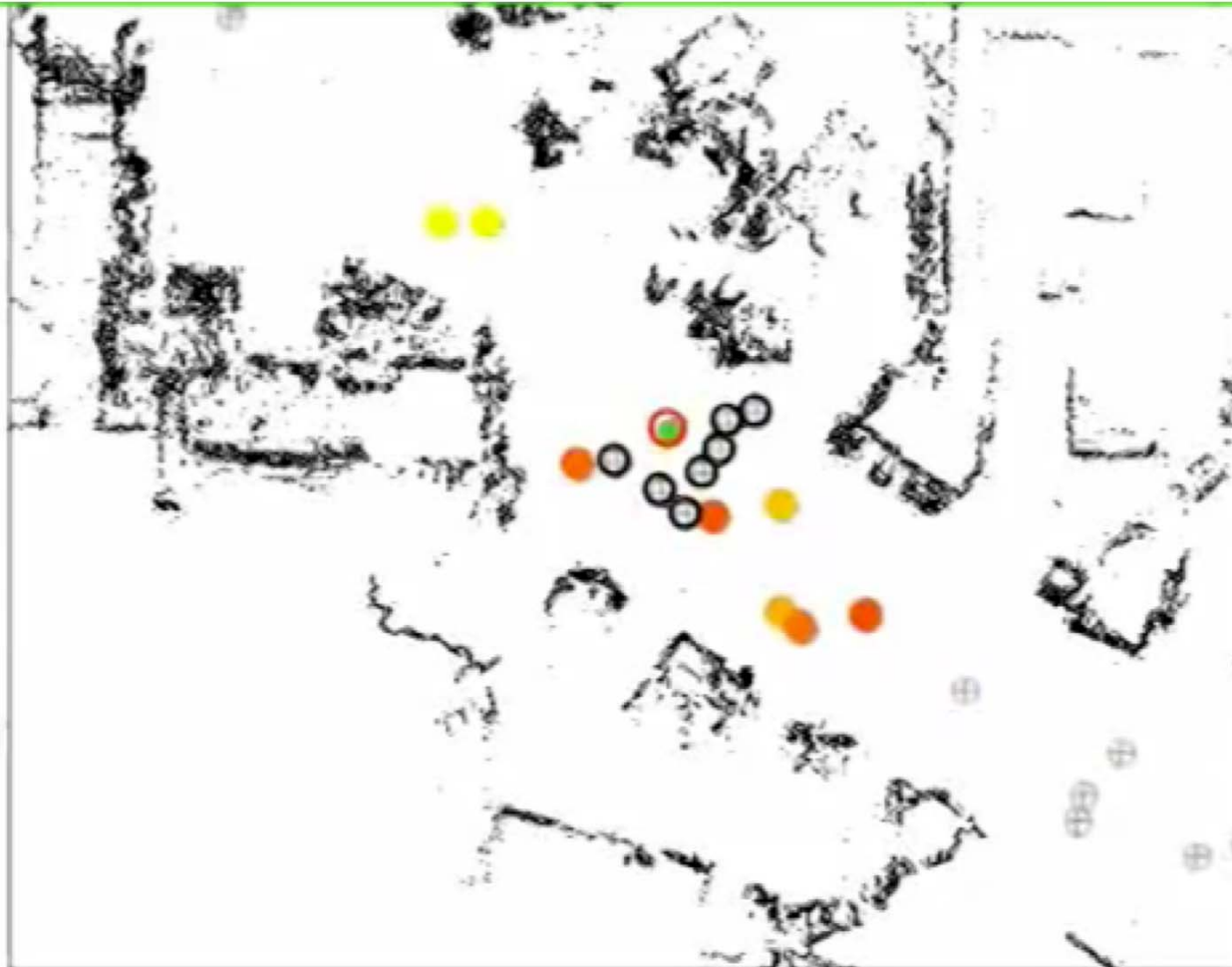
Observation



Congestion Avoidance with Criterons 1 & 2



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Focusing on distributing flyers
as an example of harmonious actuation

Distributional handing (in case of Human)

- In Japan, shop keepers often distribute flyers



Successful giver (**77.5%** success)
Approach from frontal right/left
and extending her arm when close
to receiver

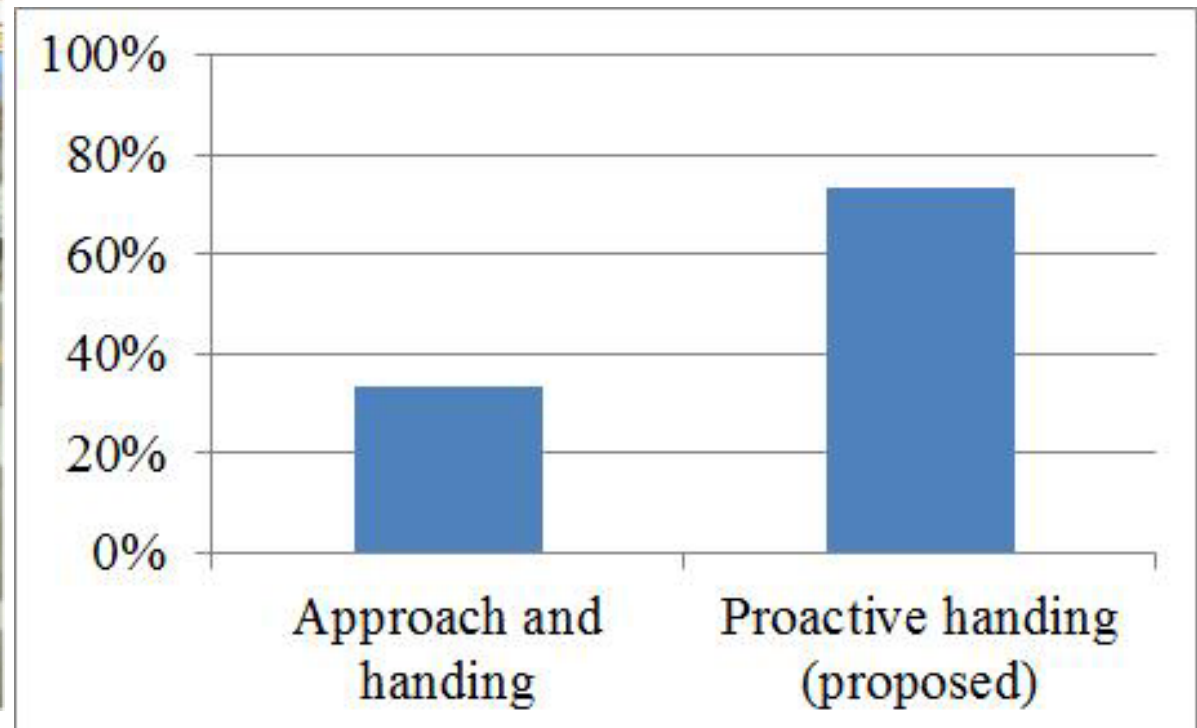
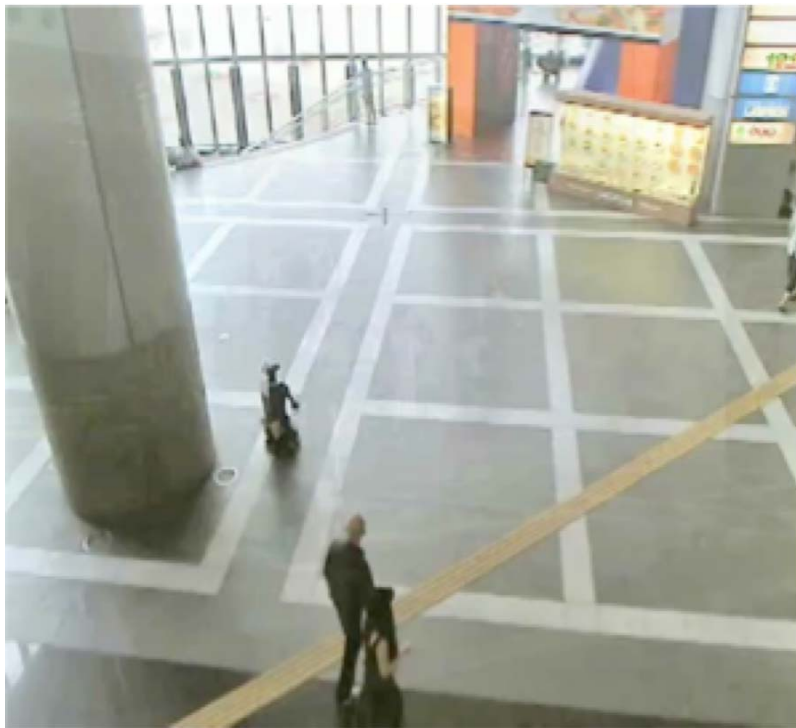


Poor giver (**12.5% success**)
Wait and extending her arm early

Robot's distributional handing



We implemented the successful behavior: “Approach from frontal right/left and extending human’s arm when close to receiver” → **73.3% of success**

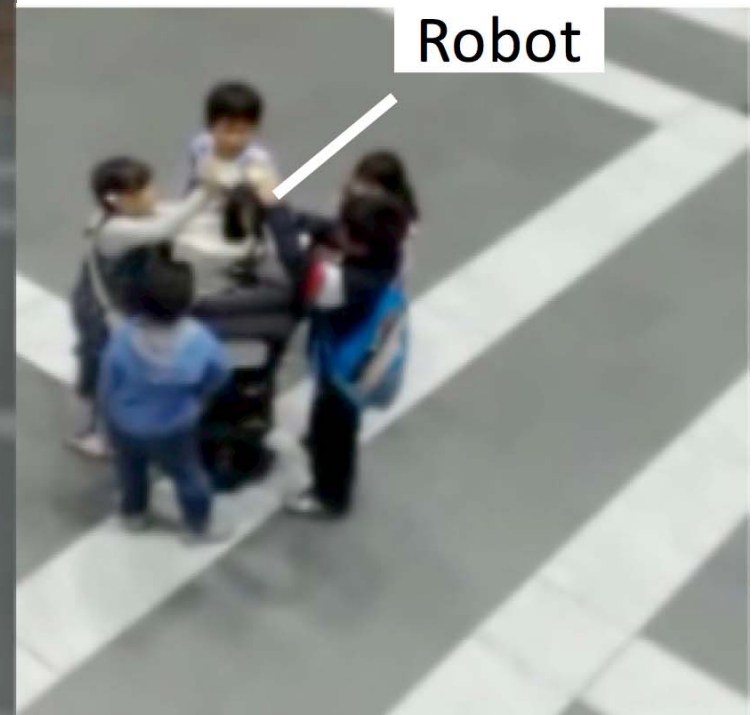


C. Shi, et al., A model of distributional handing interaction for a mobile robot, The 2013 Robotics: Science and Systems Conference (RSS 2013), 2013. (Acceptance Rate 30%)

Escaping from Children's Abuse of Social Robots while a Robot is patrolling

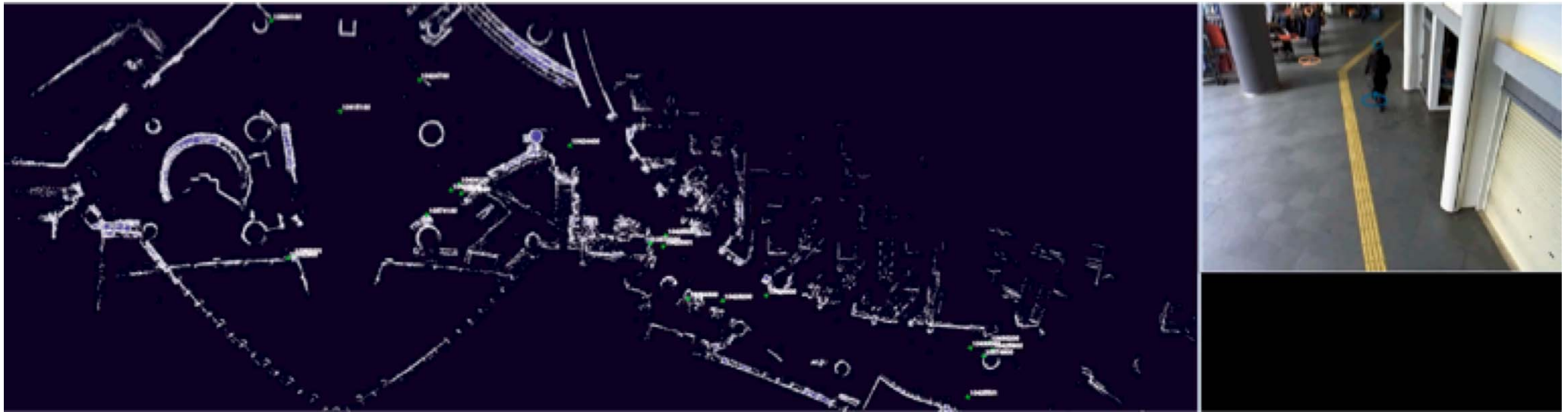


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Drazen Brscic et.al: Escaping from Children's Abuse of Social Robots,
The 10th ACM/IEEE International Conference on Human Robot Interaction,
Best Enabling Field Studies Award, Portland, Oregon, March 5th, 2015.

Pedestrian Dynamics



1. F. Zanlungo, et al., " A Microscopic "Social Norm" Model to Obtain Realistic Macroscopic Velocity and Density Pedestrian Distributions," *PLoS ONE*, 2012.
2. F. Zanlungo, et al., "Potential for the dynamics of pedestrians in a socially interacting group," *Physical Review E*, vol. 89, 2014.
3. T. Ikeda, et al, "Modeling and Prediction of Pedestrian Behavior based on the Sub-goal Concept " *RSS2012*.



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CREST Creating Situated Services

Application Domains Considering ELSI

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2015

2016

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Services**

Ambient Assisted Living

**Research & Development &
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(K. Kise)**

**Knowledge and Wisdom
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Crowdsourcing
(A. Morishima)**

Research Teams Accepted in CREST-Call 1(2014)



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Team Leader	Research theme	Developing Co-experience Knowledge and Wisdoms
Prof. Yoi'chi Sato (Univ. of Tokyo)	Analyzing Human Attention and Behavior via Collective Visual Sensing for the Creation of Life Innovation	Co-experience Knowledge on Collective Visions
Prof. Katsumi Watanabe (Waseda Univ.)	Intelligent Information Processing Systems based on Implicit Ambient Surface Information	Tacit knowledge on athletes and/or coaches for facilitating physical and mental regulations and metacognition
Prof. Kenji Suzuki (Tsukuba Univ.)	Social Imaging: Technologies for Supporting Creative Activities and Facilitating Social Interaction	Social Imaging Knowledge for enhanced children, parents, caregivers
Prof. Takahira Yamaguchi (Keio Univ.)	A Framework PRINTEPS to Develop Practical Artificial Intelligence	Common Platform for co-experience Knowledge & Wisdom

Research Teams Accepted in CREST-Call 2(2015)



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Team Leader	Research theme	Developing Co-experience Knowledge and Wisdoms
Prof. Takayuki Ito (Nagoya Institute of Technology)	Large-scale Consensus Support Systems based on Agent Technologies	Knowledge for Social Consensus Formation in SNS
Senior Researcher Dr. Masahiko Haruno (NICT)	Prediction of social attitudes and stresses based on social neuroscience and natural language processing	Knowledge for Social Attitude and Stress
Prof. Takayuki Nagai (The University of Electro-Communications)	Symbol Emergence in Robotics for Future Human-Machine Collaboration	Co-experience Knowledge on Symbol Grounding with Human- Robot Interaction
CEO Ryota Kanai (Araya, Inc.)	Construction of artificial consciousness and its application in real life situations based upon axiomatic neurocomputational theories and constructivistic engineering approaches	Artificial Consciousness Modules

Research Teams Accepted in CREST-Call 3(2016)



Today's talk

Team Leader	Research theme	Developing Co-experience Knowledge and Wisdoms
Prof. Koichi Kise (Osaka Prefecture Univ.)	"Experience Supplement" allowing experience modification and facilitating co-experience collaboration	Co-experience knowledge and wisdom via ICT-based experiences bank
Prof. Atsuyuki Morishima (Tsukuba Univ.)	CyborgCrowd : Crowdsourcing with flexible and scalable combination of human and machine resources	Global and open crowdsourcing knowledge and wisdom
Prof. Yukie Nagai (NICT)	Cognitive Mirroring allowing to share self-understanding of developmental disabilities among people	Social imaging knowledge of cognitive self-understanding

Thank you for your kind attention