Social Touch in Human-Robot Interaction

Advanced Telecommunications Research Institute International (ATR)
Intelligent Robotics and Communication Labs. (IRC)
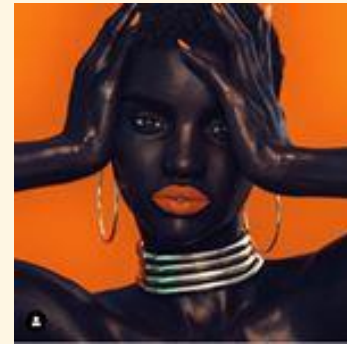Agent Interaction Design department (AID)
Group Leader

Masahiro Shiomi

Social agent in daily environments

- Not only social robots but also many social agents already exist in our world
  - VTuber, Virtual being⋯
- Why robot?
  - Because physical interaction and embodiment are essential for humans
- HRI＋Touch:
  - Social touch interaction

https://twitter.com/lilith2160

https://www.instagram.com/shudu.gram/

sayaproject.com
http://www.sayaproject.com/

Social touch in human-human interaction

- Positive effects :
  - Mental/physical benefits [Grewen,2003][Cohen, 2015]
  - Prosocial behavior [Cruso, 1984]
  - Social bonding [Bartz, 2011]
  - Even if a touch from a close person is imagined, it is effective for stress buffering [Jakubiak, 2016]

- Touch interaction with a robot has positive effects as well as human being?

Social touch in human-robot interaction

- Past studies reported several positive effects:
  - Stress buffering effects
    [Sumioka,2015][Shiomi, 2019]
  - Mental therapy effect
- However, most of studies focused on a touch from people to a robot

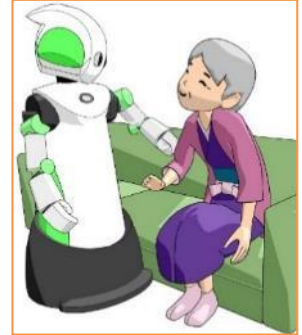- How a touch from a robot to people change such effects?

Research aim
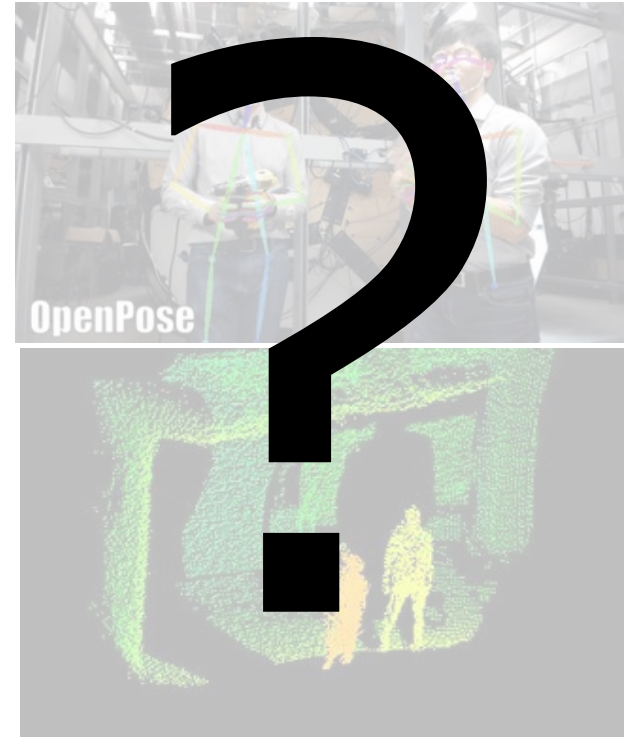

Before

Touched by people

After

Touch to people

- Several preliminary studies revealed positive effects of touch from robots to people

- What are main difficulties for social touch?

5

Difficulties in social touch: sensing

- Haptic sensing will be important in close distance
- Measurements and prediction are difficult

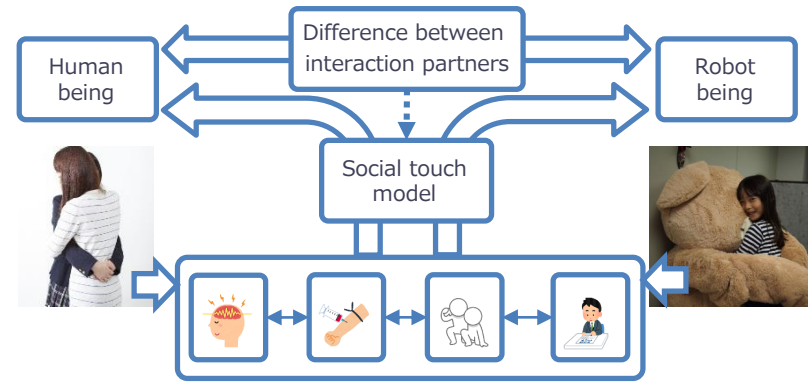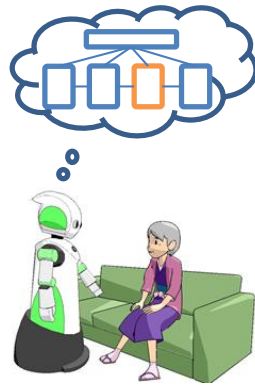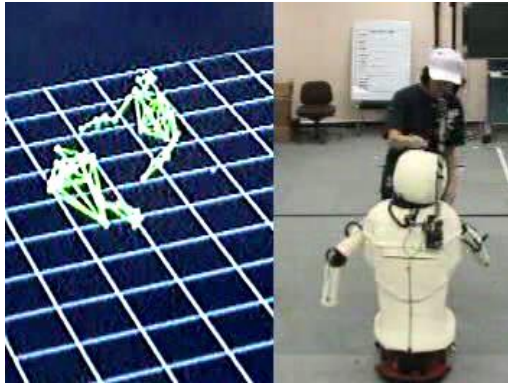# Difficulties in social touch: social norm

https://www.youtube.com/watch?v=iEN-kHe5o_Y

- Safe and trustworthy touch interaction
- Modeling of (pre/post) social touch
- Measurements for social touch
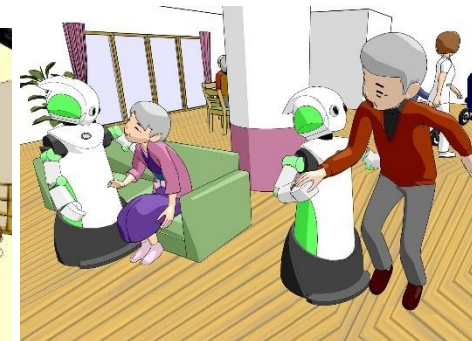
Research topics

Computational social touch

Modeling of (pre/post) social touch | Measurements for social touch

Difference between interaction partners

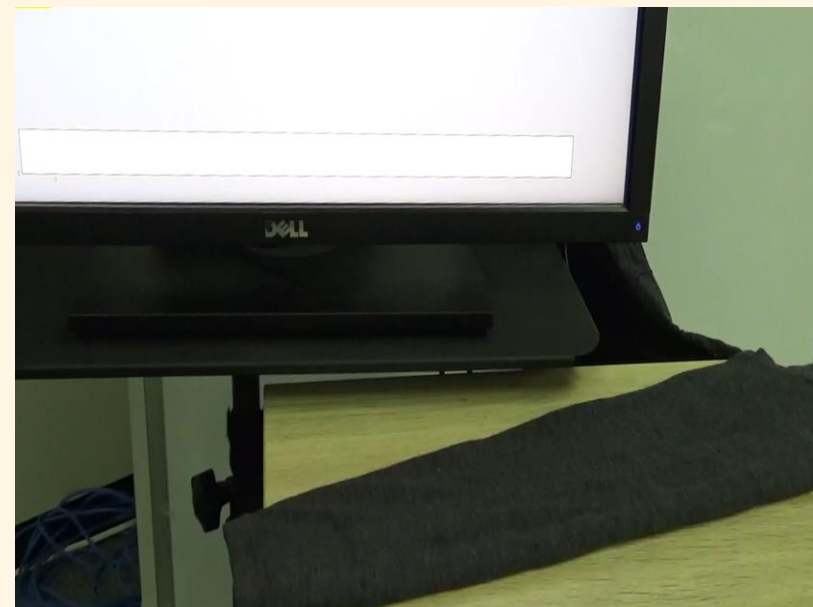Human being | Robot being
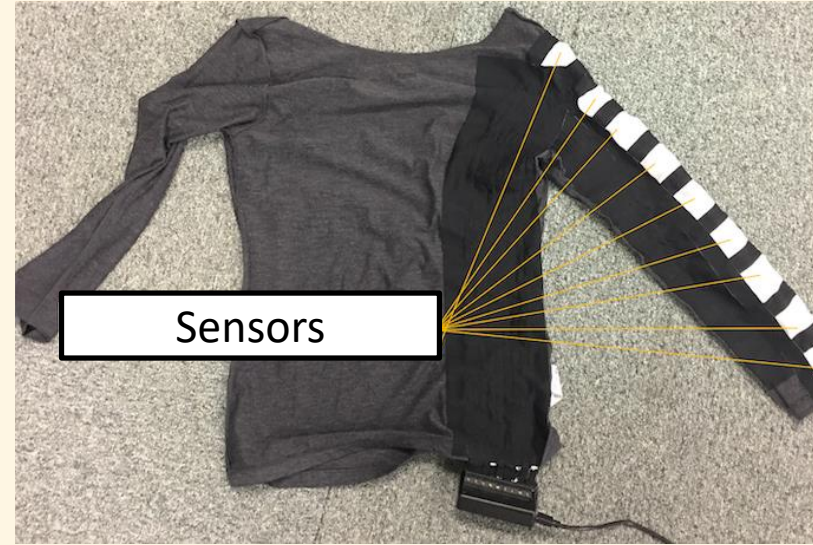
Social touch model

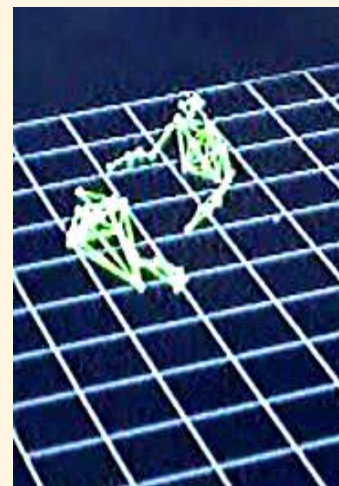## Hard-ware and soft-ware

Field trial

Touch sensor development

- We are developing a fabric capacitive sensor to detect touch

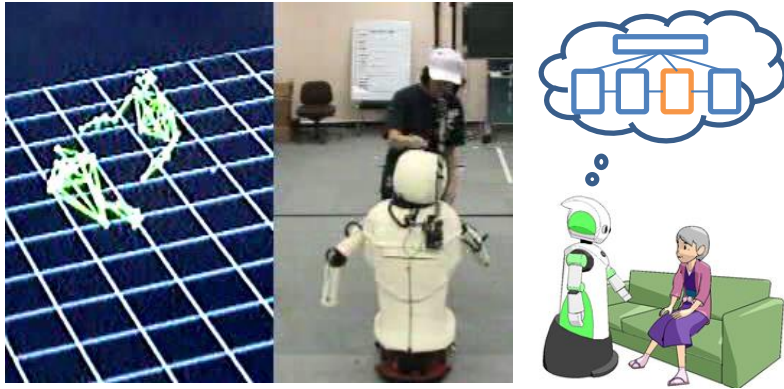- Currently, this sensor could not detect pressure; we try to integrate pressure sensors to this sensor

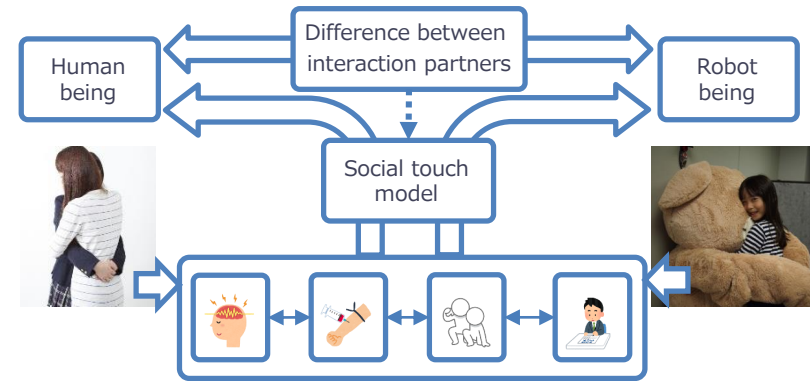Sensors

Pose estimation by using whole-body touch sensors

Reo Matsumura, et al., "Who is interacting with me? Identification of an interacting person through playful interaction with a small robot," IEEE Transactions on Human-Machine Systems, Issue: 99, pp. 1-11, 2014.
T. Tajika, et al., , Automatic Categorization of Haptic Interactions -What are the Typical Haptic Interactions Between a Human and a Robot?, In Proceedings of the IEEE International Conference on Humanoid Robots

Research topics

Computational social touch

From pre- to post- social touch

Measurements for social touch

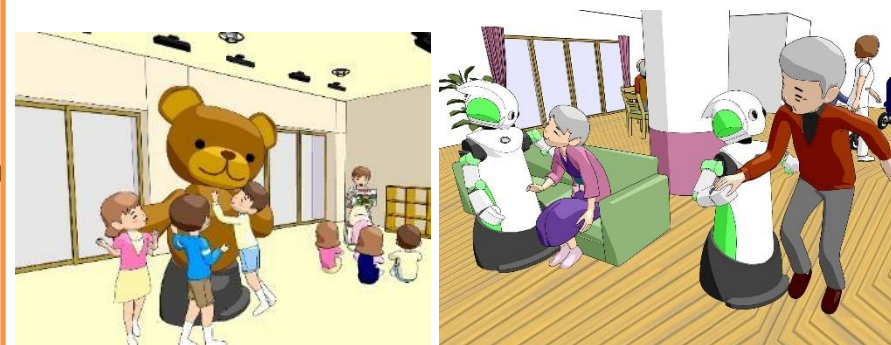Difference between interaction partners

Human being

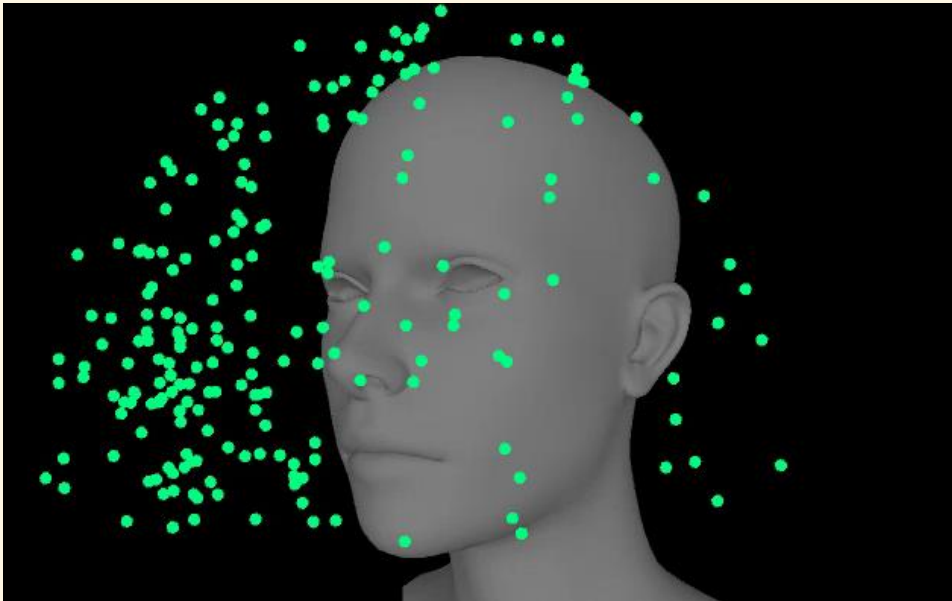Robot being

Social touch model

Hard-ware and soft-ware

Field trial

Modeling of pre-touch interaction

- People react before being touched; should a robot react before being touched by a person?
- We gathered pre-touch interaction data between people, and used its information for human-robot touch interaction
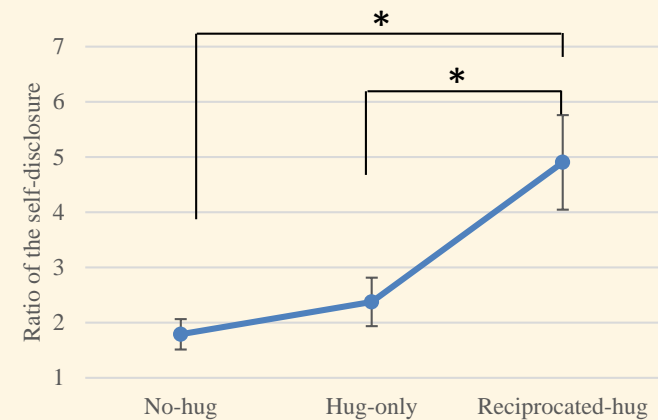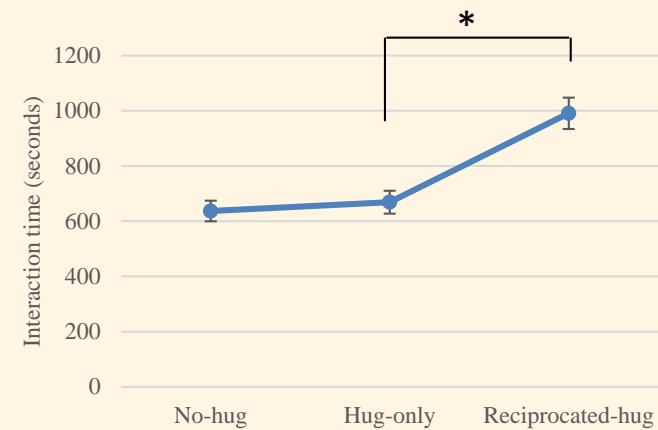

How should a Robot React before People's Touch?:
Modeling a Pre-Touch Reaction Distance for a Robot

Masahiro Shiomi, Kodai Shatani,
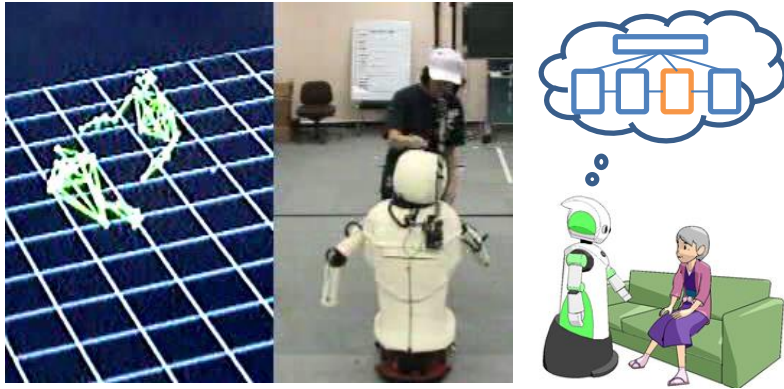Takashi Minato, and Hiroshi Ishiguro,
Member, IEEE

Behavior changes via robot's hug

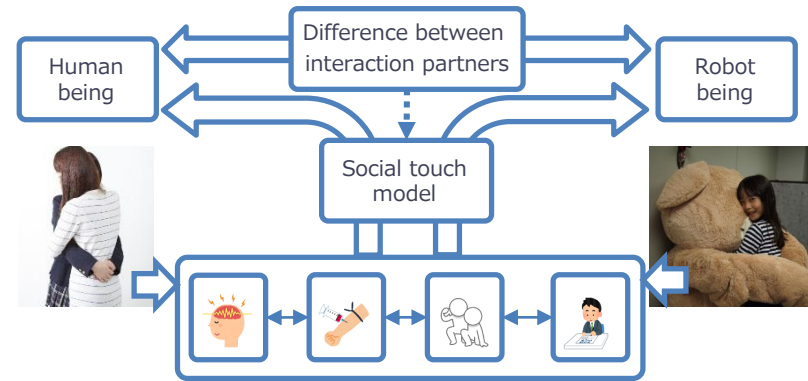- Robot's reciprocated hug increased self-disclosure and willingness to interact

Masahiro Shiomi, et al., "A Robot that Encourages Self-Disclosure by Hug," Proceedings of the Ninth International Conference on Social Robotics, pp. 324-333, 2017.

Research topics

Computational social touch mechanism
as a social-ware for human-robot touch interaction

From pre- to post- social touch

Difference between interaction partners

Human being

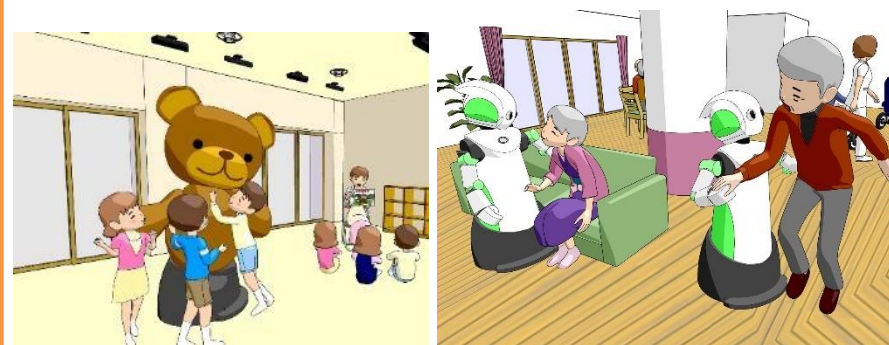Robot being

Social touch model

Measurements for social touch
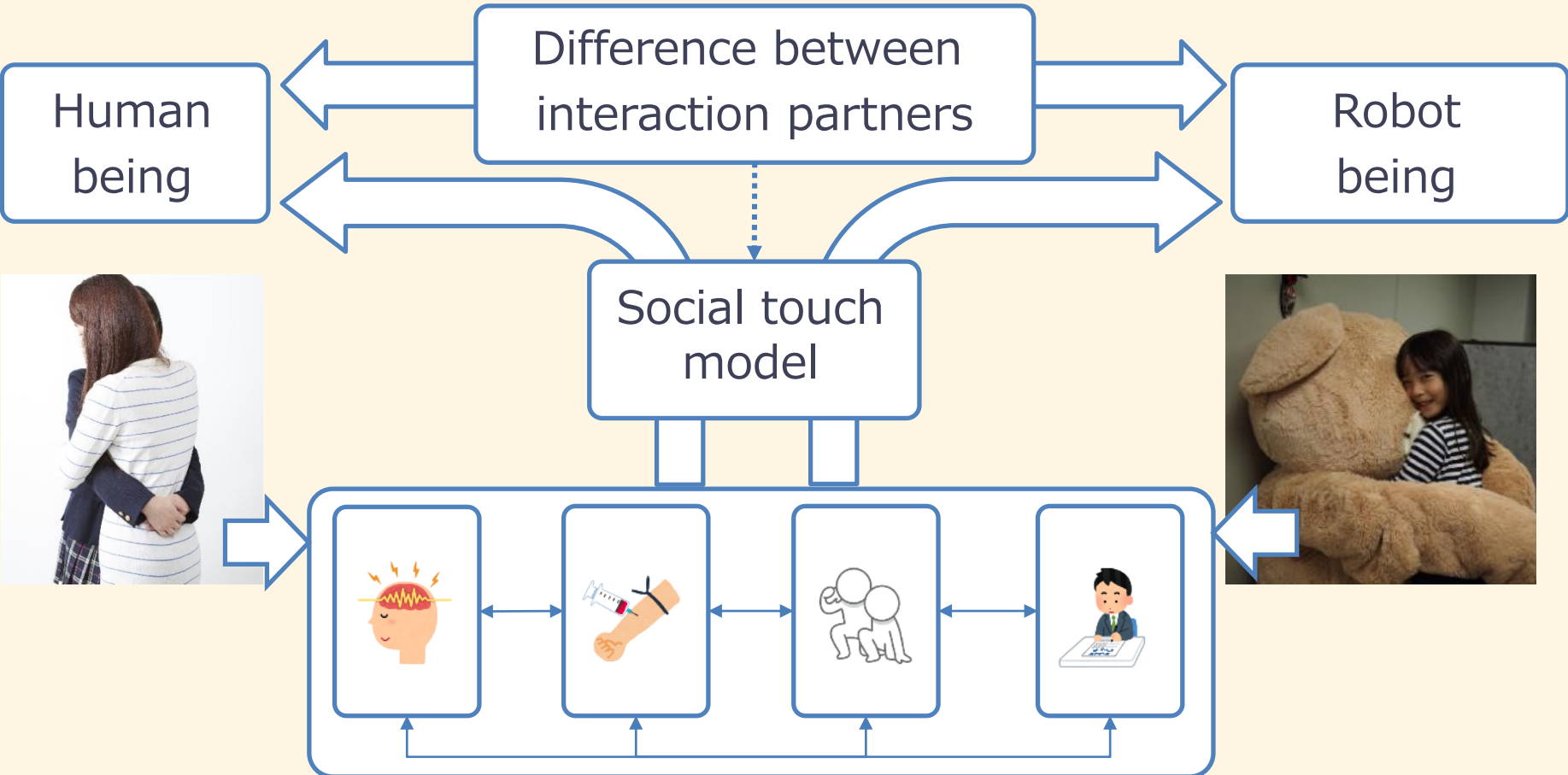
Hard-ware and soft-ware
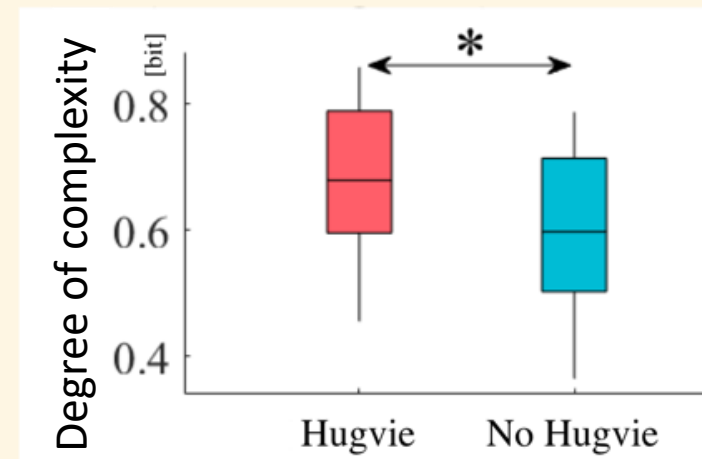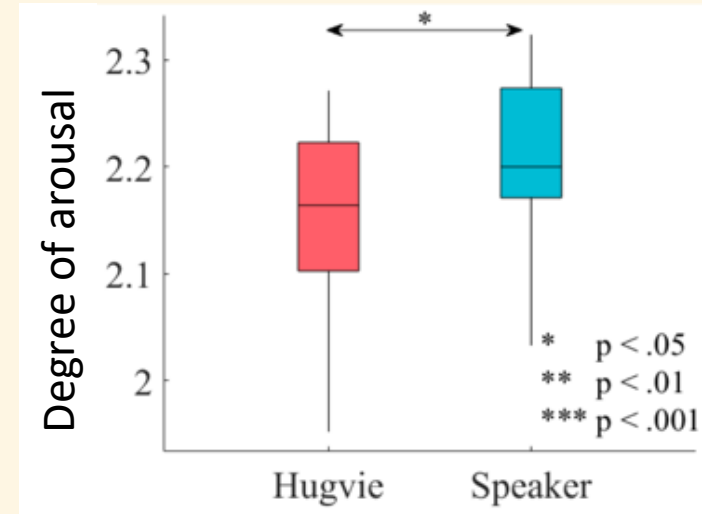
Field trial

Measurements for social touch

- Investigating relationships between social touch and different kinds of scales

Analyzing touch interaction effects on brain-related activities

- By using Permutation Entropy (PE), we compared the participants' NIRS time series data while using a phone or Hugvie during conversation

- Using Hugvie decreased PE more than a phone conversation

- On the other hand, analysis on the Multiscale Entropy (MSE) showed opposite phenomenon

Keshmiri, Soheil, et al. "Bodily-Contact Communication Medium Induces Relaxed Mode of Brain Activity While Increasing Its Dynamical Complexity: A Pilot Study." *Frontiers in psychology* 9 (2018): 1192.

Robot as a social touch display

- To investigate touch effects, robots' appearance and voice have essential roles

- However, for robots, hardware limitations complicate changing their appearance (and expensive!)

- If we can control audio-visual-touch stimuli easily, it will be useful to investigate touch effects
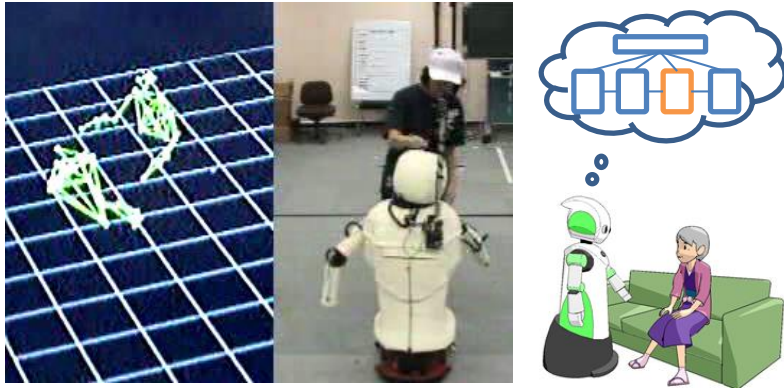
Robot+VR as a social touch display

- Based on these considerations, we developed social touch display systems which enabled us to experience various touch interaction with different audio-visual-touch stimuli
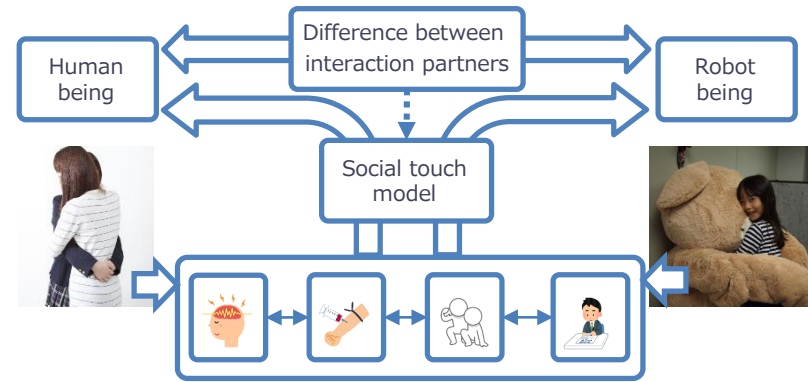
Research topics

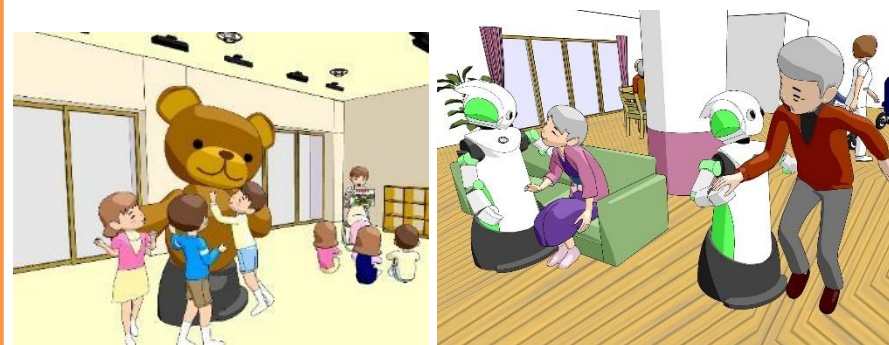## Computational social touch interaction

From pre- to post- social touch

Measurements for social touch

Difference between interaction partners

Human being

Robot being

Social touch model

Hard-ware and soft-ware

Field trial

Conclusion

Before

Touched by people

After

Touch to people

- Sensor/robot developments
- Modeling and simulation of social touch
- Measurement for social touch evaluation
- Field trial in real environments

Take-home message

- Social touch is a unique and essential factor for social robots (I believe that this is a critical reason why we use them)

- To realize social touch interaction between robots and people, the robots should consider "social norm"

- Computational social touch is a kind of constructive approach to understand social norm in social touch interaction

21