Learning by Interaction:

A Developmental Methodology for Robot Action Learning

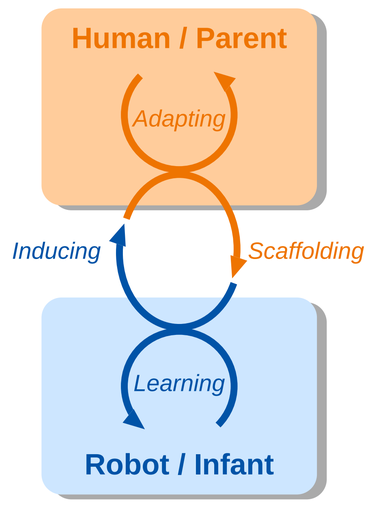
Yukie Nagai
Research Institute for Cognition and Robotics, Bielefeld University, Germany
yukie@techfak.uni-bielefeld.de

Universität Bielefeld

Introduction

"Learning by Interaction" beyond "Learning from Demonstration"

- Teachers scaffold learning.
  - Exaggerate action
  - Highlight important aspect
- Learners induce scaffolding.
  - Respond to action demonstration
  - Show their understanding



Traditional Robot Action Learning

- Robots learn *passively*. They do not react while being taught.
- Only designers can properly teach.

Infant Action Learning

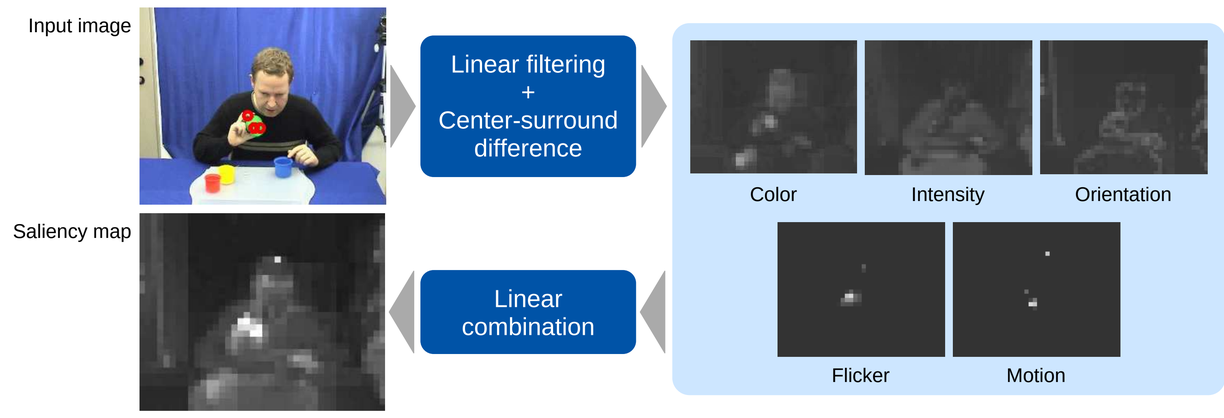
- Infants learn *actively*. Their responses influence parents.
- Parents are naturally motivated to assist learning.

Key Factor in "Learning by Interaction"

Bottom-up visual attention based on saliency:

- yields *infant-likeness* of learners.
- induces *action modifications* of teachers.
- enables learners to detect important aspects of actions highlighted by teachers.

⇒ Addressing "what to imitate" issue



Study 1: Analysis of Parent-Infant Interaction

Questions

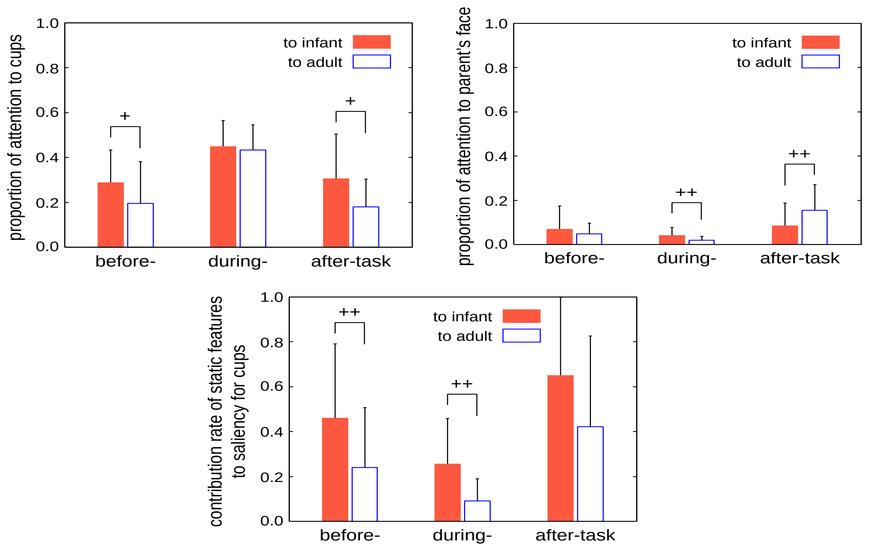
- How parents demonstrate actions to infants?
- How they highlight important aspects of actions?

Our Approach

Analyze parental action demonstrations employing a *saliency-based attention model*

Results: Characteristics of Parental Action

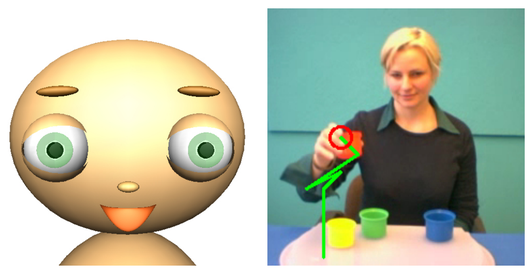
- Highlighting initial and final states of objects
  - Taking a long pause before/after the task
  - Generating additional movement with the objects before the task
- Frequent social signals indicating significant events
  - Pausing object-handling movement shortly before/after the event
  - Talking to & smiling at infants to give feedback on the event
- Underlining property of objects
  - Suppressing their body movement & closely showing the objects



Study 2: Design of Human-Robot Interaction

Questions

- How people want to teach and accept robots?
- How robots can induce parent-like teaching of human partners?

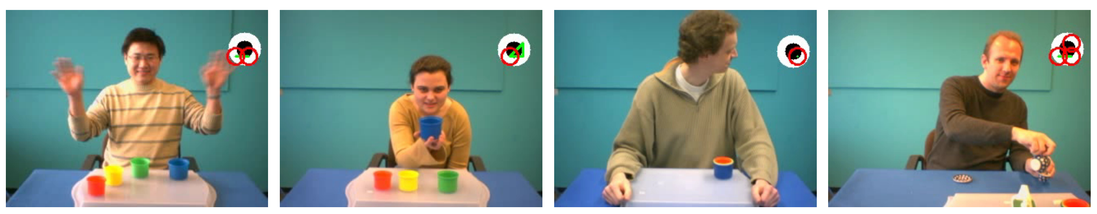


Our Approach

Equip a robot with a *saliency-based attention model* and investigate partner's responses focusing on when the robot's attention is distracted

Results: People's Responses to Robot's Distracted Attention

- Modifying their actions as parents do for infants
  - Amplifying their body movement & making noise
  - Approaching the robot & closely showing objects
- Accepting the robot as a social agent
  - Following the direction of the robot's gaze
  - Moving into the line of the robot's gaze



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