Cross-disciplinary Research on Engaging Advanced Technology for Education (*CREATE*)

NORTHERN ILLINOIS UNIVERSITY

Robots, Young Children, & Alternative Input Methods

Yanghee Kim, Workshop Organizer
Professor & Morgridge Endowed Chair
Director, *CREATE* Center, Northern Illinois University

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Background

Kindergarteners' rich multimodal and multisensory interactions with robot.

Driving Questions / Purpose

To bring cross-disciplinary experts to understand the current status of designing and evaluating child/robot collaborative systems:

- What are *the current status* of research and development in child/robot interaction?
- What are *the core theoretical perspectives* that may guide research in this area?
- What engineering assistance could expedite critical research issues for developing child/robot interactions?
- What technologies are available in these areas?
- What are the challenges in developing such technologies and research programs?

Process Outline

- Selected and invited top researchers through scholarly/professional works and recommendations by an NSF officer
- 15 invited presenters & 30 participants

During the one-and-a-half-day workshop:

- Day 1- Knowledge sharing: individual presentations grouped by social robotics, cognitive and learning theories, visual data processing, ASR & dialog generation, and ethnographic observation.
- Day Two- breakout group discussions: 1) Robot 101 (Platforms & User Expereinces), 2) Speech technology, 3) Content authoring.
- Group leaders contributed summaries to the final report.

Invited Presenters

- Breazeal, Cynthia, personal robots, MIT Media Lab
- Huang, Lixiao, social robotics for ASD children, Duke University
- Kim, Yanghee, child/robot interaction design, Northern Illinois University
- Qi, Xiaojun, visual data processing, Utah State University
- Ramani, Karthik, engineering embodiment and automation, Purdue University
- Aaron, Kline, multimodal interaction assessment, Stanford School of Medicine, Pediatric Research
- Alexander, Ajith, speech recognition and diarization, Oxford Wave Research
- Alwan, Abeer, automatic speech recognition and analysis for young children, UCLA
- Walker, Marilyn, computational linguistics (dialog generation), UC Santa Cruz
- Tony Zhao, dialog generation system (*Dialport*), Carnegie Mellon University
- Dorsey, Chad, speech technology in classrooms, Concord Consortium
- Han, Insook, Embodied cognition, Temple University
- Daro, Vinci, Social-emotional learning, Stanford Center for STEM Learning
- Kim, Kyung, Text analysis in group collaboration, Northern Illinois University
- Yoon, Jiyoon, Early science learning, University of Texas at Arlington
- Johnson, Laura, Qualitative Research (Ethnography), Northern Illinois University

Findings & Insights

1. A large number of effective designs have been developed.
2. Effectiveness of designs often exceeds expectations, & several unanticipated phenomena are observed (e.g., children's spontaneous physical actions and strong affective responses).
3. CRI is the field, more than any other in the Learning Sciences, that gathers and analyzes data of different modalities in parallel.
4. Designs are specialized; for example, robot designs to support cross-cultural communication, to help children with Autism, to support STEM learning.
5. Several theories are leveraged for design; but few efforts made to further advance such theories nor to develop the more general guiding theories.

Design Principles

CRI design to leverage children's natural way of learning and development:

1. Invite children to be active participants in playful learning; children are initiators with a sence of agency.
2. Embed robotic interaction within age-relevant meaningful narratives.
3. Integrate explicit exchanges of emotions verbally and physically ("I love you," and hugging).
4. Embrace embodied interactions: bodily movements & gestures as a valid form of engagement for learning and development.
5. The robot's mistakes are an effective tool for creating children's voluntary engagement.

Surprises & Tensions

1. CRI is such a powerful tool to engage children in desired activities, especially for those in need.
2. Rare attempts to construct encompassing frameworks for design or interpretation of interaction data.
3. Limited insights into children's spontaneous, earnest interactions, views, orientation towards the robot.
4. Urgent need for advancing computational approaches to automating data analysis; however, severe lack of children’s multimodal data.
5. A vast majority of research relies on lab trials with pre/post tests, providing limited practical implications.
6. Lacking acknowledgement of the importance of educational and learning scientific perspectives.

Recommendations

Aligned with *Convergence Research, Harnessing Data, INCLUDES*, *Future of Work,* support/demand cross-disciplinary collaboration for research and education.

1. Establish standing research communities at primary venues (e.g., AERA, ISLS, HRI) for continual engagement in this area.
2. Highlight the need for in-vivo studies & multimodal data collection for valid assessments.
3. Fund course offerings, e.g., Humanoid Robots 101.
4. Inform about the potential of robots for diversity and inclusion:
    - Robot as a cultural broker,
    - Robot as a teaching assistant,
    - Robot as a peer learner,
    - Other roles