Human-Robot Interaction in Groups: Theory, Method, and Design for Robots in Groups

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ABSTRACT
For the last decade, robots have been adopted into group work ranging from corporate offices to military operations. While robotic technology has matured enough to allow robots to act as team members, our understanding of how this alters group work is limited. In particular, little work has examined how the adoption of robots might alter group processes and outcomes. The purpose of this workshop is to bring together researchers investigating issues related to the theoretical frameworks and methodological approaches to studying human robot interactions within groups. We expect the workshop will contribute to our understanding of how to better design robots for group interactions.

Categories and Subject Descriptors
H.5.0 Information Interfaces and Presentation (e.g., HCI): General

General Terms
Design, Human Factors, Theory

Keywords
human-robot interaction, groups, teams, computer-supported cooperative work

1. INTRODUCTION
Organizations are increasingly relying on the use of work groups [3-5, 12, 16, 17]. Communication and information technologies have changed the way groups operate [1, 15, 20, 21]. The explosion of robot adoption in groups for the last decade has been reshaping how groups work in practice. As other technologies did, robots in groups can evoke new socio-technical issues between workers and technology. These issues are likely to have major implications for group processes and outcomes [7, 11, 19]. Yet, little is known about this emerging area of study.

Robots have been adopted in many contexts and domains of group work. For example, telepresence robots enable geographically dispersed teams to communicate more effectively [23]. By using robots to represent dispersed group members, these members can have a greater sense of social presence during group discussions, which facilitates social interactions between members in different locations [15]. Furthermore, some scholars believe that the use of robots to represent dispersed team members will only increase [24].

In addition, government and private businesses have adopted robots as group members [8, 25]. Extreme work groups, such as SWAT teams, use multiple robots in tactical field operations [7]. Construction companies have started to utilize autonomous robots for dangerous construction tasks to avoid loss of human life [25, 26]. Robots are also being used for non-task-related activities. Service robots such as Snackbots provide refreshments to employees throughout the work day [10, 13].

Human–robot interactions can also lead individuals to develop strong emotional attachments to robots. Evidence of this is often seen when individuals put clothes and accessories on their robots, treating them as if they were human [10]. Furthermore, research has shown that these emotional attachments can elicit in-group behaviors by which humans feel that the robot belongs to them or their group rather than the whole organization [19].

The inclusion of robots as team members can lead to new insights about how groups work, which we believe is fundamentally different from what we know of all-human groups. For example, how does the inclusion of robots help or hurt team coordination or cooperation? Does the inclusion of robots facilitate or impede the development of team trust? Despite these new and interesting questions, we know very little about this area [14, 22, 24].

2. Goals
This workshop is designed to stimulate interest in human–robot interactions within groups by assembling researchers who share a common interest in this area. Another goal is to promote the use of a diverse set of theoretical frameworks and methodological approaches to studying human–robot interactions within groups. We also expect that the workshop will inform design by providing insights into how the design of robots can facilitate or hinder group interactions. As such, the goals of this workshop are as follows:

- To bring together and establish a community of researchers and designers who are interested in human–robot interactions within groups.
- To present and discuss theoretical frameworks that differentiate research on human–robot interaction in groups from previous work that focuses mainly on individuals.
- To brainstorm and develop reliable and valid methodologies for studying human-robot interactions in groups.

Group 2014, November 9–12, 2014, Sundial Island, FL, USA.
ACM 978-1-4503-3043-5/14/11.
http://dx.doi.org/10.1145/2660398.2660426

- To identify and form suggestions and implications for designing robots to better support group work.

3. Themes

To achieve the workshop goals stated above, we suggest some potential themes that should allow a variety of perspectives to emerge. The suggested themes include but are not limited to the following:

- Theories that can be applied to or developed for human–robot interaction in groups.
- Research methods for studying social dynamics and group outcomes in groups using robots.
- Development of affordable and accessible robots for studying human–robot interaction in groups.
- Design suggestions and prototypes for robots in group contexts.
- Socio-technical issues in collaboration among humans using robots.
- Examination of the gap between social requirements and technical feasibility in human–robot collaboration [2].
- Social psychological principles for human–robot or human–human behaviors in groups using robots.
- Collaboration with autonomous, intelligent robots for knowledge-based works.
- Coordination and communication issues involving multiple humans and multiple robots.
- Development of experimental tasks for studying human–robot interaction within groups in various contexts.
- Opportunities and challenges that arise from bringing robots into group processes.
- Use of autonomous intelligent robots in groups.
- Testing team process variables such as cohesion and trust by adopting robots in collaboration.
- Group performance measures in groups using robots.
- Use of telepresence robots, which involves multiple people.

4. Workshop Structure

This is a full-day workshop that consists of four main sessions: 1) short presentations of workshop papers, 2) open discussions on topics, in general, 3) group activities in the afternoon, and 4) a reflective discussion on what was learned. However, the workshop is loosely structured so that the following arrangement can be spontaneously run on the day of workshop.

The workshop will begin with introductions to the topics by the organizers followed by a presentation of the day's agenda. Participants will each give a short presentation (10–15 minutes) on their paper. Participants are encouraged to provide demonstrations of human–robot interactions within groups by using actual robots, video and/or other materials. After all presentations, participants will engage in a discussion about the papers presented. Although there will be preplanned discussion topics there will be time set aside for emergent topics that come out of workshop discussions.

The afternoon session will be filled with small-group discussions. The small groups will be formed based on the final themes derived from the workshop discussions in the morning session. Based on the number of participants and themes, the participants will be divided into 3–4 groups. Each group will be encouraged to produce a slide show summarizing the outcome of their discussions. In the final session, the slides will be shared and discussed with all participants. The workshop will be concluded with a reflective discussion followed up with a summarization of the insights that emerged during the workshop. Participants will also be encouraged to provide feedback about the workshop and provide any future suggestions for other workshop participants.

5. Call for Participation

Potential participants should submit a two-page position paper to the organizer before the workshop. Authors can refer to the suggested workshop themes but are encouraged to bring up new perspectives that our themes do not cover. Along with the position paper, authors should also bring a 10- to 15-minute slide presentation. Please use the ACM standard format for submissions. Audio/visual equipment is highly encouraged but not required. The maximum number of participants is 15 but is subject to change based on the number of workshop submissions.

6. Organizers

Dr. Lionel P. Robert, Jr., is an assistant professor of information at the University of Michigan School of Information, Ann Arbor. His research focuses on team collaboration through virtual communication environments. Dr. Robert was a BAT doctoral fellow and KPMG scholar at Indiana University, where he completed his Ph.D. in Information Systems and minored in Social Informatics through the Center for Social Informatics.

Sangseok You is a doctoral student at the School of Information at the University of Michigan. His research focuses on technologically enabled small-group collaborations including use of intelligent robots. His recent work explores examination of team process and perception toward robots in physical human–robot collaboration such as construction sites; coordination and communication issues in collaboration in teams with multiple humans and multiple robots; and information seeking and sharing using robots in groups.

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