How to Team with Your Robot? – Exploring Challenges and Opportunities for (Inclusive) Design of Human-Robot-Interaction

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Abstract

In the industrial sector but also in medicine and other contexts, robotic assistance is gaining importance. While use cases and users are diverse and show different characteristics, the interaction between robots and humans is often based on one primary input modality. In this workshop, we explore criteria of human-machine teaming from the perspective of human-human teaming and investigate novel approaches of multimodal interaction with robots, particularly for inclusive design. By enabling close collaboration between the workshop participants, we will (a) build a common understanding of the need for inclusive design in human-robot-interaction, (b) raise awareness of human-robot teaming aspects through an interactive experiment, (c) discuss current approaches, such as artificial intelligence or emotion recognition to, e.g. predict intentions in collaborative scenarios, and (d) elaborate on a joint workshop outcome that will, provide the human-computer interaction and human-robot collaboration communities with, e.g. recommendations for inclusive design in human-robot interaction.

1 Motivation and State-of-the-Art

Robotics and automation is an important field with a continuously growing range of applications [12]. Advancements in robotics technology enable a closer interaction between humans and robots that goes even beyond classical human-robot collaboration (HRC), for example in industrial use cases [11], but also in medical [5] or social scenarios [7]. However, interacting with robots often follows single-input approaches that do not adapt to users' specific needs. Hereby, not only does the level of familiarity and expertise with new technology differ, but also the physical and cognitive capacities and constrains are neglected when designing user interfaces in robotics.

Despite significant progress, challenges remain in creating universally accessible interfaces and ensuring effective interaction across varied contexts. Efforts to survey and categorize affordances in robotic tasks [2] have provided a foundational understanding but also emphasize the need for new taxonomies that reflect diverse user needs and environments. By acknowledging users' physical and mental abilities, HRC systems can ensure broader accessibility across diverse populations. As one of the most promising approaches, AI technologies will play a significant role in improving HRC, for instance in the context of assistive social robotics [7]. Tools like corrective planning of robot actions using large language models (LLMs) [6] demonstrate the potential to make robot behavior more interpretable and user-friendly. Similarly, advancements in geometric deep learning [4, 10] and learning-friendly representations [9] allow robots to understand and adapt to human preferences in dynamic environments.

To address the different set of skills that robot users are equipped with depending on the context of usage, we aim to discuss new forms of robot interaction methods. The development of multimodal user interfaces tailored to users with varying skill levels is crucial for advancing HRC. Current research explores intuitive programming interfaces and natural interaction mechanisms that accommodate diverse user capabilities. For example, Ardón et al. [1, 3, 8] investigated semantic relations and grasp affordance reasoning, facilitating smoother robot-human interactions in tasks requiring high adaptability.

By exploring new user interfaces that facilitate integration, for example context-independent modalities or the integration of multimodal interfaces, we believe to add another important and rarely considered dimension to inclusion and diversity when dealing with robotics and assistive technologies. In addition, the insights and outcomes of this workshop could also be promising for future application scenarios that take HRC to the next level.

Consequently, we plan to tackle this important topic in our interactive workshop. We will further discuss the potential of artificial intelligence (AI) to support HRC, for instance by predicting user intentions. By creating a common understanding of current and future challenges when interacting with robots in various contexts and evaluating prospective approaches for multimodal interaction, we dive into one of the most promising topics at the intersection of research and practice, and discuss how we can enable diverse users to interact with robots adequately.

To summarize our *workshop goals*, we will: (1) Establish a shared understanding of state-of-the-art HRC interfaces across different contexts by developing a structured classification. (2) Identify and evaluate novel approaches to enhance user-robot interaction, assessing their usability and practical applicability. (3) Define the role

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Table 1: Agenda of the workshop.

Part	Timeslot	Activity
1	10 min	**Keynote:** A keynote is given embracing one of the main topics of the workshop.
	30 min	**Get-to-know:** In order to get to know each other, participants will have the opportunity to introduce themselves in casual icebreaker activity.
	45 min	**Position Paper Presentations:** Participants will present their workshop contributions followed by time-boxed discussions (10 + 5 min per paper).
		COFFEE BREAK
2	10 + 15 min	**Teaming Input + Practical Experiment:** A brief input about the teaming model with the criteria: Observability, predictability and directability will be given followed by an practical building of a shelf with observation groups.
	45 min	**Reflection and discussion:** Reflection of the observations and discussion of the consequences for HRI.
		LUNCH BREAK
3	5 + 10 min	**Lightning Talk + Activity:** A brief inspirational talk will be given followed by an creative activity to introduce the next presentation block.
	30 min	**Recap & Summary:** The main outcomes and take-aways from the presentations will be summarized and visualized interactively to form the foundation for subsequent discussions.
	45 min	**Discussion & Transfer into Practice:** Approaches on facilitating the human robot interaction will be discussed and advantages as well as disadvantages will be checked for a potential transfer into practice.
		COFFEE BREAK
4	60 min	**Workshop Outcome:** Based on the various inputs from paper presentations, discussions, and talks, recommendations for facilitating human-robot interaction are phrased.
	15 min	**Outlook & Closing:** Workshop findings will be briefly summarized and prospective collaborations among the participants will be evaluated. We will end with a short discussion on future steps.

of user-centered design processes and evaluation criteria in HRC to enhance usability and foster user acceptance. (4) Develop design recommendations to enhance human-robot interaction (HRI) through multi-modal input methods. (5) Explore the potential of artificial intelligence (AI) or emotion recognition, particularly in predicting user behavior across various scenarios.

2 Workshop mode and activities

The workshop will be conducted full day onsite and participants will be asked to present their position papers in person. Passive remote attendance will be allowed. As we aim to foster fruitful discussions and to form a well-informed understanding of the topics elaborated on in the workshops, supplemented by interactive activities. Further, the position paper presentations represent an essential part of the workshop agenda since they focus on the main research topics and show novel approaches. To moderate discussions on the presented contributions adequately, we will cluster paper presentations by overlapping topics or research questions. The workshop will be structured as shown in Table. 1.

3 Call for Participation (CfP)

We are planing to provide the CfP both in German and in English to encourage a wider community to submit to our workshop. Here we provide a draft call in German:

Die Anwendungsszenarien für Roboter wachsen nicht nur stetig in der Industrie, sondern ebenfalls im medizinischen und sozialen Bereich. Die Interaktion zwischen Roboter und Mensch ist dabei häufig singulär und basiert auf der Verwendung zumeist einer Eingabemodalität. Dabei werden die physischen und kognitiven Kapazitäten von BedienerInnen zumeist bei dem Design der Benutzerschnittstellen vernachlässigt. Ziel dieses ganztägigen Workshops ist es daher, Ansätze zur multimodalen Interaktion mit Robotern zu diskutieren und im jeweiligen Anwendungskontext zu betrachten. Fragestellungen wie beispielsweise (a) die Nützlichkeit von multimodalen Eingabemethoden wie u.a. Sprache oder Gestensteuerung, (b) der Einsatz von Künstlicher Intelligenz (KI) zur Erkennung von Absichten im Rahmen kollaborativer Szenarien, sowie (c) aktuelle und zukünftige Herausforderungen in der Mensch-Roboter Interaktion stehen dabei im Fokus. Wir laden ExpertInnen, ForscherInnen und PraktikerInnen dazu ein ihre Arbeiten, Essays und Prototypen

in Form von schriftlichen Beiträgen bis zum 13.07.2025 einzureichen. Die Beiträge können sowohl Theorien, Methodiken oder auch Studien sowie kritischen Reflektionen zum Thema Mensch-Roboter Kollaboration, Multimodale Nutzerschnittstellen, Roboter in sozialen Kontexten und den genannten angrenzenden Themen beinhalten. Die Einreichung der Beiträge (max. 4 Seiten in folg. `Format`) erfolgt über das `Conftool`. Alle akzeptierten Workshop-Beiträge werden in den MENSCH und COMPUTER 2025 Proceedings veröffentlicht. Angenommene Beiträge werden in Präsenz vorgestellt. Deshalb muss mindestens ein Autor für den Workshop und die Konferenz registriert sein. Der Workshop richtet sich an Interessierte aus Schnittstellen-Wis-senschaften sowie den Bereichen z.B. Robotik, Informatik, Ingenieurwissenschaften, Psychologie, Sozialwissenschaften, aber auch ausdrücklich an VertreterInnen der Wirtschaft, Industrie und öffent-lichen Verwaltung. Für mehr Informationen besuchen Sie unsere `Website`.

4 Organizers

Sascha Kaden
Sascha is a researcher at the Chemnitz University of Technology in the field of robotics since 2018. His research focuses on the field of HRI, with an emphasis on mental workload and situational awareness. He holds a Master's degree in Automation Systems from Chemnitz University of Technology.

Romina Poguntke
Romina is an HCI researcher and UX designer. Her main research interests are Affective Computing as well as HRC. Romina holds a Bachelor Degree in Psychology, a Master Degree in Applied Cognitive and Media Sciences, as well as a Ph.D. from the University of Stuttgart. She teaches various courses as an external lecturer.

André Dettmann
André is a scientist at Chemnitz University of Technology since 2012. His research focuses on driver assistance systems and highly automated driving, as well as HRI. He holds a Masters Degree in Systems Engineering and a PhD from Chemnitz University of Technology.

Katrin Lohan
Katrin is since 2024 Head of the Institute for Development of Mechatronic Systems (EMS) and since 2019 Professor for Robotics and Automation at the EMS at the Eastern Switzerland University of Applied Sciences in Buchs, Switzerland. Further, she is a visiting Professor at Heriot-Watt University where she joint at 2013 (as an assistant Professor). Her main research interests are in understanding the learning mechanisms between parents and infants, between adults and adults, and between humans and robots to create a natural interaction with robots.

Frieder Loch
Frieder is Professor for User-Centered Design at the Eastern Switzerland University of Applied Science in Rapperswil. His research focuses on the creation of intuitive and accessible user interfaces, especially for production environments. Frieder holds a Master Degree in Human Media Interaction from the University of Enschede and a Ph.D. from the Technical University of Munich. He is the head of the Bachelor of Science in Digital Design.

Manuel Giuliani
Manuel is Professor for Geriatric Robotics at Kempten University of Applied Sciences. Before, Manuel was Professor in Embedded Cognitive AI for Robotics at the University of the West of England and Co-Director of the Bristol Robotics Laboratory. Manuel's research interests include assistive robotics, human-robot interaction, social robotics, natural language processing, multimodal fusion, multimodal output generation, augmented and virtual reality interfaces, and embedded cognitive robot architectures.

References

[1] P. Ardon, M. E. Cabrera, E. Pairet, R. P. A. Petrick, S. Ramamoorthy, K. Lohan, and M. Cakmak. 2021. Affordance-Aware Handovers with Human Arm Mobility Constraints. *IEEE Robotics and Automation Letters* 6, 2 (April 2021), 3136–3143. https://doi.org/10.1109/LRA.2021.3062808

[2] P. Ardón, È. Pairet, K. Lohan, S. Ramamoorthy, and R. Petrick. 2020. Affordances in robotic tasks–a survey. *arXiv preprint arXiv:2004.07400* (2020).

[3] P. Ardón, È. Pairet, Y. Petillot, R. P. A. Petrick, S. Ramamoorthy, and K. Lohan. 2020. Self-Assessment of Grasp Affordance Transfer. In *2020 IEEE/RSJ Intern. Conf. on Intelligent Robots and Systems (IROS)*. 9385–9392. https://doi.org/10.1109/IROS45743.2020.9340841

[4] M. M. Bronstein, J. Bruna, Y. LeCun, A. Szlam, and P. Vandergheynst. 2017. Geometric Deep Learning: Going beyond Euclidean data. *IEEE Signal Processing Magazine* 34, 4 (2017), 18–42. https://doi.org/10.1109/MSP.2017.2693418

[5] J. Holland, L. Kingston, C. McCarthy, E. Armstrong, P. O'Dwyer, F. Merz, and M. McConnell. 2021. Service Robots in the Healthcare Sector. *Robotics* 10, 1 (2021). https://doi.org/10.3390/robotics10010047

[6] F. Joublin, A. Ceravola, P. Smirnov, F. Ocker, J. Deigmoeller, A. Belardinelli, C. Wang, S. Hasler, D. Tanneberg, and M. Gienger. 2024. CoPAL: Corrective Planning of Robot Actions with Large Language Models. In *2024 IEEE Intern. Conf. on Robotics and Automation (ICRA)*. 8664–8670. https://doi.org/10.1109/ICRA57147.2024.10610434

[7] H. Mahdi, S. Alperen Akgun, S. Saleh, and K. Dautenhahn. 2022. A survey on the design and evolution of social robots — Past, present and future. *Robotics and Autonomous Systems* 156 (2022), 104193. https://doi.org/10.1016/j.robot.2022.104193

[8] P. Ardón Ramirez, È. Pairet Artau, R. P.A. Petrick, S. Ramamoorthy, and K. Lohan. 2019. Learning grasp affordance reasoning through semantic relations. *IEEE Robotics and Automation Letters* 4, 4 (31 Oct. 2019), 4571 – 4578. https://doi.org/10.1109/LRA.2019.2933815 2019 IEEE/RSJ Intern. Conf. on Intelligent Robots and Systems, IROS 2019 ; Conference date: 04-11-2019 Through 08-11-2019.

[9] D. Ren, J. Zheng, J. Cai, J. Li, H. Jiang, Z. Cai, J. Zhang, L. Pan, M. Zhang, H. Zhao, and S. Yi. 2021. CSG-Stump: A Learning Friendly CSG-Like Representation for Interpretable Shape Parsing. In *2021 IEEE/CVF Intern. Conf. on Computer Vision (ICCV)*. 12458–12467. https://doi.org/10.1109/ICCV48922.2021.01225

[10] D. Ruhe, J. K. Gupta, S. De Keninck, M. Welling, and J. Brandstetter. 2023. Geometric clifford algebra networks. In *Proceedings of the 40th Intern. Conf. on Machine Learning* (Honolulu, Hawaii, USA) *(ICML'23)*. JMLR.org, Article 1219, 32 pages.

[11] A. Simões, A. Pinto, J. Santos, S. Pinheiro, and D. Romero. 2022. Designing human-robot collaboration (HRC) workspaces in industrial settings: A systematic literature review. *Journal of Manufacturing Systems* 62 (2022), 28–43. https://doi.org/10.1016/j.jmsy.2021.11.007

[12] T. Sutikno. 2023. An overview of emerging trends in robotics and automation. *IAES Intern. Journal of Robotics and Automation (IJRA)* 12 (12 2023), 405. https://doi.org/10.11591/ijra.v12i4.pp405-411