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Multi-Agentic Systems in HRI (MAgicS-HRI): Bridging Design and Real-World Challenges for End Users

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Abstract

Recent developments in large language models and multi-agentic systems present both opportunities and challenges for Human-Robot Interaction (HRI). However, it remains unclear how the interaction paradigms will be reshaped due to the growing complexity and opaqueness. Therefore, to bridge this gap and connect users with multi-agentic systems through embodied robot agents, this workshop aims to explore solutions for design challenges of multi-agentic systems on various types of robots in real-world contexts. Through a complementary mix of focus groups, including design activities and paper presentations, our workshop generates design considerations for real-world applications and outlines pioneering research agendas for multi-agentic systems in HRI.

CCS Concepts

• **Human-centered computing → Interaction design theory, concepts and paradigms**.

Keywords

Multi-Agentic System, Human-Robot Interaction, Design, Embodiment

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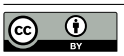

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1 Introduction

With the advances of large language models (LLMs), agentic systems are gaining increasing attention due to their goal-driven directness, long-horizon planning, and general-purpose roles [23]. Companies such as Microsoft [22] and OpenAI [1] have introduced their multi-agentic framework, signally a shift toward agent-oriented programming [19]. However, the rapid growth in system complexity and opaqueness has exposed critical design challenges [17]. New interaction paradigms and design solutions are urgently needed to address these emerging issues.

"Multi-agent" and "Swarm" systems have long been established fields in human-robot interaction (HRI) and robotics [9, 20]. Researchers explored various architectures, including hierarchical and decentralised approaches [1, 11, 22]. However, emerging multi-agentic systems powered by LLMs offer new possibilities for integration with embodied robots. Previous work explored re-embodiment and co-embodiment of agents on a single robot [8]. Robots may also be interconnected through distributed agents from the same underlying multi-agentic system [2]. The distinctive characteristics of agentic systems, including underspecification, directness of impact, goal-directness, and long-term planning [4], demonstrate strong potential to enhance robot intelligence and support higher degrees of agency, enabling robots to engage more effectively in human society.

While the integration of multi-agentic systems with robots is presenting substantial opportunities, it also necessitates careful reconsideration of key embodied properties such as autonomy [3, 25], social ability [16], and anthropomorphism [15, 26]. Importantly, multi-agentic systems in HRI introduce challenges [17], ranging from transparency, parallel interaction, cascading failures, conflicts, cognitive load, and mental models, all of which are essential for novel end-users to effectively interact with robots as embodied interfaces to complex multi-agentic systems. Further, such systems may require new ways of communicating risk (e.g., conflicts between agents in multi-agentic systems [17]) that take their embodied form

into account [14, 16], suddenly presenting robots as conduits for risk communication and as risk communicators.

Therefore, this workshop focuses on addressing these challenges in real-world contexts by bringing together researchers to participate in focus groups and discussions, defining research agendas that will enable multi-agentic robots to benefit end-users and contribute meaningfully to human society.

2 Workshop Overview

This workshop aims to pioneer solutions for the design challenges of multi-agentic systems in HRI by integrating insights from both design and technical perspectives. We invite researchers to envision and address potential user tensions through speculative narratives that reveal the consequences of poor design, then collaboratively iterate toward more effective solutions.

2.1 Format and Activities

This is a half-day workshop for in-person participants. Participants are encouraged to submit a position paper to share their recent work on the following topics of interest:

- Orchestration interfaces for human oversight of agents and robots
- Failure and trust in human-robot interaction
- Risk communication for inter-robots or human-robot conflicts
- Humans' mental model and cognitive load in HRI with multi-agentic systems
- Anthropomorphism in multi-agentic robots
- Re-embodiment, co-embodiment, distributed embodiment
- Human-multi-agents communication
- Human-robot interaction in real-world scenarios
- LLMs and agents powered human-robot interaction
- Theoretical frameworks for human and multi-agentic interaction

Authors with accepted papers will present their work during the paper madness session using a single slide to provide diverse and multiple perspectives on multi-agentic systems in HRI.

The focus group is structured around card decks inspired by [21], which provides a constructive and narrative approach to the discussion topics. There will be three decks of cards. The **robot deck** presents different types of robots, ranging from conversational agents such as Furhat, social robots such as Pepper, humanoid collaborative robots like TIAGo, to industrial robots such as Franka. The **agent deck** includes multi-agentic architectures, such as multi-body, hierarchical, and decentralised systems, as well as predefined agent roles. The **scenario deck** provides detailed contexts for real-world human–robot interaction scenarios, including domestic, industrial, and healthcare settings. The **challenge deck** introduces design challenges for multi-agentic systems derived from [17].

During the focus group, participants will be divided into small groups. In *Phase 1*, each group will draw a card from the scenario deck and use cards from the robot and agent decks as inspiration to design a multi-agentic robots for that scenario. In *Phase 2*, pairs of groups will exchange their design ideas. Each group will then use cards from the challenge deck to articulate end-user challenges and "attack" the other group's design. In *Phase 3*, the pairs of groups will exchange their challenges and iterate on their designs to "defend" them by developing solutions. After the focus group, participants will engage in a collective reflection session to discuss the activity, refining the design solutions developed under different scenarios into general design principles for multi-agentic systems in HRI.

2.2 Structure

13:30 - 13:50 Welcome, introduction, and ice-breaking
13:50 - 14:20 Paper madness
14:20 - 14:35 Focus group activity introduction
14:35 - 15:00 Focus group phase one
15:00 - 15:30 Coffee break
15:30 - 15:55 Focus group phase two
15:55 - 16:35 Focus group phase three
16:35 - 16:50 Discussion and reflection
16:50 - 17:00 Conclusion remarks

3 Solicitation Plan, Logistics, and Resources

We aim to bring together a diverse community of individuals with an interest in multi-agentic systems within the field of human–robot interaction. Participation is welcomed from researchers, industry professionals, and stakeholders spanning disciplines such as HRI, design, robotics, psychology, AI, and related interdisciplinary domains that explore both the design and technical aspects of HRI. As the main format of this workshop will be focus groups, the maximum number of participants will be approximately 50, with up to 10 accepted position papers for presentation. Authors of accepted papers will be invited to give a three-minute presentation with an emphasis on fostering collaborative discussion during the 'paper madness' session.

The call for participation will be disseminated through academic mailing lists and social media platforms, including but not limited to HRI-Announcement, CHI-Announcements, Robotics Worldwide, LinkedIn, and X. To broaden engagement, we will also share the call via lists that extend beyond the immediate HRI community, such as HMC (for scholars in human–machine communication), and the Women in Machine Learning network.

The workshop requires a meeting room for 50 participants and equipped with audio-visual facilities such as a projector, microphone, and speakers. The organising committee will be responsible for preparing the card deck and stationery for the focus group sessions.

4 Documentation

A dedicated workshop website [1] will be developed to provide detailed information, including the program format, schedule, and organising committee. Participants will be encouraged to submit a four-page position paper with additional space permitted for references on topics of interest. All papers will undergo peer review based on originality, relevance, and clarity. Submissions offering bold and critical insights are especially encouraged.

The titles and abstracts of accepted papers will be displayed on the workshop website prior to the conference. The workshop's event logs and photos will be documented and made available on the website.

5 Organising Committee

Yan Zhang. (https://yzhang2332.github.io) is a 3rd year PhD student at the University of Melbourne. Her current research focuses on the natural communication in human-robot physical collaboration and how multi-agentic systems enhance interaction [17, 24, 26]. She is part of the organising committee for HRI'26 and has co-organised HRI workshops.

[1] https://sites.google.com/view/magics-hri/home

Sarah Schömbs. (https://sites.google.com/view/sarahschombs) is a final year PhD student at the University of Melbourne researching human-centred risk communication in Human-Agent Interaction. She examines how users perceive risks communicated through agents [14, 18], including system uncertainties [16], with a focus on AI risks and agentic systems [17]. She was part of the organising committee for HRI'25 and has co-organised HRI workshops.

Jan Leusmann. (https://leusmann.io) is a 3rd year PhD student at LMU Munich. His research is situated in the domain of HRI and focuses on fostering understandable and intuitive communication between robots and humans, e.g., [5–7]. Recently, he focused on creating and understanding curious robot behaviour.

Xiang Pan. (https://pan-xiang.github.io) is a post-doctoral researcher at Kyoto University. His research focuses on human-robot interaction and embodied AI, with an emphasis on designing expressive manipulation to improve the transparency and naturalness of robot actions in human-shared environments [12, 13].

Sara Mongile. (https://iit.it/it/people/sara-mongile) is a postdoctoral researcher at the Italian Institute of Technology. In her research, she investigates how to develop cognitive architectures for social robots to promote better human-robot interactions and foster robots' autonomous and adaptive behaviour [10].

Wafa Johal. (https://wafa.johal.org) is an associate professor at the University of Melbourne. Her research combines concepts and methods from AI and HCI to create acceptable and useful robots to learn, teach and collaborate using multimodal interaction. She was the General Chair of HRI'25 and has co-organised various conferences and workshops.

Mohammad Obaid. (https://mohammadobaid.se) is an Associate Professor of HCI in the Department of Computer Science and Engineering at Chalmers University of Technology, Sweden. He has co-authored more than 100 papers on HCI and HRI across a range of topics. He has served on organizing and program committees for leading HCI and HRI conferences like CHI, HRI, HAI, and NordiCHI.

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