

Editorial introduction to the Special Issue: Interactions between humans and social robots put to the test

Keywords

Social robots
Human-robot interaction (HRI)
Human-robot relations
Human-human relations
Emotion-related reactions

1. The rise of social robots as the precondition of the relationship between humans and robots – introduction into the Special Issue

Robots contribute to a substantial extent to the annual growth of labor productivity in industrial countries. They are an important part of industrial manufacturing processes (Pedersen et al., 2016) and increasingly relevant in other business areas and services, driven by recent advances in Artificial Intelligence (AI), which opens up new potentials for the use of these robots outside the industrial environment (Campa, 2016; Royakkers and van Est, 2016). So-called “socially interactive robots” or simply “social robots” (Billard and Dautenhahn, 1997) are a specific type of sensor-based robots with an often human- or animal-like appearance that appear to have social characteristics. Although this term is regularly used, no consensual definition has been agreed on yet (Richert et al., 2017; Henschel et al., 2021). Nevertheless, some commonalities among the definitions can be identified:

- Social robots are designed to interact and communicate on an emotional level (Darling, 2016),
- social robots orient themselves to social and behavioral norms expected by humans (Bartneck and Forlizzi, 2004; Richert, 2018),
- social robots are able to communicate or to interact with their counterpart with the objective to promote emotional and affective reactions (Schulze et al., 2021, p. 18).

Overall, social robots are on the rise and are conquering many areas of human life and application areas far beyond production. The idea of using them in private and service sectors is increasingly coming to the fore, as, for example, in therapeutic settings (Rabbitt et al., 2015), in the care of elderly people (Goeldner et al., 2015; Campa, 2016; Khaksar et al., 2016) or in educational institutions. Even in the field of sex robots, human emotional affectivity is expected to become a building block of

future visions of human-robot relationships (Szczuka and Krämer, 2017). Accordingly, we can currently observe a shift in objectives of technical development processes away from merely physical towards social and emotional functions in human-robot interaction (HRI).

In the scientific and political debate, social robots are more and more recognized as an important technological innovation and increasingly as a political means to address the lack of personnel in different working areas like the service sector. However, in the scientific community, there is also an intensive debate about the nature of social and emotional facets of robots, questioning the comparability of real social interaction among humans and the interaction between humans and robots. Essentially, the appearance and functions of social robots often trigger anthropomorphisation processes (Waytz et al., 2010; Phillips et al., 2011) and enforce people's tendency to develop social bonds with robots (Groom et al., 2009). Thereby, they pose philosophical as well as anthropological questions about the *conditio humana* anew (Ferrari and Eyssel, 2016). In art, preferably in movies, this motif is depicted vividly and provocatively in many examples and raises questions about the human nature (Nida-Rümelin and Weidenfeld, 2020). However, the vague definition of social robots and human's tendency to anthropomorphize even functional robots (Kopp et al., 2022; Kopp, 2022, p. 144) prevent a consensus in the scientific discourse on the question when certain robots should be qualified as *social* robots. This controversy is also reflected in the difficult categorization of robots leading to blurred boundaries between functional and social robots (Brandstetter, 2017, 18). In sum, the most striking difference between traditional industrial robots and social robots seem to result from the latter being designed to evoke human emotions and mimic social behavior (Darling, 2016). In this sense, social characteristics of robots are expected to serve as catalysts for emotional reactions and interactions between humans and machines. We are at the beginning of the development most social robots are rather prototypes in the test phase. Therefore, it is due time to intensify the scientific debate.

The objective of this Special Issue is to examine the broad spectrum of interactions with robots as counterparts, service providers, colleagues, partners, companions, or the like. The authors from different scientific backgrounds discuss interaction styles, involved emotions, and/or changing behavior in HRI as well as critical aspects these interactions may raise in this evolving field of robotics. They address the question which kind of emotion-related reactions humans show during interactions with social robots and what this implies for the human-robot relations. This also provides an opportunity to question whether elicited emotions alter our interactions with social robots in ways that lead us to reconsider our perceptions of such robots. Based on this, the Special Issue also aims to shed light on the impact of interactions with social robots on relations between humans.

2. The different contributions within the SI

In the following sections, we will summarize how and in what sense the seven contributions in this Special Issue as listed in [Table 1](#) serve to shed light on the core research questions depicted above. Thereby, we will highlight the different interaction contexts and human-robot relationships addressed in the studies. The different authors outline the social and ethical implications for a future world, in which social robots may have emerged as daily interaction partners in the most diverse areas of life and application scenarios far beyond industrial production. The potential applications of robots covered by the contributions are in the service industry in tourism (C1) and travel (C2), in an entertainment context (C3), in (physical) work environments in manufacturing (C4) and in elderly care (C5), and in internal support processes of companies such as marketing (C6) and human resources (C7). Most contributions analyze physical human-robot interactions including communication between a physically present robot and a human interaction partner (C1–C5), whereas in one case the robot represents a tele-operated proxy for a human-being whose physical appearance should be intentionally obscured (C7). Only one article discusses merely virtual interactions in the social media context (C6). Certain human-robot relations go hand in hand with the application scenarios. In the service industry (C1–C2), the relations are hierarchical in a sense that the robot serves as a service

provider and the human counterpart as the service recipient, reflecting one vividly depicted style of human-robot relation ([Mabry, 2016](#)). Thereby, emotional analysis is centered on the emotional interaction experience, which might trigger pleasant feelings like joy and excitement on the one hand, but on the other hand also evoke unpleasant feelings like sadness, which is a common reaction for example when humans are generally preferred over machines as interaction partners or when the interaction partner is perceived as eerie as known from the uncanny valley theory ([Mori, 1970](#)). Creating joyful and meaningful experiences is also a typical goal of entertainment applications (C3). However, as our contribution illustrates by analyzing the interaction with a quizmaster robot, personalized robot behaviors can increase motivation, but can also lead to a higher susceptibility to manipulation of humans, with potentially negative emotional consequences for the users of personalized robots. The line between pleasant and unpleasant feelings becomes even more thin in the context of robots at the workplace (C4–C5), which can either be perceived as supportive colleagues or as threatening competitors for a certain job that even raise hateful feelings. In the marketing context (C6), robots can act as social media influencers and hence, be considered as idols. The possibly resulting strong emotional attachment can make followers prone to manipulation, which is why this application scenario raises ethical concerns. The final contribution (C7) again provides a shift in perspective by demonstrating a scenario, in which robot use does not raise ethical concerns, but instead is intended to minimize discrimination in job interviews. Whereas the robot use increased job seekers' feeling of being treated fairly, HR professionals felt less valued in the personal selection process, thereby raising the broader question whether emotions are beneficial or deficient in such processes. Overall, the contributions in this Special Issue address a wide range of interaction types, interaction contexts, human-robot relations, and emotion-related reactions, as summarized in [Table 2](#). By speaking of emotion-related reactions, we take into account that some articles describe reactions that do not refer to emotions in a narrow psychological understanding, but include related affective and cognitive mental states that represent, for example, components or triggers of emotions.

The first two contributions deal with physical interaction with social robots in the service industry. The article “The interplaying factors of the robotic tourism experience: The customer journey's touchpoints, context and qualities” (C1) by Aikaterini Manthiou and Phil Klaus aims to scrutinize the implementation of robots in the tourism sector. Hereby, new models of HRI are developed along the following issues: touchpoint, context, and quality of touristic presentations. The article develops different propositions in order to analyze the impact of these issues on human emotions and ergo on the social acceptance of HRI. The authors examine the different customers' feelings when using these robotic systems, concluding that these systems may range from an exciting and supportive to an unpleasant experience for the tourists. Although, the quality of HRI still seems to be open, the authors see huge economic potential from a management perspective to advance the future tourism business and its economic impact on society. In a similar application context, the contribution “The role of emotions in the consumer meaning-making of interactions with social robots” (C2) by Matteo Borghi and Marcello Mariani addresses the questions of which emotions can be observed in humans towards social robots after HRI and how these are related to the meaning-making of human interaction partners towards social robots. Thus, the authors take up the idea that the diffusion process of social robots is inherently social (see also [Rogers, 2003](#)) and that emotions of new technology users are particularly important in this process. Using text analytic techniques, the authors perform a sentiment analysis and extract emotional communication content of hotel visitors (consumers) related to robots in online communication on online review platforms of hotels. Based on emotional polarity (positive versus negative), they find that overall, there is a rather positive than negative opinion towards the use of robots in hotels on the part of consumers. The authors also find that perceived

Table 1
List of contributions in this Special Issue.

Contribution	Title	Authors
C1	The interplaying factors of the robotic tourism experience: The customer journey's touchpoints, context and qualities	Aikaterini Manthiou and Phil Klaus
C2	The role of emotions in the consumer meaning-making of interactions with social robots	Matteo Borghi and Marcello Mariani
C3	Entertainment vs. Manipulation: Personalized Human-Robot Interaction between User Experience and Ethical Design	Kathrin Pollmann, Wulf Loh, Nora Fronemann and Daniel Ziegler
C4	Robo-rage Against the Machine: Emotional and Motivational Dimensions of Attacks, Sabotage, and Bullying of Robots	Jo Ann Oravec
C5	How do care service managers and care workers understand the care robot adoption in elderly care facilities	Eunkyung Na, Yoonhyuk Jung and Seongcheol Kim
C6	Source Credibility & Emotions generated by Robot and Human Influencers: the luxury brand representatives' perception	Patricia Baudier, Elodie de Boissieu and Marie Helene Duchemin
C7	Employers' and applicants' fairness perceptions in job interviews: Using a teleoperated robot as a fair proxy	Sladjana Nørskov, Malene F. Damholdt, John P. Ulhøi, Morten B. Jensen, Mia Krogager Mathiasen, Charles M. Ess and Johanna Seibt

Table 2

Classification of contributions in this Special Issue according to interaction type, interaction context, human-robot relations, and emotion-related reactions.

Interaction type	Interaction context	Human-robot relation	Emotion-related reactions	Contributions
Physical interaction	Service	Robot as service provider	Joy, excitement, feeling supported vs. anger, fear, disgust, sadness, unpleasant experience	C1
	Entertainment	Robot as entertainer (e.g. quizmaster)	Joy, feeling supported vs. feeling demotivated, betrayed	C2
	Physical work	Robot as colleague or opponent	Joy, relief, feeling supported vs. fear, anxiety, inferiority, hate	C3
Virtual interaction	Marketing	Robot as influencer/idol	Admiration, adoration, emotional attachment vs. fear of being manipulated	C4
Proxy interaction	Human resources	Robot as teleoperated proxy for human	Satisfaction, feeling of being treated fairly vs. fear of degradation, lack of appreciation,	C5
				C6
				C7

Note. The displayed interaction types refer to the intended real-life interaction. Emotion-related reactions not only include specific emotions but also complex human reactions to robots that are closely related to emotions and can elicit them.

joy exhibited the greatest magnitude in predicting consumers' opinion towards social robots. Therefore, the authors assume that online reviews about social robots should exhibit a positive effect on future individual meaning-making about robots. They suggest that human emotions indeed play an important role in the interaction with social robots, especially with regard to the way humans evaluate robots.

The third contribution refers to a physical interaction with a social robot in an entertainment context. More specifically, in their article “Entertainment vs. manipulation: Personalized human-robot interaction between user experience and ethical design” (C3), Kathrin Pollmann, Wulf Loh, Nora Fronemann, and Daniel Ziegler address the question of how to implement socially meaningful and intuitive interactions using personalized behavior of a robot in HRI, while at the same time guaranteeing user's autonomy. The authors examine a use case, in which persons play a quiz game with a robot whose reaction can be seen in a video. Thereby, the robot takes on the role of a quiz master, which either reacts neutrally to the given answers or emotionally by cheering correct answers (via communication and gestures) or throwing his hands up in horror at incorrect ones. The authors conclude that users are likely to prefer emotional personalized feedback from a robot as a design factor that increases positive user experience in such HRI scenarios. Based on this finding, they develop design recommendations for this use case, which include a gradual application of a robot's personalized, emotional behavior by including not only extreme but also moderate levels of emotional intensity in the robot's emotional expressions. In order to achieve an optimal balance between a positive user experience and the adherence to ethical norms by avoiding manipulation, the authors suggest that personalized robots should be designed as self-learning systems that adjust the emotional expression dynamically based on user's responses.

The following two contributions raise questions about the physical interaction with social robots dedicated for physical work in the contexts of industrial production and elderly care. The paper “Robo-rage against the machine: Emotional and motivational dimensions of attacks, sabotage, and bullying of robots” (C4) by Jo Ann Oravec analyzes the emotional relation between humans and robots from a surprising perspective. Comparing actual dynamics of workers' attacks against machines with earlier attacks by the so-called “machine wreckers” and Luddites in the 19th and 20th century, the author analyzes the framing of actual emerging varieties of robot sabotage and manipulation in terms of strong human emotions. Hereby, Oravec describes the emotional relationship as a “dysfunctional contact” with robots, which are representing technological entities of modern workplaces. The “attacks” may reach many forms like simple destruction of robots by workers, verbal attacks towards robots or – maybe more present in public debates – different forms of hacking security breaches in different sectors. As the study shows, the emotional origins and intention of these “attacks” are also manifold and may reflect personal prejudice as linkages to larger concerns and assumptions to automation and economic struggle of the workers. Nevertheless, according to Oravec, the identification of hate as

the starting point of these attacks should be reflected and segregated from “normal” accidents on workplace level. Furthermore, it seems worthy to address the function of robots in the development of publicly created images and narratives. In a different, but also physical interaction context, ageing societies, staff shortage and economic restrictions are the reasons, why the introduction of robots in (elderly) care settings have been discussed intensively in public and scientific debates, especially in high industrialized societies. The contribution “How do care service managers and care workers understand the care robot adoption in elderly care facilities” (C5) by Eunhyung Na, Yoonhyuk Jung and Seongcheol Kim deals with robots in institutionalized care settings. From the perspective of the adoption of robots in care facilities, the study analyzes the question, why two professional groups, care service managers and care workers, have different perceptions towards these robots. Based on the conceptional approach of social representation theory and an empirical research process, the study analyzes the values, beliefs, knowledge, and practices of both professional groups. Furthermore, the study highlights the differences in both groups' mental representation of the care robot. The different perception of function, roles and responsibilities as well as the varying attitudes towards the technology ranging from refusal to approval resulted in different assessments of active and emotional support of elderly care. However, the role of robots as emotional supporters has been strengthened much more by the caregiver than by the managers.

Social robots can also be used to create virtual HRI for marketing purposes as Patricia Baudier, Elodie de Boissieu, and Marie Helene Duchemin demonstrate in their article “Source credibility and emotions generated by robot and human influencers: the luxury brand representatives' perception” (C6). They focus on the application of social robots in social media. Luxury brands cooperate with influencers to promote their products to their potential customers on popular social media platforms. Meanwhile, they do not merely rely on humans, but also on social robots as influencers in a sense that these virtual agents appear as embodied entities and mimic the behavior of human social media influencers. This human-robot interaction context can be created and controlled in the virtual world by an AI. This distinguishes the interaction context from the ones in the rest of this Special Issue. Interestingly, luxury brand representatives highlighted many advantages of robot influencers over human influencers, such as their ability to produce a huge amount of innovative content, which is not just copied from other human influencers, and to respond quickly to their followers. Since human influencers could also fake their appearance on their profiles, brand representatives do not consider the lack of humanness as a disadvantage. Their mere concerns regarding robot influencers are their high development costs and the risk that robot influencers do not disclose that they are not human. This underpins their instrumental view on the use of robot influencers. However, the authors also mention societal and ethical challenges which come along with a social media world dominated by virtual agents merely for marketing purposes.

The final contribution addresses the physical interaction with a

social robot as a neutral proxy for a human interaction partner in the human resources (HR) context. More precisely, in their article “Employers’ and applicants’ fairness perceptions in job interviews: Using a teleoperated robot as a fair proxy” (C7, Sladjana Nørskov, Malene F. Damholdt, John P. Uhløi, Morten B. Jensen, Mia Krogager Mathiasen, Charles M. Ess, and Johanna Seibt analyze the impact of a teleoperated robot on the employers’ and applicants’ fairness perceptions in a job interview. The robot does neither act autonomously nor simulate own emotions but serves as a proxy in the communication between a job applicant and a HR representative responsible for personnel selection. In an asymmetrical setting, the HR representative is unable to see the applicant, but interacts with the robot, which is teleoperated by the applicant. The latter sees the HR professional on a computer screen. Drawing on research about fair proxy communication, this setting aims at reducing the impact of implicit biases in personnel selection processes by hiding the appearance of the applicant to the HR professional. Whereas introducing robots as interaction partners often challenges ethical principles, in this case, the robot’s function is to contribute to fairer job interviews and to increase compliance with ethical standards. However, its impact remains controversial from an ethical viewpoint since the empirical study reveals different conceptions of fairness between HR professionals and job seekers. HR professionals conceived the robot-mediated interview as a problematic act of dehumanizing the personnel selection process, because they expect the quality of personnel selection to benefit from emotional influences and human intuition. The applicants preferred the robot-mediated interview as the fairer alternative to face-to-face interviews. Overall, the article contributes to a shift in perspectives on human-robot interactions in various ways. First, the social robot is not introduced as an autonomous entity exhibiting simulated emotions, but as a proxy for a certain person to influence the human-human interaction. Second, unlike many other contexts, the goal of the robot introduction is not to create emotional reactions but to eliminate inappropriate emotional judgements. Third, it is not the robot raising ethical issues. Ethical considerations are predominant already within the human-human interaction. The robot is introduced to address these ethical issues and to improve the human-human interaction from an ethical viewpoint.

3. Conclusions and further research

The various interdisciplinary contributions reveal the variety and heterogeneity of possible interaction between humans and social robots. Here, social robots might appear in the service sector, in tourism industry, for marketing purposes as social media influencers, as interactive quizmasters, or as helpful tools in the HR staff selection process. We have already referred to the blurring boundaries between different types of robots which complicates an unambiguous classification. The articles in the Special Issue add further levels of complexity by highlighting the heterogeneity of human-robot relationships and emotional reactions of humans in different application domains and interaction contexts. Consequently, in terms of human-robot interactions with social robots, the collective singulars “human” and “robot” obscure the diversity of humans and social robots and fall short in accentuating its relevance for evaluating the interaction. This makes it difficult to generally address and answer the overarching questions on the overall impact of emerging social robots on society and the adequateness of the attributed concepts of sociality and emotionality. However, it is noteworthy that all interactions demonstrate a considerable social and emotional impact either in the HRI or between humans. This impact cannot be generalised but provides surprising insights into new forms of socio-technical settings as well as to new cultural shifts. Without doubt these examples reach beyond the intensively discussed application areas in manufacturing or elderly care and the typical focus of such debates on acceptance issues.

Accordingly, the human-robot relations fundamentally differ in these use cases, which is why the effects of a robot’s simulated social behavior

should always be interpreted with regard to the respective interaction context. This again emphasizes the question of whether all robots deployed in settings, in which they take on the role of a social agent, can, or even should, be subsumed into a single category of robots, particularly since it is not yet possible to provide a final conclusion on whether the interactions with social robots indeed deserve to be called *social* in any sense. The differences between human social behavior and the mimicking of social behavior by machines remain large – at least in the examples discussed here. Consequently, it is questionable whether social robots’ newly developed functions deserve to be qualified as “social” and “emotional” from the viewpoint of social and human sciences. This issue should be taken seriously, since robots regularly provide a projection screen for human feelings and desires, enforced by the often mindless use of well-known terms preserved for human-human interaction to technological entities in technical debates.

However, the empirical work reveals that social robots are able to evoke intense, manifold, positive as well as negative emotions ranging from hate to joy, from feelings of being mistreated to enhanced feelings of justice. In absence of a consensual holistic theoretical framework to examine such heterogeneous interactions, the articles draw on different psychological theories on emotions and demonstrate the significance of the human-robot relation in terms of the perceived emotions, as most prominently reflected in the article about different attitudes towards robots by care service managers and care workers. Based on this, the articles in this Special Issue primarily highlight two things: First, so-called social robots seem to be able to evoke emotions in humans. This seems to support the idea that a robot’s ability to exhibit social characteristics, and thus to evoke a wide range of complex emotions in their human counterparts, could be used to distinguish it from purely functional robots. The involved emotions go beyond those which are traditionally analyzed in human-robot interaction literature in the context of short-term interactions. Second, the articles in this Special Issue illustrate that the observed complex emotion-related reactions deserve to be analyzed in a broader frame, since they can be expected to shape humans’ behavior during long-term relations. Even if robots with social capabilities arguably cannot be considered as social agents in the same sense as humans, given that they do not actually experience emotions but simulate them, their social characteristics still affect the subjective experience of humans. This can be seen as an important impulse for the development of future generations of robots, as it will make the reciprocal influence of robots and humans in long-term interactions far more complex than in interactions with robots that do not exhibit such characteristics. And maybe, it leads humans to learn more about themselves and their behavior and agency. In particular, long-term interactions with social robots raise the question about their effects on the interaction in interpersonal relationships.

In face of modern social robots, it seems that HRI becomes more diverse and includes more complex levels of social interaction that can influence human-human interactions. For example, human relationships can be considered as comparatively stressful compared to the interaction with a social robot dedicated to fulfilling someone’s needs (Turkle, 2011). Since present research predominantly studies one-on-one interactions between humans and social robots in artificial lab settings with a narrow focus on single, dedicated aspects, the technological advancement calls for a holistic and more in-depth examination of the underlying concepts of social interaction and emotionality as well as a context-sensitive assessment of social and ethical implications in a wider scope. In this sense, this Special Issue is by no means the conclusion of a field of research, but rather a motivation and starting point for delving into previously neglected aspects of HRI research that are and will be of significant relevance for public, political, and scientific debates about our future societies.

Data availability

No data was used for the research described in the article.

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