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EDITORIAL

Introduction: special issue—critical robotics research

Sofia Serholt[1] · Sara Ljungblad[2] · Niamh Ní Bhroin[3]

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1 Introduction

In recent years, the design, use and study of robots in a variety of social settings has increased, ranging from therapy and care for older adults and children, to education and domestic life. The typical discourse around these devices, in both the robotics and Human–robot interaction (HRI) fields, as well as in political debates and commercial developments, is that the robotic permeation of society is somehow inevitable. Robots are predominantly viewed as engineering problems, but are usually designed to solve societal challenges (Šabanović 2010). A resulting concern is that alternative design perspectives and more critical perspectives of the consequences of using robots in social settings remain under-researched in HRI (Lupetti et al. 2021).

Robotic technologies raise fundamental existential questions about what it means to be human. As Turkle (2011) points out, technologies that promise remedies to human vulnerabilities are very enticing. However, new technologies also affect their environments, bringing with them both intended and unintended consequences (Stahl et al. 2013). These consequences are often complex and cannot be fully understood using a single perspective or approach. At the same time, the types of questions that researchers address are heavily affected by the research tradition and community that they act within. Current HRI research, for example, does not build on humanist or social scientific research traditions, or on design traditions from the arts to any great extent (Lupetti et al. 2021). In response to this, voices have been raised advocating for more human-centered and holistic approaches to question established assumptions of design in HRI research (Ljungblad et al. 2016; Lupetti et al. 2021; Šabanović 2010). In particular, the need to critically address underlying technology-driven values in our research practices have been emphasized (Fernaeus et al. 2009; MacKenzie and Wajcman 1999). Without a community that is open for alternative design approaches and critical perspectives, experiments actually conducted may go unreported, simply because there were no significant results in favor of the robot intervention (cf. Richardson 2018).

When technologies are designed to address social challenges (such as in the context of care or education), it is important to interrogate how the challenges in question are conceptualized. This is because the development and diffusion of new technologies are grounded in contextual understandings and ideas about what their function and role might be. Critical analyses of technological innovations have been fruitful in other disciplines. For instance, Mansell (2012) interrogated the diffusion of the Internet, its expected role in the promotion of democracy, equality and the good life. Mansell's analysis highlights the need to address conflicting ideas about technologies, and how they are grounded in broader power relations and ideas about well-being. Critical approaches are, therefore, necessary to investigate technological innovations and to identify the sometimes paradoxical understandings that underpin their design and development (cf. Selwyn 2019).

In this Special Issue, we seek to bring *Critical Robotics Research* to the fore by giving space to research that investigates the introduction and use of robots in social contexts. This research identifies challenges and dilemmas that arise when using robots both in communication with, and in the immediate surroundings of, humans. It also introduces new approaches to understanding innovations in robotics and their potential social consequences. Philosophical discussions of potential futures, along with more contemporary

✉ Sofia Serholt
sofia.serholt@ait.gu.se

Sara Ljungblad
sara.ljungblad@chalmers.se

Niamh Ní Bhroin
n.n.bhroin@media.uio.no

[1] Department of Applied Information Technology, University of Gothenburg, Gothenburg, Sweden

[2] Department of Computer Science and Engineering, University of Gothenburg, Chalmers University of Technology, Gothenburg, Sweden

[3] Department of Media and Communication, University of Oslo, Oslo, Norway

issues in HRI are presented. These contributions interrogate some of the fundamental ideas of HRI from a critical perspective.

2 History of critical robotics

In 2018, we introduced the concept *Critical Robotics* in an attempt to foster what we observed as an emerging paradigm in HRI and related research. Through international and interdisciplinary collaboration, we organized the workshop *Critical Robotics—Exploring a New Paradigm* at the Nordic forum for human–computer interaction (NordiCHI) (Ljungblad et al. 2018). This brought together scholars interested in exploring critical human-centered perspectives in robotics research. We also discussed whether critical questions within the area of HRI could be considered an emerging paradigm, namely *Critical Robotics*. The workshop was initiated by *Applied Robotics*,[1] a group of researchers affiliated with the University of Gothenburg in Sweden. This group was formed due to shared concerns about robotics-centered research and, in particular, a perceived need to look beyond the social robot as a taken-for-granted solution to a range of societal challenges.

Our view of critical robotics was inspired by paradigm shifts that have occurred in the field of Human–computer interaction (HCI) in recent years, where research moved away from the optimization of man–machine interaction, towards theories about the computer and the human mind, to finally focus on interaction as phenomenologically situated. In this, approaches to participation, values, philosophy and ethics began to play a more prominent role (Bødker 2006; Harrison et al. 2007; Koskinen et al. 2012).

In parallel with these disciplines, the robotics field is currently experiencing a similar shift as demonstrated for example by the Robophilosophy Conference Series[2] that began in 2014, the establishment of the Foundation for Responsible Robotics,[3] as well as notable research projects exploring issues of ethics, sustainability, and responsibility in social robotics, including, "Responsible Ethical Learning With Robotics"[4] and "Integrative Social Robotics—A New Framework for Culturally Sustainable Technology Solutions".[5] Emerging research related to Critical Robotics has also begun to take form (cf. a recent workshop on critical design in HRI held at the International Conference on Human–Robot Interaction (Lee et al. 2019), and a proposition to consider more exploratory design approaches familiar to HCI in HRI (Luria et al. 2019)).

Our own work has also developed in these directions and includes interrogations of ethical issues surrounding educational robots (Serholt et al. 2017; Toft Norgaard et al. 2018), scrutinizing problematic aspects of interactions between humans and robots (Serholt 2018; Serholt et al. 2020), focusing on understanding challenging experiences and practices of existing robot technology in society, such as professional use of drones (Ljungblad et al. 2021), and use of robotic toys in families (Fernaeus et al. 2010). We have previously also done studies with artists to understand how artistic projects may question myths about robots (Jacobsson et al. 2013), and early work to address the need to ground ethical considerations in empirical studies and real practices rather than fictive use situations (Ljungblad et al. 2011; Nylander et al. 2012). Yet, the shaping and defining of the concept of Critical Robotics is an ongoing process that requires collective effort from the research community. This Special Issue provides a conceptual interdisciplinary backdrop to further critical approaches in HRI and robotics research.

3 Key contributions

This Special Issue consists of 12 articles by authors from a range of disciplines, each with a unique perspective to offer the Critical Robotics discussion. Some focus explicitly on the design of robots, while in others, implications for design can be understood as a by-product. Several focus on robots in care settings (Burema; Maibaum, Bischof, Hergesell, and Lipp; van Wynsberghe), one focuses explicitly on children (Pashevich), and another focuses on professional service work (Dobrosovestnova, Hannibal, and Reinboth). Two contributions encompass several application settings (Fronemann, Pollman, and Loh; Weiss and Spiel), whereas another two utilize art installations to situate their research (Gemeinboeck and Saunders; Yolgormez and Thibodeau). Finally, three of the contributions consider robots in society (Balle; Hildebrand; Nørskov), although they also touch upon different contexts in their discussions. In the following, we synthesize and reflect upon these contributions, according to converging themes.

3.1 Robotification of society

The narrative of a robot society has permeated and enticed our cultural imagination for a long time. It has been likened to the Industrial Revolution, argued to be the natural next step in human evolution. Ideas of 'the singularity', perpetuated through works of science fiction (such as the

[1] https://www.gu.se/en/research/applied-robotics-in-gothenburg.

[2] https://conferences.au.dk/robo-philosophy/.

[3] https://responsiblerobotics.org/.

[4] https://reeler.eu/.

[5] https://www.carlsbergfondet.dk/da/Forskningsaktiviteter/Forskningsprojekter/Semper-Ardens-forskningsprojekter/Johanna-Seibt_Integrative-Social-Robotics.

Terminator or *I, Robot*), suggest that robots and artificial intelligence (AI) will someday evolve to a stage where they will reproduce themselves. In the worst case scenario, robots will then no longer need humans. While this scenario is often contested and regarded as highly unrealistic, the idea that robots (or autonomous machines) and AI will pervade many, if not all aspects of everyday life is closer at hand. It, therefore, requires consideration and interrogation.

In this Special Issue, Nørskov (2021) develops a philosophically informed, speculative outlook of what the *robotification* of society could mean, including its ethical implications. He defines robotification as 'massive robotic integration', where robots permeate practically all areas of life. By drawing on Heidegger, Nishitani, Bauman and others, Nørskov makes the case that robotification could lead to *ethical cleansing,* "a sanitation of culture by the calculus of science and technology". Specifically, he argues that robotics research has ushered in a technological mode of being, where everything can be measured objectively. Nørskov posits that technology can never simply be added to an existing environment. It will always change its environment. Building on a media ecology perspective, Hildebrand (2021) also argues that advancements in robotics are not simply additions to what already exists, but fundamentally change us and our understanding of the world, amputating and extending us as human beings.

Both Nørskov and Hildebrand argue that an environment permeated by robots ('robotification') will shape our line of thought, promoting certain ways of being while discouraging others. This means that robots (social or otherwise) will influence relationships between humans, and may reduce human values to the level of services. Nørskov argues that the collective moral standards represented in robots will influence human conduct, and eventually vice versa.

By conceptualizing the robotification of society as an ecological enterprise, Hildebrand and Nørskov both make compelling cases for its disruptive potential. The ethical imperative is to look beyond fragmented understandings of innovations in society, e.g., where a robot in one context is understood as distinct from other elements of culture, and to develop more holistic perspectives.

3.2 Oversimplification of care and service work

The care and service sectors have been heavily targeted with envisioned applications for social robots. Readers will be familiar with the use of zoomorphic robots, such as the robot seal 'Paro',[6] which has for example been introduced to the therapy and care of dementia patients. State-of-the-art projects have developed robot companions for older adults living at home. With technical advancement the field keeps developing. The idea of robots providing services that we would otherwise expect from humans forces us to think about the aspects of these services that may, and may not, be replaceable. Several of the contributions to this Special Issue consider what constitutes care, and how research characterizes care and people in need of care (Burema; Maibaum et al.; van Wynsberghe). One additional contribution analyzes complex interactions between service providers and receivers in the professional service sector (Dobrosovestnova et al.).

These authors all identify an oversimplification of the role of humans in care and service work, or a reduction in the complexity of the tasks that they carry out. In her paper, Burema (2021) sheds light on *representations of older adults* in HRI, and how *ageism* may occur when older adults are depicted as dependent, fragile and vulnerable people. This renders them as "potentially burdensome care recipients", and robot technologies are presented as an optimal solution to this social problem. In a similar vein, Maibaum et al. (2021) problematize the understanding of caregivers and care-receivers: how *care practices are deconstructed* into tasks to give form to well-defined technical problems. This leads to the incremental mechanization of care, rather than to a more holistic understanding of it. As van Wynsberghe (2021) emphasizes, the practice of care constitutes instead a bi-directional relationship between caregiver and care-receiver, where reciprocity is of central importance. If a relationship based on mutual care would manifest between a care-receiver and a caregiving robot, van Wynsberghe argues that this would require a certain level of deception. This is because robots lack the ability to engage in true reciprocity. From a different vantage point, Dobrosovestnova et al. (2021) provide a sociological account of the dimensions of affective and emotional labor in professional service work. They discuss how the implementation of social robots in such contexts risks reducing the complexities of affective labor and exacerbating stereotypes of professional service workers.

While it is yet debatable whether social robots are able to carry out even simpler care and service tasks in any meaningful way, this also depends on how care is conceptualized. The authors writing in this Special Issue suggest that oversimplification, rooted in misconceptions about the provision of care, the process of ageing, affective labor in professional service work, etc., can influence the design and implementation of social robots. Fragmented and inaccurate understanding of work practices and human needs currently prevail. However, it should also be possible to address these questions in the design of robots.

[6] http://www.parorobots.com/.

3.3 The (not so) straightforward path to robot design

In contemporary HRI-projects, typically ranging between 3 and 5 years, design processes constitute a substantial part of project time. Engaging in stakeholder practices and expertise is essential for a successful design outcome. However, depending on how user-centered design (UCD) or participatory design (PD) approaches are employed, such approaches can also lead to an oversimplification of practices, as well as to stereotyped views and problematic representations of the target group. This can result in suboptimal design. Without engaging in all the design steps, i.e., empathize, define, ideate, prototype, and test (as suggested by the Hasso Plattner Institute of Design[7]) there is a high risk that the overall 'problem' and the related opportunities for robotic solutions are misunderstood.

Several of the contributions to this Special Issue highlight and problematize how UCD processes are currently conducted in HRI research. Even rigorous attempts to involve stakeholders and target groups in design risk falling short of the ideals of UCD. For instance, Weiss and Spiel (2021) provide a much-needed exposé of what goes on behind the scenes of HRI-projects, and direct criticism (and self-reflection) towards the situations they have observed. Even in cases, where stakeholders are involved in phases of conceptualization, design, and later evaluations, it is not always clear to what extent stakeholders actually come to influence design outcomes.

If stakeholders are not involved in design before a robotic solution exists, there is no space for them to reframe the problem or change the design idea. The analysis submitted by Dobrosovestnova et al. (2021) resonates with this. Open and critical reporting on existing practices, followed by ideation and other design activities could be useful for researchers working in the same design spaces. It could also prove informative for upcoming projects by ensuring sound starting points and avoiding the repetition of (early) mistakes and unsubstantiated assumptions of robotic ideas.

Accordingly, it is important to report on aspects of the research process that did not work well, including the overall limitations of the user-centered approach employed. UCD and PD require flexibility in their implementation, with particular regard to the approaches taken and the potential for alternative design methods. This in turn requires researchers to have sufficient knowledge and skills that extend beyond the application of established research methods, and take inspiration from other fields, such as Science and Technology Studies to problematize designer intentions and ideas about users (Burema 2021).

Furthermore, it is generally agreed that a rigorous design process should raise ethical questions and involve reflection on alternatives. Here, Fronemann et al. (2021) provide an example of reflective practice, discussing the tensions and tradeoffs between designing robots for a nice user experience (UX) versus ethical design. They discuss the delicate balance that can arise between user acceptance, on the one hand, and autonomy and privacy on the other. They argue that the design and evaluation of a robot solution must, therefore, be understood holistically.

3.4 Problematizing socio-emotional relationships with robots

Social robots influence human–robot and human–human relations. Aspects of social interaction and empathy are foundational for human relationships, and, therefore, garner much attention from the HRI research community. A particular concern is the potential replacement of human care providers with robotic technologies. Even so, introducing robots as complementary technologies in social settings raises important ethical questions.

Drawing on the ethics of care, van Wynsberghe (2021) considers the possible effects of nudging in reciprocal relationships between humans and robots. She argues that "social robots designed for reciprocity use reciprocity as an instrumental value to enhance acceptability of the robot", and that this is ethically questionable. In contrast, Balle's (2021) philosophical analysis, focuses on how humans develop empathic responses to robots. He proposes, based on the ethics of Danish theologian K. E. Løgstrup, that human empathy is inherently good, because it turns people away from their own self-focus (inturnedness), and argues that this applies also to relations with robots. In effect, he makes the case that claiming moral patienthood for robots is ethically sound based on extrinsic grounds (i.e., that it benefits the person responding empathically to the robot). Even so, van Wynsberghe is not focused on immediate relational reactions to robots; instead, her focus is on what happens once the relationship develops. While she acknowledges that reciprocity is indeed a component of moral development, and is in no way harmful in itself, she argues that it is uncertain whether reciprocity fostered in HRI would transfer to human–human interaction, where it would provide the most benefit. Instead, she argues that in a world of finite resources, concerted efforts should rather be focused on fostering reciprocity among humans. As Balle also reasons, one can only make a weak claim of moral patienthood for robots, i.e., it should be regarded as "permissible rather than obligatory and individual rather than universal" as far as it happens to occur in human–robot interactions.

[7] https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process.

Related to this, Pashevich (2021) investigates how the use of social robots by pre-school children could influence the development of empathy. She finds that significant knowledge gaps exist, because the robots that are currently available are not sophisticated enough. Children's actual experiences of interacting with social robots are limited, and these are usually not investigated over time. As such, the debate on unintended or undesirable consequences of empathic responses to robots requires continued attention. Moreover, as Balle notes, when research shows that humans tend to respond empathetically to robots, there is potential for malicious intent and exploitation in robot design and development. Taken together, these contributions show that ethical socio-emotional relationships with robots are not straightforward and require further consideration and analyses.

3.5 Challenging sociality in human–robot interactions

In exploring dimensions of human–robot relations, the two final contributions to this Special Issue question the basic premise of what (social) robots are and should be. When it comes to designing and studying social robots within HRI, the robots that are utilized are typically purchased from robotics companies. These may be humanoid or zoomorphic in morphology and behavior. While some research projects build robots from scratch (cf. Weiss and Spiel in this issue, or the robots developed at Ishiguro Lab[8]), most projects purchase existing robots. Either way, robots tend to resemble the appearance, behavior and movement of biological entities we are familiar with. However, the following two contributions question the focus on achieving similarity or human likeness as a goal by illustrating alternatives in designing robots for human interaction.

First, Gemeinboeck and Saunders (2021) present experiences from a research-based art installation. The authors propose another way of thinking about communication and relationships between humans and machines. As both van Wynsberghe (2021) and Balle (2021) also discuss, their core premise is that sociality is not something that can be a property of a machine, but is rather something that is enacted in an encounter, or an evolving relationship, between a human and a machine. Based on their theoretical and empirical observations, the authors argue for the importance of focusing on the enactment of social agency, rather than its representation, in the design of social robots.

Focusing on a specific relational aspect, and based on a research-creation project entitled 'Machine Ménagerie', Yolgormez and Thibodeau (2021) emphasize how contemporary understandings of human–robot relations are grounded in imaginaries of competition and control. They argue that these ideas influence our capacity to consider human–machine relations beyond frameworks of instrumentalization and utility. By designing 'useless' machines, or machines that are not designed to serve human physical or social needs, and exhibiting these machines in public spaces, they explore different approaches to socializing with robots. They argue that sustained everyday interaction between human and non-purposeful machines requires a process of 'attunement', and that this should be considered as an alternative approach to understanding human–robot relations.

4 The future of critical robotics research

The contributions to this Special Issue clearly show how Critical Robotics Research can benefit and further mature HRI as a research field. Each article provides a unique perspective on important aspects that are usually hidden or overlooked in robotics research. They articulate challenges to the robotification of society, highlight the oversimplification of care and service practices and of user centred design processes. They also untangle ethical dilemmas arising from socio-emotional relationships between humans and robots and challenge the need for human likeness in robots designed as social companions.

Taken together, the contributions underline the importance of questioning current research activities and perspectives, in particular with regard to the funding and design of robotic solutions for social problems. While doing so, they also offer alternatives to understanding and developing the role of robots in society. These are not easy topics to deal with, particularly, since it is difficult to foresee exactly how robotics will develop in the years to come, and what role our research efforts may play in shaping it.

While our conceptualization of what it means to conduct Critical Robotics Research is still in its infancy and in no way exhaustive, we hope that this Special Issue serves to outline a set of ideas, concepts and approaches to assist other researchers in further developing this field.

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[8] https://eng.irl.sys.es.osaka-u.ac.jp/.

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