



What is the message of the robot medium? Considering media ecology and mobilities in critical robotics research

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Received: 21 April 2020 / Accepted: 25 March 2021 / Published online: 20 April 2021
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Abstract

This article makes the case for including frameworks of media ecology and mobilities research in the shaping of critical robotics research for a human-centered and holistic lens onto robot technologies. The two meta-disciplines, which align in their attention to relational processes of communication and movement, provide useful tools for critically exploring emerging human–robot dimensions and dynamics. Media ecology approaches human-made technologies as media that can shape the way we think, feel, and act. Relatedly, mobilities research highlights various kinds of influential movement and stillness of people, things, and ideas. The emerging field of critical robotics research can benefit from such attention to the ways of thinking, feeling, and moving robotic forms and environments encourage and discourage. Drawing on various studies into robotics, I illustrate those conceptual alignments of media ecology, mobilities, and critical robotics research and point to the value of this interdisciplinary approach to robots as media and robotics as socio-cultural environments.

Keywords Robots · Robotics · Media ecology · Medium · Mobilities research · New mobilities paradigm · Critical robotics research · Theory

1 Introduction

It is April 2020 and we are in the midst of the global COVID-19 pandemic. In preparing for this article, I find myself wondering: What if we had more healthcare robots that could monitor health and safety along with providing physical assistance and companionship to patients, doctors, and nurses (Gordon 2020)? What if we had more remotely controlled robots that handle work and service tasks on our behalf while we can remain “socially” distant? A part of me wishes we had more of this kind of robotic support system in place to serve and protect us during this crisis. Another part of me is wary of such imaginaries towards a more advanced robotization of everyday life as some of these musings tap into dystopian fictions of robotic control and domination.

With such fictional and—to some extent—factual robotizations of everyday life underway (see for example Hildebrand & Sodero, forthcoming), scholars from a range of disciplines are driven to explore and understand their large

technological, cultural, social, cognitive, economic, ethical, and philosophical implications. Developing the field of critical robotics research (CRR) is an opportunity to weave such scholarly endeavors together while advancing research into robotics more generally. This article contributes to this mission by highlighting two meta-disciplinary frameworks which can effectively serve a human-centered and holistic approach in the critical study of robots.

The two meta-disciplines are media ecology (ME) and mobilities research (MR). Both intellectual traditions can be understood as “meta” because they transcend well-bounded disciplinary fields of inquiry (Nystrom 1973; Urry 2007) and provide comprehensive approaches for critically exploring emerging human–technology dimensions and dynamics (Hildebrand 2018). Media ecology studies human-made technologies as systemic forces that can shape the way we think, feel, and act (Cali 2017; Innis 1999; M. McLuhan 1964; Mumford 2010; Postman 1970, 1998; Strate 2017). Relatedly, mobilities research concerns the movement and stillness of people, things, and ideas (Adey 2017; Cresswell 2006; Sheller and Urry 2006; Urry 2007). The emerging field of CRR can benefit from such attention to the ways of thinking, feeling, and moving robotic forms encourage and discourage. In the following, I build on the fruitful

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connections between ME and MR (Hildebrand 2018), and argue for their intellectual merit for and applicability to CRR. I do so by drawing on relevant scholarship from ME and MR as well as reframing several existing robotics studies and cases through the suggested lenses.

This article's main contribution is the advancement of theoretical work for the study of human–robot relationships by integrating frameworks of ME and MR to robotic ontologies and epistemologies. As such, my interdisciplinary inquiry is driven by the following questions: What can ME and MR contribute to CRR? What new ways of exploring and understanding robot technologies do those intellectual traditions open up? And, how does a combined approach concretely operate in the study of robotics? In the pursuit of responding to these questions, I agree with Garrett that “[o]ccasionally reading thinkers in different systems together can bring about important insights that further the understanding of both thinkers” (2019, p. 236). In the following, I synthesize thinkers of ME and MR with those in robotics research. Ultimately, the insights are to promote and facilitate over-the-horizon studies into past, present, and emerging robots and robotizations.

2 A media ecological lens for critical robotics research

2.1 Robots are media

The introduction and proliferation of robot technology is nothing short of a major socio-cultural transformation. One intellectual tradition that has been having a keen eye on such major cultural transformations from a critical-historical lens is media ecology (ME). While a lot of its focus is on communication technologies, ME understands *any* human-made artifacts as “media.” What then is the difference between “medium” and “technology?” Postman (2006) delineates the terms, thus: “The brain is to the mind, what the technology is to the medium.” Technology is “merely a machine,” an apparatus, “a medium is the social and intellectual environment a machine creates” (Postman 2006, p. 84). In this spirit, ME recognizes that media “affect human perception, understanding, feeling, and value” (Postman 1970, p. 161).

Approaching robots, particularly social robots, as media is not new to research in human–machine interaction. Indeed, several researchers discuss robots as “media” (e.g., Breazeal and Kidd 2008; Gates 2008; Taipale and Fortunati 2018; Zhao 2006). Referencing work into the ethics of human–robot relationships done by de Graaf (2016), Taipale and Fortunati, for example, argue that

social robots can be prefigured as the next new media, which can also work as a new status symbol in the

diverse field of personal technologies by offering new dimensions, such as nonverbal communication and higher social presence, to human-machine communication. (2018, p. 214)

The authors align with ME in the sense that robots as “next new media” have mediating powers. However, here lies an opportunity to consider the technology’s mediating powers on not just individuals and their “nonverbal communication and higher social presence,” but also the socio-cultural effects that the “new dimensions” of such new media bring about. In other words, ME and its understanding of “medium” invites such critical considerations to expand in their scope.

Similarly, alignments already exist between ME and relevant work done in the field of human–machine communication. According to Guzman, human–machine communication, as a field and concept, attends to “the creation of meaning among humans and machines” (2018, p. 1), conceptualizing technology as “more than a channel or medium: it enters into the role of a communicator” (2018, p. 3). ME echoes this approach to technology, in this case robots, as communicators and the importance of understanding such human–machine relations. The ME framework then goes further again in recognizing not just the communicative elements of technology, but also its mediating powers across time and space. Technologies are media that can shape the way we think, feel, and act on micro- and macro-scales. As such, media operate as socio-cultural environments. Media ecologists study “interrelationship of people, media, culture, and consciousness, and of the changes that occur among them, and of their symbiotic alteration of human environments” (Cali 2017, p. 9). Hence, while ME is often similarly placed within the communication discipline, its frameworks promote explorations beyond the communicative processes between entities and can provide further intellectual depth to inquiries into human–machine communication.

2.2 Robotics as ecology

Next to the term “media,” the meaning behind “ecology” and its merit for CRR demand attention. ME means studying media as environments and environments as media. McLuhan, a key thinker of the field, is quoted by his son Eric as having explained this perspective thus:

It is now perfectly plain to me that all media are environments. As environments, all media have all the effects that geographers and biologists have associated with environments in the past. Environments shape their occupants. (McLuhan 2008, p. 27)

In this spirit, McLuhan traces the socio-cultural history of several major communication technologies. The phonetic

alphabet, the printing press, and the telegraph each introduced a “change of scale or pace or pattern” (McLuhan 1964, p. 8), ultimately creating a new environment that shaped its human inhabitants.

The increasing robotization of war, work, care, and leisure presents another major socio-cultural transformation. ME encourages us to understand robots as new agents that will shape our environments. Yet, what exactly does this mean? Postman compares the changes media cause in society to the changes a drop of red dye causes in water:

Technological change is not additive; it is ecological. [...] What happens if we place a drop of red dye into a breaker of clear water? Do we have clear water plus of red dye? Obviously not. We have a new coloration to every molecule of water. That is what I mean with ecological change. (1998, p. 4)

Considering such ecological workings in CRR opens up avenues for holistic studies into past, present, and emerging robots and robotization.

The intellectual merit of attending to such ecologies is noted by Castells (1996), who promotes this approach for studying changes in communication scales and patterns. He remarks, “without analyzing the transformation of cultures under the new electronic communication system, the overall analysis of the information society would be fundamentally flawed” (Castells 1996, p. 357). In his research into computer networks and virtual communities, he operationalizes a media ecological lens to assess how such a new environment “radically transforms space and time, the fundamental dimensions of human life” (Castells 1996, p. 406).

I argue that CRR can similarly benefit from understanding robotics as environments. Advancements in robotics present ecological changes as robots may not just be *added* to our ways of thinking, feeling, and being. ME encourages us to consider robots as media that like red dye may color other elements in our lifeworlds. Current scholarship into robotics alludes to the ecological nature of robots when stating that “the behavior of a robot [...] is, or at least appears to be autonomous and it can [...] influence its environment” (Loh 2019, p. 7). Next to such studies that look into robotic processes and environmental effects on individual scales, ME shifts attention to the larger ecological workings of the robotic medium across cultures and societies. Here, media ecological approaches might likewise complement the field of “domestic robot ecology,” which “shows a holistic view on the relationships that robots shape in the home” and “articulates how those relationships change over time” (Sung et al. 2010, p. 417). Referencing Jodi’s (2008) use of the term “ecology,” Sung et al. explain that “[w]e particularly chose the term, ‘ecology’ [...] to emphasize that our framework shows a holistic view on the interaction experiences that

robots create across all four temporal stages” (2010, p. 420). Drawing on ecological thinking beyond the domestic space, CRR has an opportunity to not only bring together adjacent fields such as human–machine communication, human–robot interaction, and domestic robot ecology, but comprehensively expand these frameworks.

2.3 We shape robots and then they shape us

Inscribed in this view that media, and in this case robots as media, create influential environments is the idea that “all human-technology relations are two-way relations. Insofar as I use or employ a technology, I am used by and employed by that technology as well” (Ihde 2002, p. 137). This co-shaping notion is not only central to actor-network theory and the philosophy of technology, but also ME (Irwin 2016). “We shape our tools and thereafter they shape us,” notes Culkin (1967, p. 52). This perspective is useful in critically assessing not just clearly visible but also subtle and nuanced contemporary robot workings.

Attention to the reciprocal nature of media seems particularly relevant as we move towards ecologies of interconnected robotic things communicating with each other *behind our back* (Gunkel 2017). In his media ecological probe into robotic environments, Gunkel remarks:

By connecting to each other and the home itself, your things will begin collaborating on your behalf. So instead of having a stand-alone domestic robot, like the Jetsons’ Rosie, the entire home will become one interconnected smart system. (2017, p. 252)

Whether it is Rosie, Siri, or Alexa that work our environments, media ecologists wonder how they and more invisible robotic environments may *work us*. For example, Gunkel argues:

Whether we know it or not, each of us is a thing on the IoT [Internet of Things]. Facebook has already turned us into data-gathering, interconnected sensors. [...] Fitbit and other personal tracking systems connect our bodies to the network and will eventually be used to assist both doctors and insurance companies in gamification strategies for healthcare [...]. As just another thing on IoT, each of us becomes a node in the network. (2017, p. 253)

Here, the second half of media ecological thinking, namely *environments as media* comes into full light. CRR can again be augmented with this dual perspective of *robots as environments* and of *environments as robotic*. And, as “just another thing on the IoT,” we may well also ask to what extent *we become robotic*.

2.4 Robots extend and amputate us

A key principle of ME that similarly speaks to the reciprocal relationship of humans and machines is McLuhan's (1964) approach to media as our extensions. Related to Freud (1961), Hall (1976), Mumford (1961), and Kapp (1877)'s various approaches to the idea that tools enhance human faculties or project organs, McLuhan et al. explain:

the wheel is an extension of the foot; the book is an extension of the eye; clothing is the extension of the skin; and, very importantly, electric circuitry is an extension of the central nervous system. (1980, p. xi)

Robots similarly extend various human faculties based on their design and purpose. Rooted in the Czech word “*robota*” for “work, compulsory service, and forced labor” and coined in 1920 by the artist Josef Capek (Loh 2019), robots are “at our service” by extending our hands, legs, eyes, ears and more for “tiresome, boring (e.g., repetitive) and dangerous work” (Loh 2019: 6). When imagining robots, we may more readily think of Rosie than Siri, C-3PO than Google Home which speaks to the prevalent association of robots with mimetic machines, i.e., machines that imitate the human. Imitation operates as a form of extension. In reference to Derrida (1998), Armand contextualizes this sentiment thus:

Above all there is the persistence of this mimetic faculty: to represent, to imitate. To represent the future; to imitate the human. Like so many football-playing robots, sex bots, killer robocops, or benevolent euthanasia “companion” bots, all on their way to refining themselves into what, in *Of Grammatology*, Derrida called “that dangerous supplement”: the metonymic dwarf that *extends out from humanity* and *ends by taking its place* in the scheme of things. (2020, p. 260, emphasis added)

Such mimetic qualities of robots facilitate human–machine relationships (Hoefflich 2013; Oost and Reed 2011; Serholt 2018; Zhao 2006) and human–robot communication in which “people behave and respond with remarkable similarity to how they would if the partner was another human” (Edwards 2018, p. 30). Such “anthropomorphisms” as “ascription of agency” (Serholt et al. 2017, p. 616) lead to influential agential negotiations (Zhao 2006). Beyond anthropomorphic machines that encourage or discourage us to affectively and effectively engage with them, we may employ such human-extension thinking also in the context of IoT, artificially intelligent machines, biotechnology, and cybernetic organisms.

The fact that we use robots as extensions of ourselves should also remind us that the machines we build may only be as good as we are. Selwyn speaks to this sentiment in the context of classroom robots when arguing, “all

technology is ‘human’ in its origins and implementation. Any ‘robot-teacher’ is actually a combination of people and machines, the material world, coded structures and social settings” (Selwyn 2019, p. 7). Further, the machine likely continues to be so even when it starts to code itself. Armand’s aforementioned description echoes this idea and another key principle of ME: the technological extension possibly leading to human auto-amputation.

As we extend ourselves with technology, we run the risk of becoming numb to this extension, ultimately losing awareness and control of it via auto-amputation (McLuhan 1964). McLuhan refers to this phenomenon as a “particular form of self-hypnosis Narcissus narcosis, a syndrome whereby man remains [...] unaware of the psychic and social effects of his new technology [...]” (1969, p. 4). Such numbness toward what media do with us and our environments has already been noted in the context of robotics. Turkle, for example, remarks:

An expressive machine face—on a robot or on a screen-based computer program—*puts us on a landscape* where we seek recognition and feel we can get it. We are in fact triggered to seek empathy from an object that has none to give. (2016, p. 342, emphasis added)

Such a lack of understanding what the robot can and cannot give speaks to the numbness McLuhan sees as the result of uncritically extending ourselves. Like the mythic Narcissus who falls in love with his own reflection in the water, we may fall in love with our technological extensions, forgetting their larger environmental workings, numbing ourselves to their effects, and ultimately losing awareness of their impact. Some studies into robotics allude to such ambivalent “numbing effects” in the context of, for example, children’s emotional and cognitive development (Sharkey and Sharkey 2011; Turkle 2006). Relatedly, Serholt et al.’s (2017) research highlights concerns about robot interaction leading to dehumanizing and violent human patterns. The risk of “auto-amputation” for better or worse rings in Ritzer’s warning that “[w]ith the coming of robots we have reached the ultimate stage in the replacement of humans with nonhuman technology” (1983, p. 105). Reaching “a future that does not need us” (Joy 2000, n. p.) would mean that we have effectively extended and then auto-amputated us.

“It is the framework itself that changes with new technology, and not just the picture within the frame” argues McLuhan (1964, p. 238). The robotic framework is what we may lose sight of due to the numbing effects of the robot inside the frame. As such, CRR can work towards waking and shaking all Narcissuses in studying the changes to our robotic frameworks.

2.5 The robot is the message

“The medium is the message,” summarizes McLuhan the guiding principle of ME (1964, p. 7). The multivalent aphorism describes our need to understand the *form* of a medium beyond merely its content to recognize its larger impacts on culture and society. As media create environments and environments become media, focusing on just one element within the media environment may distract from its larger ecological workings or the overarching “message”. Postman clarifies this approach by stating:

embedded in every tool is an ideological bias, a predisposition, to construct the world as one thing rather than another, to value one thing over another, to amplify one sense or skill or attitude more loudly than another. (1992, p. 13)

Each human-made artifact encourages us to think, feel, and act in certain ways based on its underlying technological “predisposition.” Verbeek echoes this perspective when writing “in fulfilling their functions, artifacts do more than function—they shape a relation between human beings and their world” (2005, p. 208). By shaping our relations to our world, they can end up shaping our world.

The media ecological lens promotes assessing robots as technologies that come out of, come into, and come to create certain environments. CRR gains from approaching a robot like Postman approaches a medium that is “a product of a particular economic and political context [that] carries with it a program, an agenda, and a philosophy that may or may not be life enhancing and that therefore require[s] scrutiny, criticism, and control” (1992, p. 185).

This critical attention to the agenda, biases, or philosophies of robots does not necessarily presuppose hard technological determinism. ME remains rooted in a human-oriented lens that recognizes that we shape technologies and then they shape us. Media explicitly and inexplicitly afford certain ways of thinking, feeling, and acting. McLuhan and McLuhan (1988) emphasize that those biases, affordances, and effects can be avoided as long as we make an effort to recognize and understand them. It is about making media workings visible to us. I suggest that CRR can and should be about *making robotic ecologies visible* to us.

2.6 Making robots visible

Understanding media as environments means recognizing that biases and effects of media can be difficult to discern. When media become environments, they start to surround us, we become immersed in them. Postman explains,

In the case of media environments (e.g., books, radio, film, television, etc.), the specifications are more often implicit and informal, half concealed by our assumption that what we are dealing with is not an environment but merely a machine. (1970, p. 3)

Living with the printing press, automobile, electricity, or television can turn those media ecologies into environments we understand as “given” (Postman 1998). However, there are several instances when the ecologies of media gain visibility. Those include when they are brand new and when they break down (Strate 2017).

In the midst of the ongoing robot media evolution, we can examine robots in their newness and in their moments of failure (see for example Ljungblad et al. 2012; Serholt 2018). When media are new or fail, they provide opportunities for critical robotics researchers to unpack their philosophies before they turn into environments that we accept as given. What tools then does ME provide for researchers taking on such work?

2.7 Media ecological tools for critical robotics research

Following this review of relevant ontologies in the media ecological tradition, I now turn to a number of tools that can serve this kind of critical study into robotics. McLuhan and McLuhan (1988), for example, propose what they call “the laws of media.” These laws encourage us to approach each medium with a set of four questions. Applied to robotics, the questions go: What does the robot enhance? What does the robot obsolesce? What does the robot retrieve from the past? And, what does the robot reverse into when pushed to an extreme? The questions do not follow a specific chronology or hierarchy. Moreover, this approach is not meant to lead to universally applicable answers. In fact, McLuhan and McLuhan (1988) promote the contextual application of these questions on micro- and macro-levels. As such, we could ask these questions of Rosie in the Jetsons’ environment as much as of Alexa in the U.S. American domestic space. Because of its exploratory nature, the tetradic inquiry can open up new avenues for understanding past, present, and emerging robotic environments.

A concrete example for this method in a robot context comes from Gross (2020), who conducts a tetradic reading of her Roomba. In the media ecological study of her engagement with the vacuum robot along with other anecdotes about lived experiences with the household machine shared online, she argues that the Roomba enhances frequency and automaticity and that it obsolesces handheld vacuum cleaners and the broom. Likewise, the cleaning robot retrieves the daily housekeeper and homemaker from the past, which prompts the author to question her guilt-free

sense of superiority over her nonhuman world. In response to the fourth “law of media,” Gross (2020) acknowledges that when the robot is pushed to an extreme via unusual conditions, wear and tear, or malfunction, the human ends up serving the machine. This study is a brief example of how the McLuhans’ laws of media can be operationalized for CRR, bringing attention to what is gained and lost with each new robotic environment.

Synthesizing this and related angles in the ME tradition, Cali (2017) similarly provides a set of useful questions for the study of media as environments that can serve existing, emerging, and future studies in CRR. His guiding questions concern (1) individuals, (2) other media, (3) and social consciousness more generally. Adopting his approach, critical robotics researchers may ask, “[h]ow does the [robot] affect our human faculties physically and physiologically?” (Cali 2017, p. 245). Turkle similarly wonders: “Who do we become when we talk to machines?” and “What do we forget when we talk to machines—and what can we remember?” (2016, p. 337/338). In the latter question in particular, Turkle also alludes to the tetradic angles about what robots might enhance and obsolesce (in this case memory). As such, this first question promotes both qualitative and quantitative research into specific human–robot biases and effects.

Following Cali’s second guiding question, we explore the relationships robots have with the technologies that precede them. He recommends asking, “[h]ow does the medium change the role of other media that came before it” (Cali 2017, p. 245)? This question could be particularly relevant for CRR with the advent and proliferation of IoT. With ME as theoretical foundation, critical robotics researchers may ask: How do Google Home and Alexa, for example, change the environment of the home? How do the Roomba and other household robots change the role of older media such as furniture (see for example Sung et al. 2010; Gross 2020)? How do sophisticated self-driving systems change the socio-cultural function of the car (see for example Hildebrand and Sheller 2018; Leon 2019)? What new socio-technical role does the smartphone take on as it turns into the “ground station” and “remote control” for consumer drone pilots around the world (see for example Hildebrand 2019, 2020)? As such, this group of media ecological questions about other media helps contextualize robotics within the ecology of things they emerge out of, get entangled in, and shape further.

Finally, Cali suggests considering the medium in the context of “social consciousness.” He asks, “[h]ow does it affect human relations? Our sense of self? [...] How is the social environment changed” (Cali 2017, p. 245)? This attention to how robots and robotic environments generate certain relations taps into a whole range of ethical issues already raised by robotics researchers (for example Royakkers and van Est 2015; Sharkey and Sharkey 2011; Turkle

2016). Royakkers and van Est, in particular, call for more research into “socialization and desocialization” along with their boundaries to better understand “where and when do social robots have a positive socializing effect and where do we expect de-socialization” (2015, p. 552). Noteworthy in their framing of a larger research agenda is the necessary *situating* of these expectations and effects, which emphasizes the nature of robots and robotics as environments. ME can help advance this kind of empirical work into the biases and effects of robots as media.

3 A mobilities lens for critical robotics research

Elsewhere (Hildebrand 2018), I have argued for the value of combining media ecology and mobilities research for a constructive and holistic approach to the study of all forms of communication and transportation. Without reiterating those alignments here, I want to now make the case for how the “new mobilities paradigm” (Sheller and Urry 2006) can contribute to the interdisciplinary formation and frameworks of CRR as a supplement to ME.

3.1 Robots in the new mobilities paradigm

“All movement has meaning” is the aphorism that underlies the “new mobilities paradigm” (Sheller and Urry 2006). Since robot media and robotic environments are imbued with different kinds of mobilities, the theoretical and methodological contributions of this more recent body of work can further enrich studies into robotics. As such, considering mobilities, in their simplest form, means asking: What kind of meaning runs through the movement and stillness of robots? And, what do robotic mobilities and immobilities mean for human mobilities and immobilities? Different kinds of material and immaterial movement are inherent to robots as media and robotics as environment and the following frameworks of mobilities research (MR) can assist in endeavors to detect, unpack, and understand those.

Foundational to MR are “mobile ontologies,” meaning “a set of apprehensions about the world characterized by movement, flow and vortices of matter, even if things appear fixed” (Adey 2017, p. 7–8). Such movement, flow, friction, and stillness create

a very certain kind of position, standpoint or way of relating—it is a way of addressing people, objects, things and places. It is way of communicating meaning and significance, while it is also a way to resist authoritarian regimes. It is the predominant means by which one engages with the modern world. (Adey 2017, p. xvii)

Part of this “modern world” are our increasing robotic environments which in shaping our thoughts, feelings, and actions, also come out of and into robot-related ways of moving and not moving.

Noteworthy in this framework is the insistence on “mobilities” over “mobility” in recognition of movement being inherently plural. Adey clarifies:

To speak of mobility is in fact to speak always of mobilities. One kind of mobility seems to always involve another mobility. Mobility is never singular but always plural. It is never one but necessarily many. In other words, mobility is really about being mobile-with. (2010, p. 18)

The mobility of robots and robotic environments may similarly be about robots being *mobile with* their users and their environment. “Mobility is a social activity of companions of people and things who move with” (Adey 2010, p. 23). We move with, because, and despite robots, move through and past robotic environments, as we move them in return.

The kind of movement described here goes beyond physical mobility of robots and includes the cognitive, affective, and digital-intangible ways of moving and not moving that robotic environments encourage and discourage. Urry (2007) for example, speaks of physical and corporeal, but also of communicative, imaginative, and virtual mobilities. Similarly, Sheller addresses affective mobilities when explaining how “[m]otion and emotion [...] are kinesthetically intertwined and produced together through a conjunction of bodies, technologies and cultural practices” (2004, p. 227). And, Thrift (1996) writes about mobility as a “structure of feeling.” As a result, Adey cautions that “[i]n many ways all of this movement can easily escape human experience and perception unless we are trained to look for and think about it” (2017, p. 7–8). A robotic mobilities lens can make visible those potentially non-representational (im)mobilities at play in the moving-with robots and moving-in robotic ecologies.

3.2 Robot im/mobilities

In the following, I briefly focus on how this lens onto mobilities and immobilities is applicable to CRR. The physical mobility and immobility of robots have been a key concern in studies into robotics without the work explicitly referencing MR. Particularly in the context of social robots, their “liveness” tends to be linked to their different capabilities for “re-acting” and thus moving one way or another in response to a human. Fritz (2018), for example, gives attention to the specific movements of Jibo and Buddy when writing:

Although Buddy can move around independently on wheels, Jibo must be carried, like an infant, from room to room. [...] Jibo is able to squash and stretch, to strike an anticipation pose while listening, to lean back and take a breath before speaking, and to exaggerate his movements. [...] Designing Jibo’s movements to reflect familiar movements of animated characters simultaneously serves to make Jibo seem not only life-like but also familiar and innocent. (Fritz 2018, p. 72)

In discussing the physical mobilities of Buddy and Jibo, Fritz recognizes the larger implications of such movement and provides an example of robotics research that can be further unpacked through the mobilities perspective. Jibo “must be carried” and is thus “like an infant,” while Buddy can move, thus mediating more independence. Lacking such mobile capacities across space, Jibo’s strength lies in the more micro-movements essential for simulating attention and responsiveness in this human–robot communication. The small robot appears to “squash and stretch,” listen, breathe, and lean back because of its micro-mobilities. As a result, the robot also taps into our familiarity with the movements of animated characters. According to Fritz, the machine’s movements allow it to appear “lifelike,” “familiar,” even “innocent.” Here, the author touches upon the impact of the differing robotic mobilities encompassing not only physical movement and stillness, but also the user’s affective (the robot appears like an infant), communicative (the robot appears to listen), and imaginative (the robot appears familiar) mobilities. For such and similar robotics research, MR offers a lens for identifying and examining the various types of robotic and robot-induced movements.

This example also illustrates the powerful quality of robots as media. Adey bridges this thinking about media and mediation with mobilities thus:

What does it mean to mediate? In the context of our study of mobility the answer is manifold; we have seen several different kinds of mediation. Mobilities seem to always carry something inside; something has stown away. Mobilities in other words are parasitic. [...] These mediating technologies mediate many forms of mobility; indeed, almost every mobility is mediated by something. (2010, p. 223)

Robots are similar in the sense that they also “carry something inside.” They are “parasitic” in mediating other forms of mobility such as those of the infant, the animal, and of course other tools that precede it. McLuhan (1964) indirectly speaks to this quality of media as mobilities and mobilities as media when arguing that any medium always serves as a container for another. In the case of the robot, we might ask, what ways of relating, moving, or communicating does it contain? What communicative and imaginative mobilities

does the robot tap into to affect certain ways of engaging with it? One way or another, robots can *move us*.

Along with Fritz's observations that allude to the physical, communicative, and imaginative mobilities of social robots, Sung et al.'s (2010) work can be similarly tied to MR in how their work addresses other types of mobilities robots inherit and engender. Their study of Roomba highlights how the robot operations changed the organization of the household, and thus the environmental make-up of the home. As such, the "roombarization" (Sung et al. 2010) of the home means that the physical mobilities of the robot shape the corporeal mobilities of its users by prompting them to adjust their domestic space. In reference to Sung (2010), Royakkers and van Est explain that "[t]ypical modifications are *moving or hiding* cables and cords, *removing* deep-pile carpet, *removing* lightweight objects from the floor, and *moving* furniture" (2015, p. 550, emphasis added). While some of these corporeal and physical movements may only be required once the Roomba has become a household staple, other corporeal mobilities, e.g., stepping out of the way of the cleaning robot and removing obstacles (Gross 2020) continue.

Virtual mobilities, as another type of movement, are likely to increase in relevance for CRR in the context of IoT. Inspired by MR, critical robotics researchers may ask: What virtual movements occur within our robotic environments, for example, as Alexa closes the garage door and turns off the lights? Virtual mobilities also matter in the case of a Japanese university enabling their graduates to virtually participate in their commencement ceremony via remotely controlled robots (Meisenzahl 2020). With numerous countries recommending and enforcing social distancing measures due to the coronavirus pandemic in the spring of 2020, Business Breakthrough University in Tokyo used "Newme" mobile robots to represent and feature their remote graduates via live video on a mounted tablet. The symbolic significance of *walking across the stage* and being *handed* their diploma mattered enough to mimic this tradition via the robotic mobile medium.

The above-mentioned examples illustrate how critical robotics researchers may employ mobilities frameworks in their studies. In what other ways can we operationalize MR for this emerging field? Synthesizing influential MR scholarship, Adey (2010) points to several methods, two of which hold particular promise for robotics research: (1) following multi-sited robot (im)mobilities, and (2) recognizing the situated (im)mobilities of researchers themselves. Concretely, this includes mobile ethnographic research that not only traces robotic movements in given settings, but also the various mobilities of the robot as it is designed, assembled, transported, used, and eventually disposed of in different social and geographical contexts. Following the thing from its origins to its end means recognizing the larger human and nonhuman ecologies the machine moves into and out

of. Likewise, MR-inspired CRR would consider the mobile positionalities of the researchers themselves. Differently mobile bodies differently experience and engage with mobile robots and robotic environments. CRR benefits from recognizing the various openings and obstacles, the mobile biases and effects that robotic (im)mobilities present in uneven and heterogeneous human-machine relationships.

3.3 Combining media ecology and mobilities in critical robotics research

How, then, might a *combined* approach of ME and MR look in CRR? Media ecologists Adams and Thompson (2016, 2020) suggest a set of technology-sensitive heuristics that expressly integrate frameworks of ME and provide space for similar critical attention to (im)mobilities. In short, they promote "interviews with digital objects." To interview robots, we can pursue "gathering anecdotes," "following the actors," "listening for the invitational quality of things," and "studying break-downs, accidents, anomalies" (Adams and Thompson 2020, p. 250). Each of these four steps aligns with approaches of ME and MR. Moreover and among other methods, Adams and Thompson (2020, p. 250) advocate for "applying the McLuhans' laws of media" and "tracing responses and passages." Their approach is neither prescriptive nor chronological. The emerging field of CRR has an opportunity to adopt these theories and methods to reveal hidden environmental dimensions and mobile dynamics in our involvement with robotic media. Gross (2020) and her Roomba study is one example for interviewing robots. In her findings, she recognizes not only the human programming of mobile robotics but also a robotic programming of mobile humans.

Ultimately, the suggested ME and MR angles may become even more relevant if Gates' speculation is correct: "We may be on the verge of a new era, when the PC will *get up* from the desktop and *allow us* to see, hear, touch and manipulate objects in places where we are not physically present" (2008 n. p., emphasis added). Recognizing the various (im)mobilities at play in these robot-human environments is and will continue to be crucial. By incorporating ME and MR, critical robotics researchers gain a lens and language for describing such past, present, and emerging ways of physically, corporeally, virtually, communicatively, and imaginatively moving and relating.

4 Conclusions

As robotics continue to gain momentum, so does the need for critical studies into robotics. This article discussed several opportunities for intellectual advancements in CRR by drawing on theoretical frameworks and methods from ME

and MR. ME can help assess robots as media that impact the way we think, feel, and act. Relatedly, MR brings our attention to the robotic ways of moving and not moving in their widest sense. As such, the article's goal was to provide a conceptual lens onto how issues in critical robotics can be comprehensively approached. This attention to “media” and “mobilities” remains human-centered in recognizing that we shape robot media and mobilities and, in return, robotic environments shape us.

More specifically, I argued for how robots can be understood as “media” and extensions of human faculties that may cause a numbness to their functions, risking auto-amputation. “The robot is the message” is already a credo for many studies into robotics. ME encourages situating the robot's *message* in a larger socio-cultural context. It is ME's mission to make visible those often-invisible environments and larger frameworks. The intellectual tradition provides several tools, such as the laws of media along with a few overarching questions into individuals, other media, and human consciousness, that may inspire, shape, and frame CRR. In addition, I shed light onto the field of MR for similarly relevant contributions to the lens and language of CRR. The “new mobilities paradigm” promotes studying the physical, corporeal, virtual, communicative, and imaginative movements, stillness, and frictions that robot media, robotic environments, and researcher positionalities engender. Throughout the article, I discussed and reframed several studies and examples of robotics through ME and MR to illuminate the intellectual merit and applicability of such conceptual work.

This article deliberately raised more questions than it answered. Questions, like robots, are human-made artifacts; they are media. As such, any critical inquiry should begin with carefully attending to the questions it raises and the problems it recognizes as a result of that (Strate 2017). McLuhan (1969) and media ecologists in his footsteps thus like to speak of “probes” when studying their research subjects. Probing means asking explorative questions, it means struggling with ideas (Plugh 2018) because *the question is a message, too*; it matters how one begins. Like a robot which probes into its new environment to learn about it and its place within it, we benefit from probes into our increasingly robotic environments. Now is the time for such robotic probing, before such new media and their ecologies have become the new normal; indistinguishable from other already accepted-as-given technologies that we struggle to change and, at times, control.

This kind of critical work is crucial for not only robotics researchers but also designers, developers, decision makers, users, and bystanders. Recognizing the larger environmental workings of robots as media for individuals and society, considering what each robot may enhance, obsolesce, retrieve, and reverse into, tracing the robot thing from conception to disposal, and acknowledging differential robot-human (im)

mobilities in their everyday entanglements can further attune these various actors to the biases and effects, the desirable and undesirable, the promising and perilous dimensions of robot media and robotic environments *before* we become numb to them. What is ultimately at stake are robot ecologies and (im)mobilities that are more equitable and more ethical than without such careful critical work.

In this spirit, I end with a suggestion for critical robotics researchers, professionals, and users to take on the role of what Postman (1992) calls a “loving resistance fighter.” The loving resistance fighter “maintains an epistemological and psychic distance from any technology, so that it always appears somewhat strange, never inevitable, never natural” (Postman 1992, p. 185). Such thinking recognizes the importance of a critical and moral lens when engaging with issues of technology and culture (Plugh 2018). Critical robotics researchers are already adopting this perspective when calling for robots to promote “human flourishing and wellbeing [...] *in a social context* and involve social interaction because human flourishing requires social connection and communication” (McBride 2020: n. p., emphasis added). This sentiment of a loving resistance fighter also echoes in Royakkers and van Est's appeal:

Robotics does not exist for itself, but for society. [...] This begins with the realisation that new robotics offers numerous opportunities for improving the lives of people, but also that there is sometimes *no space* for robots. (Royakkers and van Est 2015, p. 567, emphasis added)

To what extent there is “space for robots,” to what extent robots contribute to “human flourishing and wellbeing,” and to what extent such flourishing is set “in a social context” can all be adequately probed, holistically understood, and fruitfully described with the interdisciplinary frameworks and tools of ME and MR discussed in this article. After all, a loving robotics resistance fighter may want to operate with some strategy. The strategy suggested here is probing robots as media and mobilities.

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