Int J Soc Robot (2014) 6:249–260
DOI 10.1007/s12369-013-0221-z

The Five Robots—A Taxonomy for Roboethics

Steffen Steinert

Accepted: 18 November 2013 / Published online: 30 November 2013

Abstract The distillation of four "gravitational centers" of discourse on the ethically relevant issues regarding robots constitutes the elements of the taxonomy developed in this paper. In this paper I take the birds-eye perspective, looking on the ongoing discussions and picking out clusters: (1) Robots as mere means to achieve a specific goal; (2) the robot as an addressee/recipient of ethical behavior; (3) the robot as a moral agent; (4) the robot as an ethical impact-factor. A fifth dimension is then introduced: The "meta-perspective" invites ethicists and researchers in robotics to be sensitive to how their discipline and thinking is influenced.

One the one hand, this taxonomy helps roboticists to navigate through the ethical discourse, on the other hand it creates a common ground for the needed dialogue between professional ethicists and people with hands on experience in robotics. The paper concludes with implications for future collaborations between ethicists and researchers.

Keywords Roboethics · Robots · Ethics of robotics · Moral machines · Moral agents

1 Introduction

This paper takes it for granted that the discussion about the ethical challenges of robotics research is an urgent matter and that possible problems concerning this research need to be addressed ahead of time. Especially because the introduction of sophisticated robots into domestic environments seems to be a question of 'when' and not 'if'.[1] In the light of these important developments, a close examination of robotics and its ethical implications is necessary and justified.

The emergence of new technologies has always required the formation of new ethical concepts and the modification of old ones. This process is not only accompanied by changes in semantics [37], but also by the creation of entirely new terms. Clearly, ethicists have conceived of new words for these kinds of research branches. You just have to skim through recent professional literature to find appropriate terms like "Bioethics" [44], "Neuroethics" [17], "Digital Media Ethics" [12], or "Cyberethics" [43]. What's more, some elements of the old framework make their way into the new and old almost forgotten notions are being revived. This creates an exciting atmosphere of novelty and progress but it also fosters the dangerous tendency to complicate the ethical discourse about technology in an unnecessary way.

The purpose of the paper, however, is not a clarification of what a robot is and how we can define it wisely. A lot of ink has been spilled on these kinds of questions already.[2] Moreover, this paper is not going to review the history of the sub-discipline called roboethics, nor is it intended to investigate how the term roboethics has changed its meaning over time.[3]

S. Steinert (✉)
Research Center for Neurophilosophy and Ethics of Neuroscience, Schellingstraße 10, Room J 305, 80539 Munich, Germany
e-mail: Steffen.Steinert@campus.lmu.de

[1] South Korea's government for example wants to put robots in every household until 2020. See [30].

[2] For a definition of robots in general see [7, pp. 1–5]; for a definition of service robots see [32, p. 352]; for a definition of domestic robots see [54].

[3] It is clear that the term "roboethics" could be used in a variety of ways, grasping a wide range of phenomena, not just within philosophy but

Drawing on the recent literature of the field, I will take a birds-eye perspective, looking on the ongoing discussions and trying to discern important clusters of the discourse. In other words, the focus of attention is on the various "gravitational centers"[4] around which the ongoing discussions revolve. I will explore the various dimensions and "problem areas" that are currently predominant in debates about the ethical issues concerning robots. Disentangling the different ideas in circulation within these centers, a taxonomy is presented that will serve as a useful tool to elucidate and structure the ongoing ethical debates concerning the use of robots.

The literature on the topic can be grouped in at least four different areas of interest and scope. The outline of the paper is structured according to these four areas: The first paragraph is concerned with the "instrumental" view on robots. At the center of discussions are the actions humans take 'through' a robot. In other words, the robot is a simple means or tool to achieve a desired goal. Its ethical significance is the ethical significance of a tool: A vehicle through which an ethical agent acts. Here a robot is neither a repository of its own ethical agency nor a possible beneficiary of ethical action.

The second paragraph deals with the moral standing of robots itself. Here I focus on the idea that the robot can be considered to be a recipient of ethical behavior.

The third paragraph deals with discussions that revolve around the ethical behavior of the robot itself: the robot as a moral agent or actor.

There is also a bunch of literature that focuses on robots as an ethical impact-factor on society in general. Here the discussion concerns the ethically relevant implications of the introduction of robots into various social domains like the domestic sphere or the work place. This field of inquiry is the focus of the fourth paragraph.

The distillation of these four "gravitational centers" of the discourse on the ethically relevant issues regarding robots are the core elements of the taxonomy developed in this paper.

No doubt, it is important to think about issues like the moral standing of robots or possible impacts of robots on society. But little thought has been given to the possible influence of robotics research on the shape and form of ethical consideration itself. This is especially unsatisfactory because philosophy and ethics ought to be self-critical disciplines par excellence.

Therefore, after having laid out this taxonomy, a fifth perspective is being introduced that I will dub 'meta-perspective'. It invites ethicists and philosophers to be sensitive to the impact of robotics on their own discipline. On the other hand, engineers and designers of robots are invited to be more self-critical.

Ultimately, I hope that this paper will promote the dialogue between ethicists pondering over the moral significance of robots and the designers and engineers working in the labs. The taxonomy and the plea for a meta-perspective is also an attempt to help roboticists enter the ethical debates and might serve as a common basis for the necessary interdisciplinary discussion.

2 Acting 'Through' Robots—Robots as Instruments

No doubt, a robot can correctly be classified as "artifact" because human beings have deliberately created it. It is no surprise therefore, that in the debates concerning robots all the 'classical' questions concerning artifacts and their use may be put forward. Books and papers dealing with these problems can easily fill whole bookshelves. Readers familiar with philosophy of technology might want to complete the following list of example questions: Is technology autonomous? [11, 52]. Are artifacts neutral concerning their ends or methods of use? [33, 53]. Is technology determining the socio-economic structure of society? Or in the words of Robert Heilbronner: Do machines make history? [20].

According to the *instrumental-view*, robots are like any other tool. They are merely means to an end. Robots can be used to alter a situation according to your desires and will. For this reason, robots give rise to the same ethical questions and problems like other, simpler, devices and tools.

The instrumental view also implies that technology is neutral concerning the purpose: You can use a hammer to drive a nail into a piece of wood, or you can use the very same hammer to deliberately hurt somebody. In this case, the human being is the only responsible party and nobody would consider blaming the hammer. From an instrumental perspective on technology something similar is true for robots: You can operate a robot in order to perform a life-saving surgery in a so-called 'tele-surgery' environment, or you can use that exact same robot to purposely kill the patient. Like in the hammer scenario, you would not blame the robot. The ethical weight is on the shoulder of the human using the device. It is human and not the robot that is the ethical agent.

When we perceive robots as simple tools waiting to be used by us, ethical considerations regarding robots are highly limited in scope. Robots are at best conceived as what Asaro [2] has called "amoral robot agents". They are simply an extension of the human using them, similar to cars, guns and other tools and machines. The ethical concerns that arise from the use of these artifacts, therefore, are entirely focused on the human using them.

also in intercultural debates. For the intercultural aspects of roboethics see the survey in [6].

[4] I borrow that term from Daniel Dennett [10], who introduced it in a different context.

But an important caveat needs to be made here.[5] Not all robots are like other devices that we are familiar with. There is a crucial difference between robots that need to be controlled by a person (such as the "PackBot" that is used by the US military for bomb disposal) and robots that exhibit a higher degree of autonomy. The latter are robots that can move and operate independently from any human (such as the Roomba vacuum bot or various robots on factory floors that are programmed to complete a rigid set of movement patterns based on instructions). The first, less independent, kind of robots are similar to devices where we are in control of most of the operations. Similar to cell phones and guns, these robots are closely linked to the actions of a human operator. The second and more independent kind of robots somehow undermines our understanding of what it means to be an instrument because they carry out their operations without a person controlling it.

Nevertheless, when technology is conceived as extensions of human capabilities [28] or as an extension of our faculties to realize our intentions [5], robots need to be treated like any other of our extensions (e.g. the hammer). According to this view, robots are 'valuable' in a pre-ethical instrumental sense if they are reliable means to achieve a desired end. As for any other tool, we can ask instrumental questions like: Is the robot the best tool to realize our intentions in a given situation?

However, the instrumental use and the realization of our intentions also allow for ethical questions like this one: Is the robot used in an unethical way to realize the intention? Or is there any responsibility on the designers or producers part if the robot is used unethically? Who should or should not have access to robots and why? Consequently, we need to assess the positive instrumental gains but also the risks of robotic devices in ethical terms (something that is done in the discipline Technology Assessment already).

As with any other device, we should explore (preferably in advance) the role robots play in the human-technology relationship, as well as carefully examine the active role robots may play in the performance of an action and in shaping of intentions. In order to do this, an insight from the phenomenology of the human-technology relation is so simple that it is often overlooked: Tools are never *passive*. They actively shape the situation and the relation between humans and their environment. We are all familiar with the worn out quote 'Guns don't, kill people, people do', which, of course, is a true statement. Alas, it is under-complex and neglects the contribution of the gun itself to the shape of the pre-shooting situation. As Verbeek rightly points out: "A gun is not a mere instrument, a medium for the free will of human beings; it helps to define situations and agents by offering specific possibilities for action" [48, p. 98].

Another way to approach this issue is in terms of mediation. Technology is always a sort of "mediator" between a human being and the world [22, pp. 72–80]. Human praxis and experience is "mediated" by the very tools and devices we use. Now, this mediation is never neutral but is transformative in nature. This is particularly obvious in the case of tools that are designed to enhance perception, like binoculars: By mediating your perception, something in the distance is enhanced. At the same time however, your perception is transformed because the binoculars shrink your field of vision; it does not give you the whole panorama of what you are looking at.

This idea can be applied to robots as well. I do not see how robots are different from other devices in this regard. In being extensions of human capabilities that help us to realize our intentions, they take part in how we relate to the world. For this reason, we should carefully examine the role they play in shaping this relationship.

If we conceive of robots as mere tools, the ethical perspective is narrowed to humans with their intentions and capabilities and the tools to realize these very intentions. Because we have to expect that robots will be used in a wide range of social contexts, including the domestic, medical and military, we need to think in advance of how they will alter the situation in which they are deployed. Due to the "mediating" nature of tools and devices, robot-designers need to assume that their creations will shape the situation they are used in and also the intentions of the human using them. For this reason, it is especially relevant for engineers, designers and ethicists to pay attention to *how* robots might extend the capabilities and *how* exactly they might shape the intentions of humans in these sensitive contexts. The example of the phenomenology of the human-technology relation also shows that the humanities are a valuable resource from which researches can draw ideas and insights. This will help us to evaluate our relationships to prospective robotic "mediators" more clearly, which in turn helps designers in their attempt to actively shape that relationship according to our ethical needs.

3 Don't Hurt My Robot!—Robots as Recipient of Ethical Behavior

Another 'gravitational center' of the ethical discourse around which the discussion revolves is the robot as (possible) recipient of ethical behavior. Nevertheless, for many people (philosophers included), ethical behavior towards machines is still a long way off. Because robots are mere accumulations of metal, wires and silicon and not organic material, they argue, ethical behavior towards them is conceived as science-fiction fairy tale.

[5] I am thankful to one of the anonymous reviewers for bringing that to my attention.

However, a look at the history of ethical considerations and disputes in moral philosophy shows that the circle of ethical recipients has been continuously extended. Nowadays, it is unimaginable and ethically indefensible to hold slaves. An accomplishment that has been hard won. Furthermore, a certain ethical sensibility concerning our behavior towards animals has advanced. This inevitably leads to the question whether the moral realm might some day also encompass advanced machines like robots.

This issue immediately raises (sometimes very harsh) replies. One possible counter argument found in the literature addressing this question is the following: Robots are not persons. They don't possess "personality". Thus, the argument goes, we don't need to treat machines the same way we would treat persons like our fellow humans. But there is also a strong counterargument to consider: Societies 'make' persons, because persons are 'produced' by a process of personification, which is conferring the status of a person to something [47]. That is, society as a whole confers person status to someone. Therefore, society may confer person status to *something* too. Furthermore, a cursory glance on history shows us that the exclusive circle of "persons" has never been static but was constantly in flux: "[...] in the past, blacks, gypsies, children, women, foreigners, corporations, prisoners, and Jews have all been regarded at some points in history as being legal non-persons" [29, p. 213].

The theorizing can be backed up by empirical data. A recent study shows that the more 'intelligent' a robot acts, the more people are inclined to attribute *liveliness* to it [3]. There is a correlation between the perceived intelligence of a robot and the degree of vitality attributed to it. In turn, attributed liveliness may lead people to treat robots like they would treat other living beings, like animals for example. Humanoid robots designed and crafted to interact with humans on an emotional level are sometimes referred to as "affective humanoid social robots" [40]. To facilitate interactions with humans, they present themselves as if they had mental states, emotions and intentions. Humans quickly switch to a social mode of interaction as soon as they make contact with these *social robots*: "[...] individuals engage in social behavior towards technologies even when such behavior is entirely inconsistent with their beliefs about the machines" [40, p. 250]. Another recent study on the emotional effects of robots on people, published in this journal, lends further support [36]. It reveals that humans have strong emotional reactions towards the robot used in the study and showed empathetic concern for it after watching a video of it being tortured, even when participants had no prior contact with the robot.

Because a person is "what can put on a human performance in any social situation" [47, p. 162], I believe that given that they can attain a certain level of behavioral complexity, robots will be considered as having critically human characteristics such as rational behavior or personality. This, in turn, will increase the likelihood of their inclusion in the category of ethically considerable beings.

A simple tool to settle the question whether a given robot may have achieved the status of a moral person comparable to human beings is the so-called "Turing Triage Test" devised by Sparrow [42]. Based on the traditional Turing-Test, he proposes a "[...] test for when computers have achieved moral standing by asking when a computer might take the place of a human being in a moral dilemma, such as a 'triage' situation in which a choice must be made as to which of two human lives to save" [42, p. 203]. If the moral dilemma stays intact, the machine has achieved moral standing.

Given the intimate contact between robots and humans that can be expected in the future, we are well advised to establish some criteria that help us assess the human-robot interaction. A good starting point is to seek out certain categories of interaction in order to get a hold on how people conceive of a robot and what they attribute to it. In presenting 9 psychological benchmarks, Kahn, Ishiguro, Friedman and colleagues [23] propose a useful account of how the success of building a humanoid robot can be measured. These benchmarks (or categories of interaction) can then be translated into testable hypotheses that can guide the empirical research of human-robot interaction.

The closeness of humans and robots entails ethical relevant issues. Regarding artificial pet companions, Sparrow [41] has argued that there is a big deal of delusion involved in the affection that humans have towards them. But whether humans are really delusional in their affections and interaction towards robots is a question that has to be settled by empirical research. In an interesting study about the affection and attachment of preschool children towards the artificial pet companion AIBO, Kahn and colleagues found that only one quarter of them attributed animacy to the robot whereas half of them attributed biological properties [24]. Nearly two-thirds of the kids assigned mental states and moral standing to the robot. What is particularly interesting, however, is that when confronted with a stuffed pet dog, the children evaluated it in the same way as they evaluated AIBO. The study also shows that while the judgments about the two artifacts are in an equal proportion, the children acted differently in the two cases: Although half the children claimed that both the stuffed dog and AIBO could feel pain, "[...] results showed that children often mistreated the stuffed dog (184 occurrences) but seldom mistreated AIBO (39 occurrences)" [24, p. 428]. The authors acknowledge the mismatch between the explicit statements of what the children believed about the device and their actual behavior: "[...] while in one sense the children knew that AIBO was an artifact, that knowledge did not stop them from conceiving of and treating AIBO socially in some ways as if it were

a real dog" [24, p. 429]. The findings seem to indicate that the story about our attachment to robots is more complicated and cannot be simply written off as instances of delusion.

Whatever empirical research will reveal, there is one thing that can be claimed in advance: To use the appearance of a robot to deliberately deceive the users about its capabilities is ethically questionable. This is especially crucial when it comes to 'socially assistive robots'. These are robots that are supposed to assist humans via social interaction and are therefore in close contact with humans. To avoid the possibility of deception, it should always be clearly communicated to all people involved which capabilities the robot has and which it lacks. The potential for deception should be minimized wherever possible [13].

With the use of robots in more common areas (e.g. work-robots in the factory or robots for domestic use), the emotional bonds between humans and their machines are likely to strengthen, especially if robots start to behave like fellow human beings. Particularly interesting in this regard is the ability to display recognizable facial expressions, like the famous KISMET [4], or the use of gestures and language. Given the importance of the appearance of something for our conduct and evaluation of it, some authors have evoked an "ethics of appearance" [8].

What does all that amount to? Because our moral judgments are at least to some degree grounded in our feelings, emotional responses and affective engagement with something [19, 34], I would like to emphasize that researchers and designers of robots should be sensitive to the impact that their creation might have on the emotions, and hence moral compass, of the humans that interact with robots. Designers should be aware of the possibility that the appearance of the machine might deceive users into believing that it has capabilities that it in fact does not have. Thinking about their creations as possible recipient of ethical behavior can help them to gain a better understanding of their work and their responsibility as creators of robots.

4 The Acting Robot—Robots as Moral Agents

In contrast to discussions that revolve around robots as tools or possible recipients of ethical conduct, I now want to identify a third 'gravitational center' that has attracted the attention of ethicists and philosophers. Robots might not only be conceived as passive recipients but also as active moral agents. The focus here is the behavior of the robot itself and it's standing as a moral agent: The robot is conceived as a moral agent.

Some tasks and problems have reached a level of complexity that justifies the use of semi or fully autonomous technological systems that have the ability to make crucial decisions on their own. The situation might call for a quick reaction and bringing a human into the loop would slow down decision making and cause harm. I understand autonomy here in the broad sense of self-government without a human operator that is controlling every move. There are already several autonomous robotic systems embedded in the everyday lives of people. These devices are so sophisticated that one might call them "decision-makers". The decision that these systems make can have pervasive consequences. Here are some familiar examples: Software-agents deployed to independently buy and sell stocks. Another crucial system we are all familiar with is the autopilot in airplanes. Perhaps the most striking example comes from the German city of Nuremberg, where commuters can enjoy a ride in an automated driverless subway.

Of course, the assistance supplied by autonomous robotic technology in our domestic and public lives has a lot of advantages. However, the shining benefits of robotics should not blind us to possible unfavorable outcomes. Our dependence upon technological systems has also exposed us to new risks. Wallach and Allen [51] present a noteworthy case that reveals the serious ethical implications of autonomous systems: In 2003 autonomous power control units shut down in 8 states of the USA, causing a massive blackout. Since energy supply is critical for hospitals, nursing homes and the cold chain, the ethical explosiveness of this incident can be expressed in one simple formula: Energy = Life.

For all these reasons, autonomous systems need to be designed to weigh risks and values. The systems will need to have the ability to assess various options and adopt different perspectives in order to be used in a human environment with all its uncertainties. The question is not only what humans do with their computers and machines but also what these machines can or ought to do on their own. The government of South Korea seems to have the necessary foresight that is needed here because it has set up a "roboethics-charter", that includes instructions for users and producers, but also directives that ought to guide the programming of ethical standards into robots [30].

According to Wallach and Allen [51] the design of artificial moral agents should incorporate two dimensions: Autonomy and sensibility for values. Ethical behavior requires the possibility of free action. This in turn means that the more autonomous a technology is, the more it needs to be sensible to values and norms. Autonomous systems need to perceive and interpret their present situation in order to be able to identify what is demanded, forbidden or tolerated.

These situations not only include information about the environment that can be captured by means of sensors, but also morally relevant marginal conditions, which need to be grasped and processed [16]. In order to be in a position to do this in an adequate way, the robot also needs the ability to learn from past situations and has to be able to cope with new and unforeseen circumstances. For artificial moral

agents to function in the realm of human beings, they have to be 'learning' machines. They need the capacity to absorb and gather norms and standards from their environment [51, p. 106].

Although I think that the design of artificial moral agents is a goal that is worth pursuing, it faces some serious difficulties. Not only is moral behavior and ethical reasoning a very though nut to crack (as the hundreds of years of ethical thinking clearly indicates), but there are also more general questions that need to be addressed; preferably before one dives into the details of design and programming. The questions I have in mind here are: Which ethical standards and routines should we implement into a robot? or Should developers favor a 'top-down' or a 'bottom-up'-approach? The top-down approach refers to the implementation of ready-made principles and algorithms, whereas the bottom-up method favors machines that make their own 'experiences' in several circumstances and 'learn' morally appropriate behavior.

Increasing sophistication in robots has led some people to the conclusion that robots clearly qualify as agents and therefore need to be addressed as such. Floridi and Sanders [15] for example developed a framework that allows for the integration of artificial entities into the class of agents. Their approach does not depend on anthropocentric presumptions about agenthood or having mental states.

Whether you believe that anthropocentric presumptions should be dropped or not, thinking about robots as moral agents opens up new perspectives on the impact of this technology on the lives of human beings. By extending their horizon beyond the mere technological capabilities of the machines they build, it helps manufacturers and designer to gain a more complex view of their role in the process.

Ultimately, I think the single most important question we should ask is the following: Do we want autonomous robots? If the answer is yes, we should subsequently ask: How autonomous do we want them to be? Having said that, we should be aware that, given the highly context-dependent nature of this technology, there is no 'one-size-fits-all answer'. Different areas of application have different standards and norms attached to it. Right now, a robot intended to support you with your daily household chores, like the vacuum robot Roomba, has a higher degree of autonomy then a combat robot or a drone that needs to be operated by a human being on the battlefield or in a control center. Apart from technical and practical limitations that accompany the use of robots in the open field, the different degrees of independence also reflect the moral significance of the context in which they are used: The possible damage done by a household robot is far less severe than the possible harm that can be inflicted by a combat robot. The vacuum bot might endanger furniture and little animals, whereas the combat robot puts human lives at risk.

Of course, this is how matters stand now, which does not imply that it is going to stay that way. There may be good reasons in the future to endow a combat robot with more degrees of freedom. The interesting ethical question then becomes: Do we want and need combat robots with more autonomy? A satisfying answer needs to balance practical considerations with ethical concerns. Which calls for close collaboration between people with hands on experience and professional ethicists and philosophers.

5 Robots and the People—Robots as Influence on Society

I claim that regardless of whether we conceive of robots as mere tools, recipients of ethical behavior or as moral actors, we also need to think seriously about their social impact. It may seem that robots conceived as actors have a more powerful influence on social norms or values. After all, I think we are inclined to rethink our concepts of responsibility and autonomy (in the moral sense) if a robot is conceived as an agent. But even as a simple tool, robots can have an enormous impact in society and might contribute to the restructuring or even erosion of norms, standards and customs. The sometimes very heated discussions surrounding the influence of computers or the Internet on privacy and identity and on our social lives [45] are a reminder of that.

Please note, similar to every significant technological development, the introduction of robots should be accompanied by a careful investigation of the ethical issues they may bring about. Feil-Seifer and Matarić [13] show how that should look like. They examine the challenges of socially assistive robots and present core principles, derived from medical ethics, that can be used to assess the risks involved. In the introduction I referred to Moor [31] who distinguishes four different types of ethical agents. One of them is what he calls "ethical-impact agents". He claims that technology (computer technology in particular) frequently has ethical significance for social norms and values. I think that this is an important insight. Whether robots are used as tools or are endowed with a certain degree of freedom, we should take the road of precaution and consider in advance how robots may affect our social lives.

Here is a 'classical' example of how robot-technology is thought to have an influence on the social fabric: the fear that machines will replace human beings. A recent cartoon in *The New Yorker* (January 21, 2013) depicted a line of framed pictures of employees of the month, the last four showing a robot. The cartoon seems to echo the common concern of people that robots might replace human beings in the workplace. Robots are seen as rivals and competitors. (Various science-fiction plots arguably also encourage this concern.)

This worry is not completely without empirical foundation, however. The statistical department of the International Federation of Robotics states that since the introduction of the first industrial robot in the 1960's, robotics companies sold a total number of 2.3 million industrial robots worldwide. The year 2011 was the most successful year for robot sellers so far.[6]

For this reason, the introduction of robots may be viewed as an ethically questionable enterprise, because it supposedly drives people out of the workforce. I do not have the space and time to discuss whether this fear is justified or not (Personally, I think it is not). Nevertheless, nobody will doubt that the introduction of the first industrial robots in the USA during the 1960s has lead to a profound change of the working conditions of human workers. It comes as no surprise then, that there is considerable buzz within professional Technology Assessment concerning the replaceability and non-replaceability of humans (e.g. [9]).

I think that the term "replaceability" is too abstract. We should bear in mind that replaceability never stands for a holistic replacement, but rather a replacement in specific contexts of action and fields of duties. But the spread of service-robots and the intrusion of robots into the domestic domain and personal sphere confronts us with ethical questions that go beyond the replaceability of human employees. Echoing concerns that the introduction of robots into our lives may have disturbing effects, Arkin [1] asked what would happen if, instead of being confined to the '3 D's' (dull, dirty and dangerous), robots were used for housekeeping and babysitting and would conquer our domestic domain.

Considerations like this take us back to the classical Aristotelian question concerning the good life: How do we want to live and how are we *supposed* to live? We might want to expand this question and include robots and their contribution to the way of life we desire. Robots conceived as socially important impact factors imply a shift in perspective. Away from questions about the moral status of robots (either as agent, recipient, or if they are able to "act" ethical), toward questions concerning the life we want to live. Coeckelbergh argued that we ought to shift from a "robocentric" to an anthropocentric stance: "Rather than focusing our ethical worries on robots, let us worry about humans, about what we think, feel, and dream of [...]" [8, p. 219]. I would like to expand that idea by adding considerations about the role we want robots to play in our society.

These concerns are especially important when it comes to the members of the society that are most vulnerable. The use of robots that care for the elderly and watch over toddlers (so-called "child-minding robots", see [38]) can have delicate ethical consequences. Despite the obvious relief for human caregivers that these machines can bring, a major possible danger involved in their use is the full delegation of care to the robot. Children and older people would thus be deprived of important interpersonal contacts.

In a recent publication, Sharkey and Sharkey [39] focus on the potential ethical risks of using robotic surrogate nannies in child care. They point out that children spending time with robots ultimately form a bond with them and will perceive them as friends. Of course, to create robots that appear to have mental states or emotions is not ethically questionable per se. However, according to the authors "the illusion becomes a harmful deceit both when it is used to lure a child into a false relationship with a robot and when it leads parents to overestimate the capabilities of a robot. If such an illusory relationship is used in combination with near-exclusive exposure to robot care, it could possibly damage a child emotionally and psychologically [...]" [39, p. 173].

Nobody will deny that socially assistive robots present some serious ethical challenges that need to be tackled, but I think the image that Sharkey and Sharkey draw is too simplistic and falls short of the complexity of the problem. Based on state-of-the-art research in the field of assistive robotics, Feil-Seifer and Matarić [14] argue that the intention behind the development of socially assistive robots is not to pass the responsibility of care over to the robot. A study conducted by one of the authors shows that the robot does not easily fool children and that they are not convinced of the social skills of the device. So, although it is certainly correct that a lack of attention and care can lead to attachment disorders in children, the worries that the Sharkey's put forward are not supported by empirical evidence.

I strongly agree with the claims made by Feil-Seifer and Matarić. We should turn the argument that the Sharkey's make back on its feet: The current state-of-the-art robots do not cause detachment, but they may be brought into an already existing climate of questionable parenting. Sharkey and Sharkey simply get the causality wrong: Robots do not cause bad parenting, but can be used by negligent parents. Assistive robots are certainly not designed to replace human beings as caregivers. They should be used as an augmentation, enhancement and supplementation of care, not as a replacement.

Although I presented the four dimension of the taxonomy in separate chapters I strongly believe that we need to consider them in conjunction because the boundaries between them are blurry. Reality tends to be messy and our categories and concepts should account for that.

To show how ethical, legal and social questions are connected to the behavior of a robot, just consider the possibility of harm brought upon human beings or valuable property by a robot. How should responsibility be distributed if robots 'act' without any human being 'in the loop' in ethically sensitive areas such as hospitals or war zones? Who should be

[6] For annual statistics visit http://www.worldrobotics.org/index.php?id=home. The numbers I have stated in the text can be found here: http://www.worldrobotics.org/index.php?id=home&news_id=261.

held accountable for the unethical behavior of the robot? Should we blame the producer or the user? And who is the user anyway if the robot acted without human supervision? Should we blame the robot? Under which circumstances is it justifiable to endow the robot with a higher degree of freedom? As already indicated in section four, the desirability of an increase in the degree of freedom of a robot depends on the ethical sensitivity of the context in which it is going to be deployed. The ethical salient features of the context of a vacuum bot are remarkably different from the features of the situations in which a combat robot is going to be used.

These and similar questions cannot be answered by any discipline in isolation. We may think about reshaping our concept of responsibility in order to be able to locate liability for failures within complex robot-human-world settings as Gräbner [18] proposed. But how exactly we should reshape involves the effort of a variety of disciplines and should not be left to professional philosophers or ethicists. Again, in focusing the attention on specific dimensions, the taxonomy can serve as a common springboard for transdisciplinary discussions. Particularly, the taxonomy is an effective framework that helps designers and producers come to grips with the current debate concerning ethical issues of robotic research.

6 Robots and Ethics—The Meta-perspective

Philosophers are always quick to make critical suggestions and to draw attention to the flaws in the work of scientists. Unfortunately, they often turn a blind eye when it comes to their own discipline. They are also very eager to point out the influence of technology on other disciplines and on society. Sadly, philosophers and ethicists working on the ethical implications of robots rarely address the implications and ramifications of robotic research on their own discipline. In taking an outside or bystander-perspective, they often exclude themselves from the disciplines they consider to be influenced by technology.

However, the aphorism *Fabricando fabricamur*- in manufacturing things, we manufacture ourselves- by Jan Amos Comenius, a theologian and pedagogue of the 17th century, is still strikingly up-to-date in the 21st century. It should also be applied to ethics and philosophy: In manufacturing things we also reshape and remodel ethics as well.

Some remarks in the former sections of this paper already slightly touched upon the impact of the design and development of robots on ethics and philosophy. One crucial influence is more than obvious: Robotics is the subject matter of examination by professional ethicists and in this regard it is not different from other cutting edge technology like genetic engineering or nanotechnology. Technology has always exerted a certain pull on intellectuals and has drawn scholars towards thinking about the ethical problems associated with it.

In the process of reflecting on technology, philosophers were always required to critically rethink and reshape their concepts and paradigms. Technological progress and innovation is a crucial constructive impetus for ethics itself: Be it the reevaluation of the distinction between artifacts and living organisms [26] brought by biotechnology or the reshaping of the relationship of parents to their yet to be born child in the case of advanced imaging technologies like ultrasound [49].

In the light of this observations it is surprising, therefore, that ethicists seldom critically examine the influence that technology has on the theoretical level of their discipline. They don't hesitate to evaluate the influence of robots in particular niches such as medical care and the "social impact of intelligent artifacts" [35]. But they hardly illuminate the various forms of influence that robotics has on ethics itself. That is alarming because it is not clear how professional ethics can thoroughly deal with ethical questions regarding robotics if the influence of this very technology on the theoretical framework of ethical consideration itself is not submitted to thorough and critical scrutiny.

Please note that this is not a plea for a radical separation of ethics from robotics and artificial intelligence. My suggestion here is more modest: Roboethics ought to be more self-critical regarding its subject. That is, ethicists working in the field of robotics (or all scholars dealing with the ethical implication of technology for that matter) should take a self-critical perspective when it comes to their own discipline.

I want to elucidate what I have in mind by turning again to Artificial Moral Agents (or AMAs) that I have introduced in chapter four. Wallach and Allen [51] distinguish three important questions in connection with so-called machine morality: (1) Do we need AMAs?, (2) Do we want machines to make moral decisions?, (3) How should engineers and philosophers implement the design of AMAs? Although these questions are undoubtedly relevant, I would propose that ethics as a science of reflection should also ask more self-reflective questions like 'Can our present ethical theories and paradigms cope with new developments in technology, or is it necessary to rethink and revise them?' We should critically inquire into the extent to which the concepts need to be reshaped or dropped entirely.

I claim that ethicists working on the ethical significance of robots should consider the possible disadvantages of adjusting their paradigms and concepts in order to accommodate the latest technical developments. Hence, I would like to supplement the taxonomy that I developed earlier by one important aspect. What I am proposing here is a double meta-perspective of sorts: On the one hand, *ethicists* should be more sensitive to how research in robotics technology

and its products might influence their thinking. On the other hand, *roboticists* should also pay attention to the terminology and concepts they deploy.

The following two examples are supposed to make clear what a self-critical *meta-perspective* reveals about the influence of robotics on the discipline of ethics: Throughout history various technologies have served as so-called "epistemology engine" [21]. That means a technology (or more precise the workings of a technology) is used as a metaphor or a model for understanding some human feature. To name just two examples: Both the camera obscura and the computer have been utilized in order to get a better grasp on how to think about the human mind and cognition.

I think that it is possible that the robot may serve a similar purpose in that it becomes the glasses through which we conceive and interpret ourselves as human beings. Furthermore, robots may come to be used as a model for the acquisition of morals and ethical conduct; thus, being used as some sort of 'morality-engines'. Of course, all of this is highly speculative because no robot so far is sophisticated enough to be used as the model for the acquisition of moral competence. We should be vigilant nevertheless. Robots as "epistemology engine" may seduce us to model the feature in question according to a particular technical aspect. Which means that features related to that aspect are emphasized while other, seemingly unrelated, aspects are being played down.

I do not think that this is a disadvantage per se. It lies in the nature of a model (and an epistemology engine is nothing but a model) to limit our scope and pick out certain aspects rather than others. Otherwise it would not help us to cope with an intricate phenomenon. Having said that, the terms in which a problem at hand is framed have significant implications for how people look at the problem and how the solution is approached and formed [7]. In psychology this phenomenon is known as a cognitive bias referred to as "framing effect". How the choice is presented (how it is 'framed'), influences the decision that individuals make [25]. Therefore, I strongly insist that we are self-critical in our use of models and how we frame certain problems. More important, we have to be sensitive to the models we may hold implicitly. Otherwise we may end up thinking about humans within a framework in which the robot as the measure of all things.

The second example of what a critical *meta-stance* might entail can be gleaned from the criticism brought forward by some philosophers regarding the terminology that is used by some robotic-researchers. Some of the vocabulary in use strongly leans towards an anthropomorphism that calls for critical attention. In order to get a clearer idea, I want to introduce an idea from linguistics.

In their groundbreaking work *Metaphors we live by*, Lakoff and Johnson argue that our concepts, which we use to make sense of the world around us, are mostly metaphorical in nature. That is, we usually understand and also experience "one kind of thing in terms of another" [27, p. 5]. An example is the concept of 'mind', which is often conceived of in terms of the discrete entity 'machine'. This amounts to statements such as 'The mind *operates* in such and such way' or 'The mind can *break* down'. We make sense of the elusive concept 'mind' in terms of something that is more specific and more easily graspable.

We can also find metaphors of personification, in which we use features of a person to understand other concepts. In saying that 'society is healthy' for example, we take an aspect of the concept of person to conceptualize something non-physical.

The metaphorical structure of our conceptual framework has some important implications for our theoretical attempts. If the mind is conceived as a discrete entity like a machine, we also think about it as having parts that interact with each other, as having an energy source, transforming input to produce some output and so on.

The metaphorical nature of our concepts also influences the way we live our lives. If the mind is conceived as a machine, the solutions that are sought when we encounter problems of the mind (e.g. mental illness) are likely to be phrased in technical terms, which may lead to a rather technical treatment in order to 'fix' the mind and to bring it 'back on track'. The heavy reliance on drugs in the treatment of mental illness can be considered to be a technical treatment in this sense.

Metaphors have a double-nature of sorts. As much as the metaphorical structure helps us to understand the phenomena surrounding us, at the same time it obstructs the view of other features. Metaphors always focus on certain aspects while hiding others. They are like a beam of light that illuminates certain parts while leaving others in darkness. Obviously, mind and machine are not the same category of things and the 'mind as a machine' metaphor emphasizes only very specific aspects: A very distinct set of descriptions of what it is to be a machine is used to conceptualize the mind. Alas, the metaphors are often taken to be veridical description of the phenomena.

Now, I wish to argue that the anthropomorphic vocabulary (terms like 'will' or 'belief') that is often used for the characterization as robot behavior should be conceived of an instance of a personification metaphor. Thus, we have to be aware that while highlighting certain aspects they conceal others. In addition, concepts like 'autonomy' (in terms like 'autonomously-intelligent robots'), 'intelligence' and 'action' are all part of the word pool of researchers. The anthropological and ethical connotations of the vocabulary that is used here may be taken to be true descriptions of robots, disguising important differences between humans and machines.

I do not want to imply, of course, that the use of certain terms in the robotics community is unethical. Different disciplines have different standards when it comes to the use of terminology and the use of the same vocabulary in various disciplines is inevitable. Having said that, I propose here that designers and engineers should think critical about the implications and hidden complexities of their conceptual framework and how these shape the way they think about their work.

What about roboethics? I argue that if robotics researchers are criticized for their uncritical use of anthropologically and morally charged vocabulary, philosophers should also critically examine the ways in which they frame certain ethical problems. It may very well be that their vocabulary is already 'infiltrated' by technologically charged termini and concepts that influence their thinking and lead it down a path that they are not aware of taking. This influence should be kept in mind and reflected upon at all times.

An example is the way in which Floridi and Sanders frame the problem of artificial agency in their seminal paper "On the morality of Artificial Agents" [15]. Their guidelines for agenthood include the three criteria interactivity, autonomy and adaptability. They describe interactivity as the response to a "stimulus" by a "change of state" and in terms of "input and output", whereas autonomy and adaptability are expressed in terms like "internal transition rules" and "modes of operation". The choice of terminology and the way the problem is framed approximates humans and machines. This, again, is not a big problem as long as such decisions are clearly communicated and warranted by the goal that wants to be achieved.

Taking the *meta-stance* brings an advantage in that it enables creative thinking outside the box. More than often the critical energy of scholars is focused on one of the aspects or dimensions concerning robots that I have presented in the taxonomy. Ethicists for example might focus on the instrumental use of robots or the question if the robot qualifies as moral agent. Furthermore, ethicists often focus on the influence of certain kinds of robots on certain kinds of people. They are, for example, focusing on how assistive robots in health care might affect patients, relatives and personnel. Or their primary focus might concern the psychological effects of combat robots on soldiers and superiors.

This, of course, is perfectly understandable given the limited time and resources of busy scholars. I want to advocate, however, that the proverbial bigger picture should always be part of the process of thinking about particular issues. In other words, the meta-perspective should be used as sort of a critical corrective that helps to broaden the scope of the in-depth considerations. The taxonomy developed in this paper is a useful tool that helps to bring a critical meta-perspective to its fullest potential. It can help scholars to gain a more nuanced view of their own work and how it relates to the work of others.

The taxonomy promotes a critical meta-stance because it enables specialists to ask questions that locate their work in the broader context of the theoretical landscape of robotics research. By using the taxonomy to figure out where in relation to the other dimension or 'gravitational centers' of the discourse their own work is located, the scholar is empowered to consider aspects (e.g. cultural, social, individual) that completely escaped her attention.

Apart from enabling scholars to assume a self-critical meta-perspective on their own work, the taxonomy also enhances the in-depth considerations mentioned earlier by opening up fresh perspectives on the problem and disclose connections between topics previously hidden from view. Further, the researcher is invited to examine her own solutions and approaches in the light of the other aspects: Does my way of thinking about the problem make sense in the light of the other aspects in which robots can be examined?

People have the tendency to acquire some of the peculiarities of the things they are close to. Partners in a relationship become more alike and students very quickly grow into the jargon of their field. People working in roboethics and designers and creators of robots should be aware that the closeness to their subject may influence their terminological toolkit and thinking in a way they are not intending.

7 Concluding Remarks

The main aim of this paper was to present a useful taxonomy concerning robotic technology that can be used by professional ethicists, designers and engineers of robots in a joint effort to tackle future and present ethical challenges of this technology.

It was not intended to deliver a semantic examination of the term 'roboethics' or an analysis of how the term is actually used in the literature. Rather, I entangled the threads of the ongoing debates and differentiated four 'gravitational fields' around which ethical considerations revolve: the robot conceived as mere instrument or tool, the robot as recipient of ethical behavior, the robot as moral agent and, last but not least, the robot as social impact factor.

Furthermore, I introduced an additional dimension, which I have dubbed 'meta-stance' and argued that robotics and roboethics should get into a critical state of mind concerning their own work.

I know that all the important issues concerning robots cannot and should not be addressed from the armchair alone. Thus, I would like to conclude with some implications of the presented taxonomy for the collaboration between roboticists and ethicists:

First, ethical, social, cultural and technical considerations should be combined. Only by bringing various disciplines to the table can any satisfying headway be made. People with

hands on experience in robotics and people coming from the humanities should engage in a lively discussion. This can be a tough endeavor given the different backgrounds and seemingly incommensurable mindsets of these two groups. With the presented taxonomy, the various disciplines have a common pool of ideas and issues that they can use to dive into more detailed discussions.

Second, it can be argued that engineers approach artifacts from a predictive future-directed perspective. They are trying to predict how the artifact, which does not exist yet, will behave and they are also predicting the behavior of possible users of this artifact [46]. I think that this perspective should not only include practical concerns such as usefulness or functionality of the device but also the impact of the artifact on the lives and values of the users, as well as its impact on society. Engineers and designer of technology should reflect in advance on the impact of their creations.

Because it is not easy for engineers and roboticists without any training in ethics to find their way through the thickets of ethical debates, it is the responsibility of professional philosophers and ethicists to support them in their effort. The presented taxonomy proves as a good starting point for roboticists who are interested in the ethical implications of their work. It is a handy tool to structure the ethical debates and get a hold on issues that features in this debates.

Third, professional philosophers and ethicists who want to evaluate emergent robot technologies may also find the taxonomy advantageous. Placing technology along the coordinates of this taxonomy can help them to make an informed assessment.

Fourth, the taxonomy presented here is a necessary and needed supplement to already existing taxonomies. It is not intended to be a replacement but a necessary extension. Moor [31] for example develops a taxonomy that distinguishes four forms of ethical agents. Although he is sensitive to the general impact of computing technology on identity and privacy, his classification mainly focuses on agents. This scope is too limited because it neglects other important dimensions like the robot as tool or as recipient of moral behavior with unique moral standing; dimensions I have explicitly included in the taxonomy presented in this paper. Likewise, the taxonomy that has been put forward in the Roboethics Roadmap [50] only focuses on one dimension. It categorizes robots according to their technical specifications and intended areas of usage. In focusing on the ethical dimension of robotics, however, my taxonomy includes an important perspective that is neglected by the Roadmap.

Acknowledgements I would like to thank the anonymous reviewers who really helped me to improve the quality of this paper. Further, I am indebted to Editor-in-Chief Shuzhi Sam Ge and JEO Assistant Anand David for their guidance during the publication process.

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Steffen Steinert is a Ph.D. student at the Graduate School of Systemic Neurosciences at Ludwig-Maximilian-Universität München, Germany. Previously he has studied at Technische Universität Dresden, Germany and the New School for Social Research, New York. Besides philosophy of technology, Steffen's research interests include philosophy of humor, philosophy of mind and philosophical issues related to cognitive sciences and neuroscience.