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The Universal Robot of the 21st Century

BENDEL, O.[a 1]
[a] *FHNW School of Business, Switzerland*
ORCID ID: Oliver Bendel https://orcid.org/0000-0003-2623-9119

Abstract. Developments in several areas of computer science, robotics, and social robotics make it seem likely that a universal robot will be available in the foreseeable future. Large language models for communication, perception, and control play a central role in this. This article briefly outlines the developments in the various areas and uses them to create the overall image of the universal robot. It then discusses the associated challenges from an ethical and social science perspective. It can be said that the universal robot will bring with it new possibilities and will perhaps be one of the most powerful human tools in physical space. At the same time, numerous problems are foreseeable, individual, social, and ecological.

Keywords. Service Robots, Social Robots, Large Language Model, Generative AI

1. Introduction

The idea of the universal robot is an old one. In 1939, Elektro was presented at the two-year World's Fair in New York. It was designed to resemble a human being, was over two meters tall, could move and talk, and smoke a cigar. The very next year, Sparko, a small, cartoon-like robot dog, was found at its side in the same place [1]. Elektro gave the impression that it could take immediate action and do many of the things that humans do. Of course, this was not the case, as this was a very basic model. And yet, it seemed to be a new fellow citizen and fellow campaigner. After that, it was mainly industrial robots that were built, as well as service robots for use in crises and disasters, such as clearing and demolition robots. Since the 1990s, there have also been many social robots with a humanoid or an animaloid design. But only today is it becoming clear that the idea of the universal robot, for which Elektro had made a promise through its appearance and behavior, will soon become reality, probably in the 20s of the 21st century. This is because significant progress has been made in recent years in all areas required for this. These include large language models (LLMs) that are integrated into robots [2].

The concept of the universal robot means that it can be used in almost all areas in which we also work and can carry out numerous activities like us, sometimes with comparable thinking, problem-solving, and decision-making skills. Of course, there are always limitations because robots are not humans. After all, humans are the result of millions of years of evolution, and tens of thousands of years of civilization and culture, and their brains and bodies are capable of top performance of all kinds. However, such artificial generalists will be able to do things that we cannot do, and for the same reason: robots are not humans. We can expect the universal robot to be able to do the shopping,

[1] Corresponding author: Oliver Bendel, Bahnhofstrasse 6, 5210 Windisch, Switzerland; e-mail: oliver.bendel@fhnw.ch.

load and unload the dishwasher, water the plants, and walk the dog (whether it is a real dog or a robot dog). It can be expected to work in the factory and the office, on the building site, and on the farm. But it becomes clear that the universal robot can do more. It can see at night, it can perceive sounds that we cannot hear, it can speak hundreds of languages, it can lift and move heavy things. That being said, this article does not focus on artificial general intelligence (AGI), which is not in sight even today and which is not a prerequisite for a universal robot. Rather, the prerequisite is the ability to carry out all relevant activities and simulate all relevant skills.

For the universal robot to be able to do all this, it is best if it has a humanoid design, in the tradition of Elektro. It should be about the size of a human and have similar limbs and hands, in a similar number. Then it can easily use all the artifacts we have created, especially paths, buildings, vehicles, and tools. It should also be able to communicate and behave like a human. In other words, it should be a typical social robot, like Pepper, Ari, or Sophia, only on a different motor and 'intellectual' level, on a level that a few service robots already have [3]. Basically, the universal robot will be seen as a service robot that can be used in business, science, education, healthcare, and the private sector. The essential thing is that it is a social robot due to the features described. Of course, the humanoid design also has disadvantages. But the advantages seem to outweigh them. It is a human world, and machines have to be adapted to it.

The research question is: Can and should the universal robot be built today or in the near future? To answer it, this article first presents the technologies and approaches that have developed significantly in recent years, and which make it likely that the universal robot will soon be part of everyday life. This is followed by a discussion from an ethical and social science perspective. There is no doubt that the universal robot will be a help in all areas. But it will also displace, devalue, and worry people, and it will take their space and power. It will also disturb animals—although it could help them to live in peace. At the end, the research question is answered, together with a summary and outlook.

2. Steps Towards a Universal Robot

This section explains the areas in which progress has been made that ultimately enables the universal robot. First, the author briefly explains which disciplines and fields of work play a role. He then names a whole series of areas and outlines the progress made in these, insofar as they are relevant for a universal robot. The findings are brought together in a further section. The universal robot becomes visible.

2.1. Disciplines and Fields of Work Involved

The steps towards the universal robot are due in large part to developments in robotics—including social robotics—and artificial intelligence (AI). AI can be seen as part of computer science or as a separate discipline. In this article, it is assumed the reader is familiar with AI and robotics. Machine ethics and artificial consciousness are also relevant [4, 5]. There are various attempts to systematize these disciplines or fields of work. Misselhorn, for example, sees machine ethics as lying between computer science and philosophy, while the author of this paper sees it as somewhere between computer science, robotics, and philosophy, emphasizing the engineering character and the design task of the

discipline [6, 7]. Artificial consciousness can be understood as a sub-area of artificial intelligence, but also as a separate field of work with an independent character.

2.2. Progress in the Various Areas

2.2.1 Motor Skills

The motor skills of service robots and social robots are usually limited and restricted to parts of the machine. Some models are capable of forward and backward movement and movements of the head, body, and limbs. Legs are rarely present, instead wheels, rollers, or caterpillars are used. However, the two-legged Atlas—in 2024, the electric version replaced the hydraulic one—and the four-legged Spot from Boston Dynamics are very agile and can carry heavy loads [8]. Manufacturers such as Unitree Robotics have followed suit with models such as Go1 and Go2 (quadruped) or H1 and G1 (biped). H1 is marketed with terms such as "universal humanoid robot" and "full-size general-purpose humanoid"[2]. Figure 01 has been launched by Figure and is due to start work at the BMW plant in Spartanburg. "Figure is the first-of-its-kind AI robotics company bringing a general purpose humanoid to life."[3] The robot was connected to GPT-4 and demonstrates its perceptive and explanatory abilities in a video.[4] At the same time, you can see its fluid, natural movements. The successor is Figure 02. Other well-known models are Digit from Agility Robotics, Ameca from Engineered Arts and NEO from 1X and OpenAI. Tesla's Optimus was still in development in 2024 and had fallen short of expectations by then.

2.2.2 Sensor System

Service robots and social robots often have sensors corresponding to human senses, such as cameras, microphones, and odor sensors [9]. They can be equipped with sensors that enable them to perceive things differently to humans. Examples include ultrasonic sensors, lidar, and radar, which play a role in automated and autonomous vehicles, quadrupeds, and bipeds such as the Unitree Go2 and the Unitree H1, as well as care robots such as Lio [10]. Night vision devices—even a small social robot like Cozmo has one—and thermal imaging cameras are also widely used. This means that some robots surpass human perception capabilities, although the associated processors and models are of course also relevant for them. In some cases, motor and sensory skills are combined with artificial intelligence to calculate and enable the best possible step or grip.

2.2.3 Networking

The networking of robots, in the sense of the Internet of Things and machine-to-machine communication, is becoming increasingly important. Direct or mediated agreements can be made and swarms and herds can be created. These can be used to cover large areas with civilian or military applications. One example is the drone swarms developed by Zhejiang University, which can even roam through forests [11]. The author and one of his students developed a concept for a system that combines wildlife cameras as static components and drones and robots as mobile components [12]. Individual bears are recognized and ultimately protected with the help of facial recognition. If there are several

[2] https://www.unitree.com

[3] https://www.figure.ai

[4] https://www.youtube.com/watch?v=Sq1QZB5baNw

service robots or social robots in the hospital and nursing home of the future, they will also have to coordinate with each other and with facilities such as elevators [13].

2.2.4 Collaboration

Cobots—robots that were originally used primarily in industry and are intended for collaboration with humans—work closely with humans in production and logistics without causing injuries [14]. Both sides play to their strengths with the aim of completing the task as efficiently and effectively as possible and protecting the worker. Some service robots and social robots are essentially cobots mounted on mobile platforms or installed in specific settings. Lio has one arm, P-Care from the same company (developed together with a Chinese company) has two arms [10]. With two arms, hugging, dressing and undressing patients, handing and scooping food, moving furniture together, carrying parcels together, etc. are possible in principle, with appropriate further development of the software or AI system.

2.2.5 Design

Many industrial or service robots are designed to look like things. However, the arms are reminiscent of living beings. Animaloid and humanoid appearances are a popular approach for certain service robots and social robots [9]. There are possible combinations, including with the tangible design. One advantage of the humanoid design is that the robot can move through artifacts, across streets, and in buildings. It can use and manipulate all the objects that we have created for ourselves, for example with the help of its hands or body. In addition, the humanoid design creates acceptance (until it slips into the Uncanny Valley) and enables intuitive use. Pepper, NAO, Alpha Mini, and other social robots are humanoid in design in various ways [3]. Sophia, Harmony, and Emma are social robots with human-like silicone skin and mimic abilities. Some models, such as Pepper and Emma, have touch sensors on the surface or body heat. In addition to electric or cable-actuated hands, there are also those with flexible, pneumatic kinematics.

2.2.6 Partial Autonomy and Autonomy

Many robots are semi-autonomous or autonomous, i.e., they act (over a certain period of time) without direct control by a human, choose independently from various options, and solve certain problems on their own. These capabilities are being developed primarily in the discipline of artificial intelligence (with the help of machine learning). Service robots and social robots often need to be autonomous. Vehicles are also being given more and more autonomy so that a driver is no longer necessary. Segway transport robots are remote-controlled by humans—they appear autonomous to passers-by [15]. In the future, it will often come down to hybrid solutions. In the event of an accident, the autonomous car would make an emergency call to a control center, which could—e.g., with an unfit driver—immediately steer it to safe ground until the ambulance arrives. However, such structures are again complex and cost-intensive, which is why there will certainly be many autonomous solutions after a transition phase, unless human life depends on them.

2.2.7 Natural Language Capabilities

Natural language capabilities are being developed in AI and linguistics. LLMs such as GPT serve as the basis for the dialog system of social robots. ChatGPT (then with GPT-3.5) formed the dialog system of Pepper, which was presented at a German TV show in early 2023 [16]. Harmony has been using GPT since 2019 [17]. The LLMs contain 'world knowledge', whereby the focus is not on the representation of knowledge, but on learning, and not on logic, but on stochastics. Additionally, one can provide the system with extensive documentation, for example, about the company or an area of application, and give it sample dialogs. In this way, neural networks are combined with knowledge bases, as known from rule-based chatbots, and the answers are improved—an approach called retrieval-augmented generation (RAG). This makes it possible to have very open, arbitrarily long conversations without the system losing itself in arbitrariness and imprecision. With a text-to-speech engine, the robot can convert the text into spoken language, whereby numerous high-quality voices—male, female, and neutral [18]—are available or can be cloned (also with the help of LLMs).

2.2.8 Sociability

Social robots are sensorimotor machines designed to interact with humans or animals. They can be defined by five dimensions that relate to living beings, namely, interaction, communication, representation (of aspects), proximity, and utility [3]. They are hardware robots or, in a broader sense, software robots. Social is to be understood in the sense of being together with humans and animals. Many social robots are service robots, some service robots are social robots [9]. They simulate social skills, including empathy and emotions, often with the help of AI. While some are of the opinion that there are dangers, such as deception and fraud, others emphasize that in a certain setting such a simulation is purposeful and necessary. This is undoubtedly true—the teacher robot should be able to praise the child who has done something right [19]. However, the boy or the girl should certainly gain insight into the fact that it is feedback from a machine and not from an entity that is really interested in performance.

2.2.9 Artificial Morality

Thanks to machine ethics, household robots or care robots are given an artificial morality and become moral machines. They often work with (initially predetermined) moral rules. Prototypes in this area are LADYBIRD and HAPPY HEDGEHOG, animal-friendly domestic robots [20, 21]. Some systems can change the rules and adapt to the respective requirements. Anderson and Anderson have developed a value-guided system for a NAO in a care context [22]. In another project by Bendel, users can transfer their own beliefs and ideas to the machine via so-called morality menus (MOMEs) [23]. This was developed as a prototype for a care robot like Lio. Under the name constitutional AI, chatbots based on LLMs—such as Claude from Anthropic—are trained with high-level ethical guidelines [24]. In addition to fine-tuning, prompt engineering is used to create moral rules or 'guardrails' which are used to assess and, if necessary, reject prompts.

2.2.10 Perception

ChatGPT, based on the multimodal large language model GPT-4, has been able to see since fall 2023. It analyzes images that have been uploaded in relation to any aspect. This enables numerous applications, including for blind people, such as Be My Eyes with Be

My AI.[5] The analysis of moving images will be essential here in the future (and possible thanks to GPT-4o and Co.). The Be My AI function describes an image of the surroundings in detail. On request, it 'zooms in' and lists further explanations. It provides information on the atmosphere of an environment or the condition or posture of a person. The chatbot is cautious when assessing attractiveness. In addition, nudity is usually not analyzed, even in the case of world-famous works of art [25]. PaLM-E can be used for service robots [2]. Images of rooms and objects and their respective states over time captured by the cameras are integrated into the language model. The service robot or social robot can perform tasks when called upon without having to know and master them beforehand. Another example in this area is the aforementioned Figure 01. The perceptual possibilities may be relevant for the discipline of artificial consciousness [26].

2.2.11 Cyborgization

A cyborg is an organic structure into which technical structures are built. There are both human and animal cyborgs (and plant cyborgs). Many people have implanted chips with no medical purpose. A reverse or inverted cyborg is a technical structure into which biological structures are fitted [27]. Skin, nerve cells, and, in the future, perhaps also brains or parts of brains (or 'brain organoids') are integrated or implanted [28]. Developments of this kind can be located within robot enhancement [29]. These are primarily extensions and improvements to service robots and social robots where they are given clothing, accessories, artificial skin, additional limbs and tools, or even biological components. Service robots or social robots equipped with biological components can have different capabilities than their purely mechanical or AI-supported counterparts.

2.2.12 Replication

One vision is for machines and robots to replicate and repair themselves. The DNA of things can play a role in providing the necessary data [30], while 3D printers can be used to manufacture parts. Self-replication could make sense in huge nature reserves where robots take care of animals [31], or on alien planets such as Mars. In fact, humans themselves will probably not be able to conquer space beyond our solar system, including their physical presence. However, service robots and certain social robots are capable of doing this. Of course, the question arises as to which social entities these social robots communicate and interact with when no humans are present. They may be animals from Earth that prove to be resistant to radiation and other influences. It has been established that social robots can also be created for dealing with animals [3]. Or perhaps, they are extraterrestrials, which are very likely to exist on other planets.

2.2.13 Space and Energy

Like us, service robots and social robots require space and energy—so we use the same resources [9]. Most robots have replaceable batteries or exchangeable or permanently installed rechargeable batteries, and some can visit a charging station on their own. A few are solar powered, like Farmdroid[6], or can recycle organic material like EATR [32]. In undeveloped areas on Earth, in primeval forests, or desert regions, a self-sufficient

[5] https://www.bemyeyes.com

[6] https://farmdroid.com

energy supply, for example, by means of solar cells, would be particularly important. This also applies to foreign planets where there is no or no existing energy infrastructure. The density stress caused by service robots and social robots is still largely a fictitious problem. However, it can be observed in the USA, for example, that the interaction between robots and humans does not always function smoothly. This applies, e.g., to robot cabs that cause traffic chaos because the fog has paralyzed them [33], or transport robots that increase the complexity of road and pedestrian traffic.

2.3 The Universal Robot

Based on the results so far, an ideal-typical picture of a universal robot can now be put together. It must be said that the developments in the various fields are not sufficient in themselves. The components have to be integrated, which is by no means trivial. However, several examples have already been given of how robots with their motor and sensory components and LLMs with their natural language, visual perception, and moral adaptation capabilities have been linked. Against this background, the following result is quite conceivable and could be realized in a few years.

The universal robot of the future will be highly agile and fast on two or four legs; it will see, hear, and smell like (or better than) humans and animals; it will be organized in herds or swarms in which individuals communicate with each other; it will work hand in hand with other entities in close proximity; it will be designed to resemble humans or animals, right down to human-like skin and highly mobile, hard or soft hands; it will weigh options and make ‘decisions’ with significant implications; it will have natural language abilities with a large ‘world knowledge’ and a convincing voice; it will have social characteristics and abilities and the ability to be a partner; it will have an artificial morality and follows either fixed, derived, or ‘own’ rules; it will perceive the environment and its changes multimodally and work off prompts in physical worlds; it will be able to fuse with organic structures such as nerve cells and (parts of) brains; it will replicate and repair itself and thus, in principle, survive forever and conquer space; it will have a self-sufficient energy supply or be able to obtain the necessary energy at any time.

A service robot or a social robot as a universal machine could be used in schools and universities, in the office, in the factory, in building construction and civil engineering, in the household, and in leisure and travel. It could explain and present facts, water flowers, stand on the assembly line, carry out track work, load and unload the dishwasher, walk the dog, guard and protect a person. It could serve as an interlocutor, teacher, coach, and mentor as well as a sports or sexual partner. It could become a partner who ensures our survival in an increasingly dangerous and hostile environment, or an opponent that turns against us. It could exist and work on the moon or Mars or further out in space. All of this is possible because it is a universal robot with a humanoid appearance, not a specialized one that is only familiar with certain areas of application and only fits these. When the problem of universality is solved (and it has obviously been solved except for a few subtleties), there are no more limits, and the universal robot can even do things that are impossible for us.

3. Ethical and Sociological Discussion

This section discusses universal robots from an ethical and social science perspective. The aim is to identify opportunities and risks. Not all points can be dealt with here. In

any case, the focus is clearly on the universal robot. Certain fundamental aspects can also be found in ethical and sociological works on service robots and social robots [3, 34].

3.1. The Universal Tool

The universal robot could be the most comprehensive and at the same time most powerful tool that man has ever created for his physical reality, could make his work easier and relieve him of it, could prevent overuse and injuries, and could assist him in crises and disasters. This corresponds to one of the original ideas with regard to robots. Just as household appliances and automated services make our lives easier, the universal robot could create new freedoms. This is also the case in social contexts. The universal robot becomes a companion and partner. It may also make specialized machines such as care and sex robots unnecessary and surpass them in various aspects, not least in the mobility of the entire body [35].

3.2. Effects on Living Beings

When the universal robot protects sheep from wolves, takes the dog for a walk, and feeds the cat, when it roams through the woods and mountains looking for injured or hungry animals, it becomes clear that there can be effects not only for humans but also for animals, in line with the above definition of social robots. Some animals, especially pets, may lack human attention. Others, such as wild animals that shy away from the smell and presence of humans, can be helped and protected. One vision that has been developed in this context by the author is of huge nature reserves into which hardly any humans are allowed, but where machines are allowed to enter for monitoring and care [31].

3.3. The Problem of Simulation

The universal robot becomes a companion and partner that is convincing due to its comprehensive capabilities, but ultimately makes promises that it cannot keep because such a relationship always remains one-sided. The robot is not really interested in its human counterpart, does not love it, and does not hate it. It is ultimately a simulation machine. Empathy and emotions are also simulated, which is justified and necessary in certain contexts [19]. However, empathy and emotions are evoked and amplified in people, and the danger of deception, fraud, and manipulation arises. It can be argued that our lifetimes are too short to spend with simulation machines and to become part of simulation machines ourselves.

3.4. Violation of Privacy and Intimacy

The universal robot is one that is in constant proximity to persons and groups, interacting and communicating with them. It has sensors that mimic our senses as well as sensors that exceed human capabilities. As a result, it constantly collects data from the user [36]. To some extent, this can be mitigated by technical solutions such as outline recognition or data deletion. However, there are still problems associated with the fact that several robots are supposed to work together and exchange data with each other. In addition, people must expect to be recognized at any time, even in the dark, or to be screened by special technologies. This jeopardizes their informational autonomy and privacy.

3.5. Incorrect Perception and Behavior

If large language models are used for universal robots, errors in recognition and perception can occur. As tests with Be My Eyes have shown, not all objects are classified correctly [25]. For example, high windows were mistaken for doors. This can lead to incorrect behavior on the part of the user. Prompts with service robots and social robots can also be misunderstood, with the corresponding consequences. In addition, accidents inevitably happen when moving forwards and backwards quickly. Unlike chatbots in virtual environments, injuries and fatalities can occur in physical space.

3.6. Limits of Moral Abilities

Machine ethics has made progress in the effort to give systems moral rules to which they adhere. This is particularly useful in semi-open environments such as households or company premises [7]. In the open world, for example in road traffic, there are insurmountable difficulties. The universal robot would have to find its way around different cultures, contexts, and situations and adapt and improve its moral skills with the help of machine learning. This leads to numerous challenges and difficulties, including in terms of acceptance, as the human moral agents are now joined by artificial moral agents that are incomplete in various ways, for example, in that they lack consciousness and free will.

3.7. Improper Use of the Robot

Some users will use prompts specifically to inflict damage. For example, they can turn the universal robot into a weapon. However, such prompts can also be rejected by large language models with the help of moral rules or ‘guardrails’. This in turn can lead to misunderstandings, or users may try to hijack or jailbreak the robot [37]. If the LLM is too restrictive when handling prompts, the usefulness of the machine is called into question. Last but not least, universal robots can also be equipped with conventional weapons—as has already happened with service robots, including the Unitree Go1—and thus cause damage [38]. The dual-use problem is evident in all of these points.

3.8. Slavery and Speciesism

Human-like robots that are among us and do our everyday work in the factory or office may remind us of slaves. This seems to reinforce a concept that people have been trying to combat for a long time [39]. However, it can also be argued that these are not humans, but machines, even if they are human-like, and one can try to counter the intuition of the users with a form of enlightenment and make them reflect. Furthermore, one could speak of a new speciesism, which this time is not directed against animals but against machines. The same argument as the one above can be used to counter this.

3.9. Devaluation and Depreciation

When the universal robot supports us, we miss out on some tasks that we enjoy doing. This includes seemingly boring, unnecessary activities that actually relax us. They also include demanding activities, and in a certain sense there is a devaluation of our work and a devaluation of our being. This discussion is already taking place with regard to

generative AI [40]. It seems that robots can do many of the things that we humans can do, and the question arises as to what constitutes our humanity. However, this is also an opportunity, and we could decide to focus on intellectual and artistic excellence—or on a pleasurable life, both mentally and physically.

3.10. Space and Resources

The universal robot shares space with us and takes up our resources [9]. This can contribute to density stress and to resources becoming even scarcer and, e.g., electricity having to be produced more intensively, which contributes to environmental problems. The mere production of universal robots, which must be available in large quantities, also leads to such problems. In addition, the machines have to be supplied with spare parts or disposed of, which in turn contributes to environmental degradation. Finally, the LLMs have a poor environmental footprint, which is related to training and provision via cloud [41]. The problem can be mitigated with locally running applications, but this is unlikely to be a solution, especially for universal robots that rely on networking and live data.

4. Summary and Outlook

The research question can therefore be answered as follows: It is possible in principle to build a universal robot today or in the next future, even if it will initially make a few mistakes and cannot be operated without malfunctions. It will be a powerful tool, always with us, among us, in the right place at the right time. It will be an important assistant, companion, and point of contact for all those who can afford it or for whom it is provided. At the same time, numerous questions arise about its nature, our relationship with it, and its future in an increasingly exploited and destroyed world. In this sense, a contradictory finding emerges: we need robots to relieve us and to get us through crises and disasters, but they themselves will contribute to untenable and delicate conditions.

Developments in these areas will continue. GPT-4o and other multimodal LLMs process moving images and audio. This is a benefit for apps such as Be My Eyes, and robots will also gain ever better perception as a result. In both cases, this is often live data from reality—the LLMs gather information in the midst of reality, just like animals and humans. They are also learning more and more about the living beings themselves, how they behave in social environments, how they name and classify things—which they may be pointing to at that moment—and how they evaluate circumstances, including from a moral perspective. The simulation machine will probably reach a level of perfection that will make us completely forget that it is only a machine.

There is no evidence that computers and machines of the conventional kind will achieve real consciousness. They will also have no free will, no real empathy, and no real emotions. This also means that they are not capable of morality in the true sense—the moral machines that are being built around the world are, again, simulation machines, which is not harmful at all, because, ultimately, they are supposed to abide by rules that we set for them, perhaps in a more consistent way than we do. Nevertheless, there is a way to achieve everything that has been mentioned. If you manage to integrate brain cells or even parts of brains into robots, you get the reverse cyborg. It could remain as a biological machine at a simple level and improve or change its sensory abilities. But it could also fill in some of the gaps that are missing to be human. This would be a dangerous path, and ethics, law, and politics should be used to prevent such developments.

References

1. Sharkey N. Elektro's return, New Scientist, Volume 200, Issue 2687, 2008:46-47. Available from: https://doi.org/10.1016/S0262-4079(08)63234-0.
2. Driess D, Xia F, Sajjadi MSM et al. PaLM-E: An Embodied Multimodal Language Model (2023). Available from: https://palm-e.github.io/assets/palm-e.pdf.
3. Bendel O, editor. Soziale Roboter: Technikwissenschaftliche, wirtschaftswissenschaftliche, philosophische, psychologische und soziologische Grundlagen. Wiesbaden: Springer Gabler; 2021.
4. Wallach W, Allen C. Moral Machines: Teaching Robots Right from Wrong. Oxford: Oxford University Press; 2009.
5. Anderson M, Anderson SL, editors. Machine Ethics. Cambridge: Cambridge University Press; 2011.
6. Misselhorn C. Grundfragen der Maschinenethik. Ditzingen: Reclam; 2018.
7. Bendel O, editor. Handbuch Maschinenethik. Wiesbaden: Springer VS; 2019.
8. Guizzo E. By leaps and bounds: An exclusive look at how Boston dynamics is redefining robot agility. IEEE Spectrum, vol. 56, no. 12, Dec. 2019, pp. 34-39.
9. Bendel O. Serviceroboter als klassische und als soziale Roboter. In: D'Onofrio S, Meinhardt S, editors. Robotik in der Wirtschaftsinformatik. Edition HMD. Wiesbaden: Springer Vieweg; 2023. pp. 41-57.
10. Bendel O, Gasser A, Siebenmann J. Co-Robots as Care Robots. Accepted paper of the AAAI 2020 Spring Symposium "Applied AI in Healthcare: Safety, Community, and the Environment" (Stanford University). In: ArXiv, 10 April 2020. Cornell University, Ithaca 2020. Available from: https://arxiv.org/abs/2004.04374.
11. Zhou X et al. Swarm of micro flying robots in the wild. Sci. Robot. 7, eabm 5954 (2022).
12. Bendel O, Yürekkirmaz A. A Face Recognition System for Bears: Protection for Animals and Humans in the Alps. In: Ninth International Conference on Animal-Computer Interaction (ACI'22), December 05-08, 2022, Newcastle-upon-Tyne, United Kingdom. ACM, New York; 2023. Available from: https://dl.acm.org/doi/proceedings/10.1145/3565995.
13. Law WT, Fan KW, Li KS, Mo T. Applied Design and Methodology of Delivery Robots Based on Human–Robot Interaction in Smart Cities. EAI Endorsed Transactions on Smart Cities, 7(2) (2023).
14. Faccio M, Cohen Y. Intelligent cobot systems: human-cobot collaboration in manufacturing. J Intell Manuf (2023). Available from: https://doi.org/10.1007/s10845-023-02142-z.
15. Holt K. Coco's restaurant delivery bots are headed to more warm-weather cities. In: engadget, 8 February 2022. Available from: https://www.engadget.com/coco-remote-control-food-delivery-robot-expansion-austin-miami-dallas-houston-220005161.html.
16. Amirov R. Münchner Runde live – erstmals mit Roboter als Talkgast. BR24, 25 January 2023. Available from: https://www.br.de/nachrichten/deutschland-welt/muenchner-runde-live-roboter-und-kuenstliche-intelligenz,TTwlnay.

17. Coursey K. Speaking with Harmony. In: Bendel O, editor. Maschinenliebe. Wiesbaden: Springer Gabler; 2020. pp. 35-51.
18. Danielescu A. 2020. Eschewing Gender Stereotypes in Voice Assistants to Promote Inclusion. In: Proceedings of the 2nd Conference on Conversational User Interfaces (CUI '20). Association for Computing Machinery, New York, NY, USA, Article 46, 1-3. Available from: https://doi.org/10.1145/3405755.3406151.
19. Schulze H, Bendel O, Schubert M et al. Soziale Roboter, Empathie und Emotionen. Bern: Zenodo; 2021. Available from: https://zenodo.org/record/5554564.
20. Bendel O. LADYBIRD: the Animal-Friendly Robot Vacuum Cleaner. In: The 2017 AAAI Spring Symposium Series. AAAI Press, Palo Alto 2017, pp. 2-6. https://aaai.org/proceeding/01-spring-2017/.
21. Bendel O, Graf E, Bollier K. The HAPPY HEDGEHOG Project. Proceedings of the AAAI 2021 Spring Symposium "Machine Learning for Mobile Robot Navigation in the Wild". Stanford University, Stanford, California, USA (online), March 22-24, 2021. Available from: http://arxiv.org/abs/2401.03358.
22. Anderson M, Anderson SL, Berenz V. A Value-Driven Eldercare Robot: Virtual and Physical Instantiations of a Case-Supported Principle-Based Behavior Paradigm. Proceedings of the IEEE, Vol. 107, No. 3, March 2019, pp. 526-540.
23. Bendel O, Heimann M. The CARE-MOMO Project. In: He H, Cavallo F, Sorrentino A, Fiorini L, Rovini E, editors. Social Robotics: 14th International Conference, ICSR 2022, Florence, Italy, December 13-16, 2022, Proceedings. Lecture Notes in Computer Science. Cham: Springer International Publishing; 2023.
24. Kundu S et al. Specific versus General Principles for Constitutional AI. In: arXiv, 20 October 2023. Available from: https://arxiv.org/abs/2310.13798.
25. Bendel O. How Can Generative AI Enhance the Well-being of Blind? In: Proceedings of the AAAI 2024 Spring Symposium Series, Symposium "Impact of GenAI on Social and Individual Well-being". Stanford University, Stanford, California, March 25-27, 2024. The AAAI Press, Washington, DC 2024. Available from: https://ojs.aaai.org/index.php/AAAI-SS/article/view/31232/33392.
26. Hildt E. The Prospects of Artificial Consciousness: Ethical Dimensions and Concerns, AJOB Neuroscience, 14:2 (2023), 58-71.
27. Bendel O. Chips, Devices, and Machines within Humans: Bodyhacking as Movement, Enhancement and Adaptation. In: Brommer S, Dürscheid C, editors. Mensch. Maschine. Kommunikation. Beiträge zur Medienlinguistik. Tübingen: Narr Francke Attempto; 2021. pp. 252-276. Available from: https://elibrary.narr.digital/book/10.24053/9783823394716.
28. Smirnova L, Caffo BS, Gracias DH et al. Organoid intelligence (OI): the new frontier in biocomputing and intelligence-in-a-dish. Front. Sci., 28 Feb 2023, Volume 1. Available from: https://doi.org/10.3389/fsci.2023.1017235.
29. Bendel O. Möglichkeiten und Herausforderungen des Robot Enhancement. In: Schleidgen S, Friedrich O, Seifert J, editors. Mensch-Maschine-Interaktion – Konzeptionelle, soziale und ethische Implikationen neuer Mensch-Technik-Verhältnisse. Münster: Mentis; 2022. pp. 267-283.

30. Koch J, Gantenbein S, Masania K et al. A DNA-of-things storage architecture to create materials with embedded memory. Nat Biotechnol 38 (2020):39-43. Available from: https://doi.org/10.1038/s41587-019-0356-z.
31. Bendel O. Passive, Active, and Proactive Systems and Machines for the Protection and Preservation of Animals and Animal Species. Frontiers of Animal Science, 3:834634 (2022). DOI: 10.3389/fanim.2022.834634. Available from: https://www.frontiersin.org/articles/10.3389/fanim.2022.834634/full.
32. Graham-Rowe D. Artificial gut frees robot from human helpers, New Scientist, Volume 207, Issue 2769, 2010:18-19. Available from: https://doi.org/10.1016/S0262-4079(10)61724-1.
33. Swan R. Waymo says dense S.F. fog brought 5 vehicles to a halt on Balboa Terrace street. San Francisco Chronicle, 11 April 2023. Available from: https://www.sfchronicle.com/bayarea/article/san-francisco-waymo-stopped-in-street-17890821.php.
34. Hakli R, Mäkelä P, Seibt J, Nørskov M, editors. Social Robots in Social Institutions: Proceedings of Robophilosophy 2022. Amsterdam: IOS Press; 2022.
35. Bendel O. Sexroboter als soziale Roboter für unterschiedliche Bedürfnisse und Anliegen. In: Weber K, Reinheimer S, editors. Faktor Mensch. Edition HMD. Wiesbaden: Springer Vieweg; 2022. pp. 101-114.
36. Bendel O. Der Spion im eigenen Haus. IT for Health, 4 (2014) 1:22-24.
37. Gupta M, Akiri C, Aryal K, Parker E, Praharaj L. “From ChatGPT to ThreatGPT: Impact of Generative AI in Cybersecurity and Privacy”. In: IEEE Access, vol. 11, pp. 80218-80245, 2023.
38. Hambling D. U.S. Marines Test Robot Dog Armed With A Rocket Launcher. Forbes, 1 November 2023. Available from: https://www.forbes.com/sites/davidhambling/2023/11/01/us-marines-test-robot-dog-armed-with-a-rocket-launcher.
39. Rogge R, Lindenauer T. Androids shouldn’t be Slaves. In: Bendel O, editor. Soziale Roboter: Technikwissenschaftliche, wirtschaftswissenschaftliche, philosophische, psychologische und soziologische Grundlagen. Wiesbaden: Springer Gabler; 2021. pp. 557-579.
40. Bendel O. Image Synthesis from an Ethical Perspective. AI & SOCIETY, 27 September 2023. Available from: https://link.springer.com/article/10.1007/s00146-023-01780-4.
41. de Vries A. The growing energy footprint of artificial intelligence. Commentary. 50 Joule, VOLUME 7, ISSUE 10:2191-2194, OCTOBER 18, 2023. Available from: https://doi.org/10.1016/j.joule.2023.09.004.