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Robots in Popular Sciences Compared with their Real Capabilities

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ABSTRACT

In this paper, statements from popular science sources are contrasted with data from primary science articles and studies. It is observed to what extent the opinions and statements of the popular science articles differ from the studies and scientific articles in terms of ethics and acceptance. For this purpose, the field is divided into 4 fields, which are processed independently. To begin with, the industrial robots are examined. These are used in the area of production as well as in the area of maintenance and repair. These robots are able to learn from each other and to work with each other and with humans. Even a tire change can be carried out by an industrial robot today. Likewise, new developments offer construction spaces that are difficult for humans to access. Activities that do not serve industrial production, but rather the performance of services for people and facilities, are carried out by service robots. They are freely programmable motion devices that perform services partially or fully automatically and are used in the areas of care, gastronomy, tourism, as well as private households. In the future, skills such as flexibility and judgment must be perfected. The use of some service robots is already safe for humans. Similar to service robots, social robotics also focuses on interaction between humans and robots. These are sensorimotor robots that can communicate with humans in a social manner. In doing so, they can build social relationships and constantly learn. The social robots are usually in a human-like (humanoid) or animal-like (animaloid) body, but can also be used merely as software. Examples for application are care, therapy and entertainment robots.

Keywords: Industrial robots, Service robots, Social robotics

INTRODUCTION

In view of increasing digitalisation, new advances are constantly being made in the field of robotics. Technical system access is increasingly being used in industrial and everyday processes. The aim of the following paper is to compare the capabilities presented in popular science sources as of 2017 with the actual state of the art and research. For this purpose, the field of robots is divided into industrial robots, service robots and social robots.

INDUSTRIAL ROBOTS

According to VDI Guideline 2860, industrial robots are universal movement machines with several axes whose movements are freely programmable (i.e., without mechanical intervention) with regard to sequence of movement and paths or angles and, if necessary, are sensor-guided. They can be equipped with grippers, tools or other manufacturing equipment and can perform handling and/or manufacturing tasks. For Industry 4.0, new approaches are required for safe connections of the robot systems as well as an improvement of their interaction with humans (Kamarul Bahrin MA, et al. 2016).

Deep-Learning

According to the secondary source (Cleve T. 2020), it is possible that robots learn together and the learning success is equivalent to the number of robots (what one robot learns in 8 hours - 8 robots learn in one hour). The primary source confirms collective learning at this point, but does not specify how much faster the robots can work as a result.

For example, at CeBIT back in 2017, robot manufacturer Fanuc demonstrated that robots with area vision sensors and deep learning can retrieve parts from a box and not only learn on their own, but also deliver a better result as the number of trials increases. In addition, they store their learning processes in a cloud, which other robots can access simultaneously and both retrieve the information and upload their own learning process.

This also enables robots to work and learn collectively on the same project, where several robots can learn the task correspondingly faster than a single robot (Fanuc 2017). Similarly, the study by Levine et al. 2016 also confirms that robots can show independent learning success in the repeated grasping of different objects. Even though this study only took place under laboratory conditions and cannot be directly projected to an everyday application, the learning success, especially of hand-eye coordination, cannot be dismissed. The same applies to the learning process of grasping different objects at different points. Thus, it could be observed that the system tends to take a different approach when grasping soft objects than when grasping hard objects. For hard objects, the fingers need to be placed on both sides of the object to grasp it successfully. Soft objects, on the other hand, can be grasped by simply pushing into the object, which is most easily achieved by placing one finger in the centre and the other finder on the side of the object (Levine, S. et al. 2016).

Furthermore, the robot manufacturer Boston Dynamics confirms that robots trained by deep learning in this case can precisely locate boxes and pallets even in poor lighting conditions without having to register them beforehand. These robots only need to be trained with a few boxes beforehand and installation and commissioning is correspondingly quick and easy (Boston Dynamics. Pick™ 2021).

Collaborative, Cooperative or Coexistent?

Especially for industry, collaborative, cooperating and co-existing robots are repeatedly advertised. Prof. Dr.-Ing. Christian Köhler has examined this more closely and has come to the conclusion that robots can only really be described as collaborative in the rarest of cases. In doing so, he refers to the corresponding taxionomy levels according to Onnasch (Köhler C. 2017). The corresponding excerpt on the taxonomy of cooperation and collaboration from Onnasch: "In contrast to co-existence, cooperation and collaboration describe a genuine collaboration between humans and robots for a common goal achievement. Cooperation involves working towards a higher-level common goal. However, the actions are not directly dependent on each other because there is a clear division of tasks between humans and robots. Humans and robots thus work on different subtasks of the final result, the allocation of which is determined in advance of the task processing. The use of pick-and-place robots in production can serve as an example of this form of cooperation. Both robots and humans work together on a production chain with a common overriding objective: the manufacture of a specific product. For example, the human can label bottles, which the robot then takes over and packs into cartons.

Collaboration describes an interaction as direct cooperation between humans and robots. Both pursue a common goal; in contrast to cooperation, sub-goals are also pursued jointly in this case. This means that partial actions to achieve the goal are also carried out jointly by humans and robots, so that there are immediate coordination challenges. The allocation of subtasks takes place continuously and, if necessary, adapted to the situation directly during the collaboration. Furthermore, collaboration is characterised by the creation and use of synergies" (Onnasch L et al. 2016). This is also shown by an example from a BMW plant published by the robot manufacturer Kuka itself: "Where the workers at the BMW plant in Dingolfing used to have to lift and join heavy bevel gears for front axle transmissions on their own, they now work together with their collaborative colleague, the LBR iiwa [...] This enables close cooperation between humans and robots without any protective fence at all". Here Kuka describes the work itself as cooperation, but the robot as collaborative. According to Onnasch, this would only be a cooperation. However, Kuka also writes that the term "human-robot collaboration" is the most common. However, the "K" in MRK can also stand for both coexistence and cooperation, depending on the type of collaboration, and thus refers to Onnasch's taxonomy (KUKA AG 2021).

In particular, in order for robots to be able to collaborate with humans in a more optimised way, research has already been carried out with the aim of optimising the movement of robots through human intervention. There are already working models for this, but it remains open how a robot is supposed to distinguish which intervention should serve as a learning function for it, or only represents a one-time interruption (Bajcsy A et al. 2017).

In the secondary literature, industrial robots are not found as frequently as other types of robots. This can probably be attributed to the fact that the interested parties tend to be companies that are advertised through other channels. Nevertheless, some publications can be found for the areas of manufacturing as well as maintenance and repair. The largest area of application today is still manufacturing. However, current robot developments offer promising and potential advantages for the maintenance and repair of industrial plants. No deviations from statements from popular science sources can be found.

SERVICE ROBOTS

Among a multitude of definitions for the term service robot, the following are frequently cited: “A service robot is a freely programmable motion device that performs services in a partially or fully automated manner. Services in this context are activities that do not serve the direct industrial production of material goods, but rather the performance of services to people and facilities (IuG AU 2021). “A service robot is a robot that performs useful tasks for humans or equipment excluding industrial automation application (IFR 2021) The direct benefit of service robots for humans is the main focus. As a subclass of industrial robots, they are again divided into two categories. First, the service robots for domestic, non-commercial use such as vacuum robots or lawn mowers. These are often not monitored and can be controlled by any person. On the other hand, service robots are used for commercial tasks. For example, for commercial applications such as assisted surgery systems or milking robots. These are operated by trained persons. The following is a summary of what state of the art in the field of service robotics is published in popular science sources.

Use of walking robots: There are already different types of service robots, which are used for different service areas. In classical industrial robots, long-term fluid locomotion and manipulation with multiple contact points are problematic to control. Since other robots are not suitable for tasks such as those in the field of aircraft construction, Airbus has joined forces with the French research institute CNRS to advance the technology of walking machines through the laboratory ROB4FAM (Marsiske, H. 2019). As a heavy-duty robot, this walking robot is capable of transporting and attaching large loads. Pulling aircraft weighing 3.3 tons, for example, is also possible at low speed. Climbing and moving over uneven ground is already possible for the heavy-duty robot. Possible errors during movement sequences can be compensated for by speed.

Use in private applications: Consumer robots are finding their place in the private household sector (Vdiv 2021). It is emphasized that there is no such thing as a “jack-of-all-trades robot” that can perform the entire household. There are smaller devices for different tasks that perform or facilitate various steps of everyday life.

Use in nursing and medicine: In the field of nursing, service robots can already completely take over tasks (F.A.Z. 2020). Primarily, they are needed to compensate for the lack of manpower in this service sector. Various telepresence systems, such as the one from the company InTouch Health, perform only a few tasks close to the body, such as listening to the lungs via an attached stethoscope. They allow the physician to make rounds without having to be present. The robot, unlike a present, empathic physician, is not able to express emotions, such as compassion, through body language. Robots support human employees in time-intensive tasks by briefly transporting and distributing medications. Medical technology also offers an area of application for service robots (Beck, V. 2021). They provide doctors with more time to concentrate on important tasks by handing out, cleaning and organizing. Interventions assisted by robots are also possible. In this case, a surgeon controls a robotic arm for more precision in execution.

Use in gastronomy: In the restaurant industry, robots are used for serving or for cooking or preparing simpler operations. These speeds up the process and allows a restaurant to expand its capacity.

Use in tourism: The use of service robots is expected in the tourism industry (DER SPIEGEL 2016). The robots "Pepper" and "Mario" are in use on cruise ships of the Aida Cruises fleet. They can recite daily offers and excursion tips or act as aids at the reception desk. These robots cannot handle abrupt changes of topic, unrelated questions and irony. Therefore, they offer no substitute for a human receptionist. However, they are considered an interesting experience for some visitors.

SOCIAL ROBOTS

Social robots are primarily used in the field of health care or public administration. While they are used in the health sector for nursing activities and therapeutic measures, the focus of robots in public administration is on communication with humans. In the course of the project study, the propagated application possibilities and prognosis of the use of different types of robots are looked at. These are then compared with the actual evaluations from the corresponding primary sources, expert interviews and statistics. For this purpose, the following picture emerged in social robotics. Out of 34 articles on social robotics, 15 articles dealt with the possible uses of social robotics in healthcare. This suggests that the most important field of application for social robotics in the future will be in the area of care and health. Many reports propagate a coming nursing crisis. The number of people in need of care will increase steadily, while the already thin staffing situation will be confronted with problems as a result. According to an article in the FAZ, in 2035 there will be a shortage of about 500,000 skilled workers in the health sector who can look after and care for people in need of care (F.A.Z.a2021). If one looks at studies on the future occupancy of nursing homes, the statements are fundamentally true (Radtke 2020). Regardless of the skill and effectiveness of social robots, the technology can only enter the market if it is accepted by the carers and the people being cared for. Experts in the field of nursing generally have a higher acceptance level for the use of technologies and robots in the field of nursing. However, the acceptance level for activities with a higher interpersonal component is lower. Particularly striking in the following table is the low level of acceptance for everyday conversations. Social and emotional activities, and thus the integration of social robots into everyday care, are therefore rated particularly critically. The predominant opinion of secondary science articles towards social robotics considers the use of these technologies ethically and morally questionable to indefensible (F.A.Z.b2021) (DW 2019).

The German Ethics Council has published a statement specifically on this discussion and issued a recommendation for the implementation of robotics in care. It does not come to the conclusion that the use of robots in care is ethically and morally questionable. Robotics in care can help in the future, as long as it is "aligned with the goals of good care and assistance" (Deutscher Ethikrat 2020). It should therefore be tested in a practical way already in the development phase. The ethical evaluation of robotics thus depends on the way it is implemented and cannot be presented as unjustifiable from the outset.

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CONCLUSION

Only minor discrepancies between the secondary literature studied and the state of the art can be observed in the texts examined.

For the industrial robots, no deviations from statements from popular science sources can be found. In the secondary literature, however, these are not found as frequently as the other robot types studied. This is probably since the interested parties tend to be companies that are advertised through other channels. Nevertheless, some publications can be found for the manufacturing and maintenance and repair sectors. The largest application area today is still manufacturing. However, current robot developments offer promising and potential benefits for the maintenance and repair of industrial plants.

In comparison, the research on service robots have shown that a variety of characteristics and capabilities are attributed to them in the secondary literature, most of which are consistent with the status quo of service robotics.

Service robots are used in everyday processes alongside production and manufacturing processes. However, they are not expected to be able to fully take over human activities, especially those that require emotional responses.

It can be noted that the state of the art in service robots has advanced worldwide. They are increasingly being used in areas such as catering and nursing. The state of the art is that further research is needed on items such as estimation or flexibility to provide mature results. Robotic systems are increasingly able to take on non-standard tasks that were previously left to humans, at an economically viable cost. The increasing intelligence of machines, as well as their memory and learning capabilities, will enable interaction not only between humans and machines, but also between machines and systems. Collaborative work is increasingly enabled by optical, acoustic and haptic signal processing systems. This allows robots to work better with humans without endangering them in their workspace. The safety of humans inside is the most important prerequisite for robots in the service sector, as they have to manage without a protective cage, especially in areas without a standardized working environment (Rethink Robotics 2021).

In the next area examined, social robotics, the claims from the secondary literature, as with the previous robot types, deviate little from the primary scientific facts. In the technical area, the claims of the secondary literature are fundamentally true, although the ability of robots is generalized in some aspects. For example, robots are said to be able to recognize human emotions, even if this is limited to only a few emotions. Especially in the ethical area, the statements of the secondary literature differ from the primary scientific works. Many popular scientific articles question the use of social robots for nursing activities and consider them morally questionable. However, the report of the German Ethics Council sees the inclusion of social robots as possible and even helpful, provided they are used sensibly and thoughtfully.

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