

Future of Robotics

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ABSTRACT

Popular interest in robotics has increased in recent years. Robotics technology has been implemented in a variety of fields including medicine, elderly care, rehabilitation, education, home appliances, search and rescue, car industry and more. Robotics constitutes one of the most exciting fields of technology today, presenting new applications for autonomous systems that can impact everyday life. Understanding where the field of robotics is heading is basically using our insights on the impact robots might make in the near future. Due to the incredible potential of robotic technology, application opportunities are limitless in the future. In this paper we discuss the future of robotics and robots.

KEYWORDS: robots, robotics, future of robots, trending topics

INTRODUCTION

Robots are already a part of our lives. They are becoming more and more common in our society and more integrated into our lives. This is due to the fact that they are becoming smarter, smaller, cheaper, faster, more flexible, and more autonomous than ever before, largely due in part by incorporating artificial intelligence. The six major types of robots are autonomous mobile robots (AMRs), automated guided vehicles (AGVs), robotic arms, cobots, humanoid robots, and hybrids. Robots are being used in a variety of areas such as manufacturing, healthcare, entertainment, military and defense, service industries, law enforcement, education, shopping, and agriculture. Today, there are robots that can autonomously sense, reason, plan, act, move, communicate, and collaborate with other robots. The robot revolution is going to change us as humans. Although robots are poised to displace millions of humans in various industries, they are nowhere close to behaving like humans [1].

Robotics is the study of robots, which includes designing and making robots. It is the discipline of creating robots. It may also be regarded as the process of manufacturing, designing, and operating robots. It

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is a multidisciplinary field where computer science, engineering, and technology all meet. It has come out from fictional movies to real-world settings, performing intricate tasks and changing the world we live in. As the field of robotics advances, more intelligent machines become part of our society.

The use of robotics in various areas of our lives will lead to fundamental changes in society and increase the quality of life of everyone, especially the elderly [2]. It will also bring many social and cultural challenges.

WHAT IS A ROBOT?

The word “robot” was coined by Czechriter Karel Čapek in his play in 1920. Isaac Asimov coined the term “robotics” in 1942 and came up with three rules to guide the behavior of robots [3]:

1. Robots must never harm human beings,
2. Robots must follow instructions from humans without violating rule 1,
3. Robots must protect themselves without violating the other rules.

Robotics has advanced and taken many forms including fixed robots, collaborative robots, mobile

robots, industrial robots, medical robots, police robots, military robots, officer robots, service robots, space robots, social robots, personal robots, and rehabilitation robots [4,5]. Robots are becoming increasingly prevalent in almost every industry, from healthcare to manufacturing.

Although there are many types of robots designed for different environments and for different purposes/applications, they all share four basic similarities [6]: (1) All robots have some form of mechanical construction designed to achieve a particular task; (2) They have electrical components which power and control the machinery; (3) All robots must be able to sense its surroundings; a robot may have light sensors (eyes), touch and pressure sensors (hands), chemical sensors (nose), hearing and sonar sensors (ears), etc. (4) All robots contain some level of computer programming code. An autonomous robot must have a basic body structure (the chassis), sensors, a central control system (microprocessor), actuators (motors), a power supply and an overall program for its behavior. Programs are the core essence of a robot since they provide intelligence. There are three different types of robotic programs: remote control, artificial intelligence, and hybrid. Some robots are programmed to faithfully carry out specific actions over and over again (repetitive actions) without variation and with a high degree of accuracy.

The advantages of robotics include heavy-duty jobs with precision and repeatability. Despite these advantages, there are certain skills to which humans will be better suited than machines for some time to come. Humans have the advantages of creativity, decision-making, flexibility, and adaptability. Robotics is one of the emerging technologies, as shown in Figure 1 [7].

Depending on applications, there are many types of robots including the following [8]:

- **Industrial:** Perhaps the most common use of robots is for simple and repetitive industrial tasks. Examples include assembly line processes, picking and packing, welding, and similar functions.
- **Military:** More recent developments mean that military forces worldwide use robots in areas such as UAVs (Unmanned Aerial Vehicle), UGVs (Unmanned Ground Vehicle), drones, and surveillance.
- **Service:** One of the main growth areas in robotics is in the personal service industry. Uses include for manual tasks such as dispensing food and cleaning.

- **Exploration:** We often use robots to reach hostile or otherwise inaccessible areas. A good example of exploratory robots is in space exploration.
- **Hazardous Environments:** Again, certain environments can be dangerous for humans to enter, such as disaster areas, places with high radiation, and extreme environments.
- **Healthcare:** In the world of healthcare, medtech robots are being used in all kinds of ways. Whether it is managing laboratory specimens or assisting with surgery, rehabilitation, or physiotherapy.
- **Entertainment:** Increasingly (particularly during the pandemic), people are buying robots for enjoyment. There are several popular toy robots, and there are even robot restaurants and giant robot statues.
- **Drones:** These are flying robots that are poised to proliferate in certain commercial sectors.
- **Telepresence Robotics:** They act as stand-in at remote locations. They are used in hospitals and for business travelers, with the idea of saving both time and money.

FUTURE GENERATION ROBOTICS

The robotics industry worldwide keeps innovating, combining artificial intelligence and vision and other sensory technologies. There are numerous predictions for the future of robotics. After decades of research, it is now possible to make predictions about the future evolution of robotics and the robotics industry. Integrating recent developments in machine learning and artificial intelligence in robotics means that we may see an increase in human-to-robot interactions in the future. Here are some ways we can expect robotics to transform our future [9].

- **Robotics in Manufacturing:** Technologies are gradually moving away from replacing manual labor and toward improving the efficiency of existing manufacturing processes, thereby making industrial processes safer and more efficient. The possibilities of collaboration between humans and robots will expand due to advanced AI. Changes in customer behavior have emerged as a significant driver of the industry's development. The use of robotics will increase productivity and has the potential to bring more manufacturing production work back to developed countries. Most robot adoption has occurred in manufacturing, but with continued innovation, robot use is spreading to other sectors. In the early 21st century, robotics is becoming increasingly important in many industries. US manufacturers

are making concerted efforts to drive down operational costs in order to be competitive worldwide. Figure 2 shows the future of automation [10].

- **Robotics in Business Industry:** Robots have the potential to reshape the way businesses are done. Robotic adoption will likely be a critical determinant of business productivity. An increasing number of businesses are employing delivery robots, adding robotics to various aspects of restaurant operations, and so on.
- **Robots in Education:** Since education is one of the leading sectors of human development, the use of robotics can be beneficial. But our educational system is not adequately preparing students for workplace of the future. Robotists foresee robots as tutors or teachers of children. In the education sector, the line between classrooms and individual learning settings is already starting to blur. Computer-based learning is boosting personalized learning and enabling students to learn at their own pace. Learning with educational robotics provides students with opportunities for them to stop, question, and think deeply about technology. NAO, the humanoid robot, is already forming bonds with students from around the world. It comes with important senses of natural interaction, including moving, listening, speaking, and connecting. In the future, robots could be with college students throughout all of their years in school [11].
- **Robotics in Medicine:** Robotics will shape the future of medicine. Surgical robots can perform extremely precise operations and could eventually carry out surgeries independently. Robots will help relieve tired nurses and cleaners. The future of robotics in medicine can be seen in medical procedures like surgeries, health support systems, and health monitoring systems. Healthcare robots can assist in patient care, especially with elderly populations. The future of robotics in surgery is an essentially extension of the physician's hands designed to increase surgeon precision. For surgeons, the main benefits of using robots include a smaller incision, better control, precision, and access to hard-to-reach areas. Figure 3 shows a typical example of robotic surgery [12]. Robots will be our caretakers in the future.
- **Robotics in Workplace:** Robots will have a profound effect on the workplace of the future. It is likely that this trend will persist and spread to more industries.

Collaborative robots are evolving in the workplace with high degree of flexibility and safety. In the future, collaborative robots will be able to sense human behavior and have futuristic new abilities. Robots free up their human co-workers to do more meaningful work by taking on repetitive tasks. The future of work will most likely be one where man and machines work hand in hand. In order to take full advantage of collaboration between humans and robots, companies must understand how machines can effectively enhance what we do best. The future of robotics and automation relies on workers with advanced skills [13].

- **Robotic Engineering:** This is the study of robots through designing, assembling, and programming of robots. Engineers are needed to be trained so that they can create and design robots and robotic systems. Mechanical engineer is among one of the most qualified to become a robotics engineer. Robotics engineers should keep an eye on telepresence robots. In today's world, robotic engineers are in high demand due to advances in technologies such as artificial intelligence, machine learning, and computer vision. Robots require a large amount of data to guide its decision-making and help engineers design more detailed behavioral models.
- **Robotics in Construction:** Robots are now making their way into a variety of construction tasks, using brick-laying robots, street-laying robots, drones, autonomous vehicles and large-scale 3D-printing robots. Construction projects often take place in unstructured, outdoor environments, and work sites are always changing. Construction robots usually have to be mobile and be able to respond to variables in their operating environment. They are beginning to disrupt the industry due to the many benefits they offer [14].
- **Robotics in Space:** Commercial space robots have been designed for servicing satellites and performing construction on the moon. The goal is to allow for space-based manufacturing, which will reduce the complexity and cost of building large structures that can support human life. Some robots will effectively eliminate some of the problems that have limited our exploration of space. Robots would enable the repair and construction of simple structures being built in space [15]. NASA's Johnson Space Center is designing the next generation of autonomous robots that will help humans explore the solar system. While autonomous robots have conducted

scientific missions in the past, NASA's team is focused on advancing human space exploration. The goal is to enable human beings to visit other planets and do meaningful work there.

- **Autonomous Car:** Self-driving cars still require some human intervention. Every automobile producer is pursuing this technology, with Uber being one of the strongest players. Driving an automobile is deceptively simple. It requires little skill.

Future applications of robots will be amazing due to increasing demand, popularity, and usability.

BENEFITS

In the last two decades, robotics has exploded, both in terms of research and applications.

Robots are transiting from repetitive tasks machines to cognitive partners. Sensor-driven revolution is transforming robots from rote machines into cognitive collaborators. Automation and robotics will boost the overall standard of living. They will also help to solve social problems of health and safety. Humans no longer need to worry about hazardous environments due to the ability of robots to handle those jobs. Since they are custom-designed for exact, repetitive tasks, they hardly commit errors.

Robots can offer increased productivity, efficiency, quality and consistency in certain settings. Unlike humans, robots don't get bored. They can be very accurate. Robots can work in environments that are unsafe for humans, such as with dangerous chemicals or in areas of high radiation. Robots will free human workers for more complex tasks, but also eliminate jobs for an estimated 120 million workers globally.

Perhaps the main benefit of humans operating with robots is that everyone can carry out what they do best: the robots perform repetitive tasks, while people carry out complex tasks. Today, the field of robotics is transforming and evolving at a very fast pace. The impacts of robots will likely differ between developed and developing economies.

CHALLENGES

The size and weight of the robots can cause them to be challenging to navigate in some types of environments. Current robots are less dexterous than humans and cannot compete with a human's abilities. Robots with practical applications are generally expensive in terms of the initial cost and maintenance. Other the challenges facing the robot future include:

- **Job Loss:** The most common concern about robotics is that "robots will take over our jobs!" In some industries, robots are replacing human

jobs, which can create socio-economic problems. As robot adoption increases, the future production system will lead to massive job loss. For example, cab drivers will be replaced by self-driving automobiles in the future. Those who may be replaced by robots need retraining and education in areas where opportunities exist. Workers will need technological skills, and there will be an even greater need for those with expertise in STEM.

- **Fear:** Robots remain controversial; they are either destined to save the planet, or doomed to destroy it. Robots may be feared or embraced. Robots do still instill fear. We remain afraid that they will one day surpass us and take over our jobs. Robots overthrowing humans is also a familiar trope in popular culture. The idea that robots are everywhere watching our every move may conjure up fear. As workers increasingly use robots (at hospitals, workplace, care homes, etc.) the need for anthropomorphic features will become increasingly important.
- **Cybersecurity:** As robots become more mobile, collaborative, and connected, they can become a target for hackers. Companies may become vulnerable to malware, cyber-ransom, production delays, and business disruption. A comprehensive, end-to-end approach to cybersecurity is needed. The robot operator's IT team must be engaged, actively monitoring threats and updating security measures [16].
- **Ethics:** Once a robot begins to make decisions, the ethics of its judgement inevitably come into question.

CONCLUSION

There is no doubt that robots will play a major role in the future of the economy, both local and global. Since robotics can be applied to almost every industry, it will somewhat disrupt them. Although some challenges need to be addressed, the future of robotics is bright. Robotics in the future will be dominated by industries such as manufacturing, pharmaceutical, and packaging. In anticipation of the exciting future of robots, top tech companies are in a constant race to change the way robotics are implemented in people's everyday lives. On a global level, the jobs impact of technology automation is quite staggering.

Many people worldwide are not equipped to earn their living in a future society where all the routine tasks are automated. People with skills in robotics will be highly sought after in the future. Young people today will be our future designers, engineers,

architects, doctors, dentists, scientists, researchers, politicians, lawyers, retailers, and future business leaders. They will inherit a world with several challenges: aging infrastructure, corrupt governments, disruptive technologies, ethical dilemmas, etc. [17].

If you are an aspiring to be a roboticist, you will need to work on some key skills, such as mathematics, science, programming, and problem-solving. You'll also need to understand the basics of robotics. More information about the future of robotics can be found in the books in [18-27] and the following journals devoted to robot-related issues:

- *Robotica*
- *Robotics and Autonomous Systems*
- *Robotics Research*
- *Frontiers in Robotics and AI*
- *Robotics and Computer-Integrated Manufacturing,*
- *Advanced Robotics*
- *Autonomous Robots*
- *Journal of Robotics*
- *Journal of Robotic Systems*
- *Journal of Robotic Surgery*
- *Journal of Robotics and Mechatronics*
- *Journal of Intelligent & Robotic Systems*
- *Journal of Mechanisms and Robotics-Transactions of the ASME*
- *Journal of Automation, Mobile Robotics and Intelligent Systems*
- *Intelligent Service Robotics*
- *IEEE Journal on Robotics and Automation*
- *IEEE Robotics & Automation Magazine*
- *IEEE Robotics and Automation Letters*
- *IEEE Transactions on Robotics*
- *International Journal of Medical Robotics and Computer Assisted Surgery*
- *International Journal of Robotics Research*
- *International Journal of Social Robotics*
- *International Journal of Humanoid Robotics*
- *International Journal of Advanced Robotic Systems*
- *ISRN Robotics*
- *Recent Trends in Mobile Robots*

- *Science Robotics*
- *Journal of Future Robot Life*
- *Journal of Robotics, Networking and Artificial Life,*

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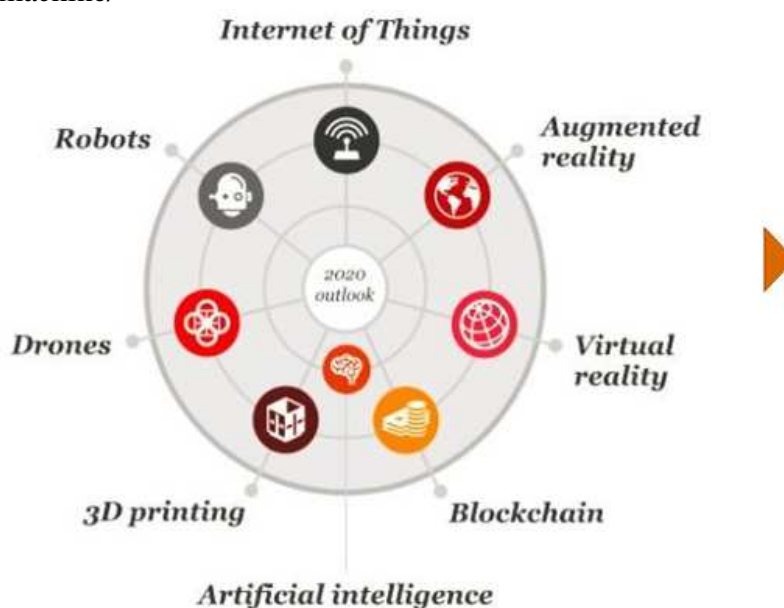


Figure 1 Robotics is one of the emerging technologies [7].



Figure 2 The future of automation [10].



Figure 3 A typical example of robotic surgery [12].