Advances in Robots Technologies and Implementations

Dina Darwish *Editor*

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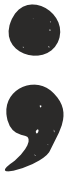

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Preface

In Czech, the word "robota" means "serf work," which is where the name "robot" originates from a drama written by Karel Čapek in 1920, in which machines take control of the world, is credited for popularizing the term "robot." However, the rethinking of human life has always been something that mankind has been interested in. Ever since the beginning of the 20th century, there have been several attempts to rebuild a human person, and there are stories that tell of those who have been successful before. Paracelsus, an alchemist who lived in the 16th century, is credited with having one of the most well-known theories. He asserted that a miniature human-like entity, which he referred to as a homunculus, could be made in a flask by doing nothing more than employing chemical processes. In the latter part of the 16th century, the term "golem" became well known to the general population. In accordance with a traditional tale, the golem was constructed out of clay and had the ability to provide assistance to anyone if a unique paper was put into either its mouth or its forehead. According to the narrative, the golem ultimately met its creator and eventually turned against him. This occurred after some time had passed. When one considers the history of robotics, one discovers that there is a widespread interest in endowing robots with humanity or elements that are characteristic of humans. In general, there are primary criteria, which are as follows:

- The robot must be able to resemble a human being in some manner (in terms of look, thinking, and personality, for example).

- The robot needs to be superior in some way (that is, it needs to be stronger, smarter, etc.).

This means that the designer of the robot must have full control over the robot themselves. When it came to the history of robotics, a significant turning point occurred when robots that were more powerful than people were created. It was about the year 1769 when the first industrial revolution began, and it was around this time that machines began to supplant the human input to labor. During that time period, the primary objective was to increase the number of products as well as decrease the amount of time and money spent on manufacturing, all without involving any human intervention.

At that point in time, automation emerged as the most common notion. Automation allows for the completion of several procedures without the need for any involvement from a human being. People were forced to come up with new methods of working and living as

a result of humans being replaced by robots. Machines are able to operate around the clock because they do not experience fatigue in the same way that people do. Automation led to a reduction in both the likelihood of making mistakes and the quantity of waste produced. In addition, robots are distinguished by their regulated precision and their enhanced efficiency. It was not possible to have access to computer technology in the 1800s. Nevertheless, mankind was able to construct gigantic machines that were capable of carrying out difficult jobs.

Following the year 1950, there has been a significant advancement in the field of robots. The discovery of the moon's surface by the first mobile robot that was operated remotely, which occurred around the year 1970, is another significant event in the history of robotics. Later on, in 1986, Honda initiated a project with the intention of developing humanoid robots that have a similar appearance to that of humans. Robots began to appear in an increasing number of industries, including healthcare, manufacturing, and logistics, as the progress of the technology continued. In spite of the fact that the development of robots is still in progress, we can already find robots in our everyday life. For example, robots can be found in the household (in the form of vacuum cleaners), in the office (in the form of assembly robots), and in the medical field (in the form of social robots in patient therapy or surgical robots).

This is the fourth industrial revolution that humanity is now experiencing. This revolution is integrating the most cutting-edge developing technologies, such as robots, internet of things, fifth-generation wireless networks, artificial intelligence, and many others, in order to propel the industry to new heights. There are several categories that may be applied to robots. We will examine the following four primary approaches to classification:

Size, Application domain, Purpose, Number of users per application.

When considering dimensions, the following categories can be distinguished:
- ***Nanorobots***, also known as nanobots, are constructed out of nanomaterials and can range in size from 0.1 to 10 micrometers. To give you an idea of how little these nanorobots are, a human red blood cell is around 5-10 micrometers in size. The notion of nanobots is now in the preliminary phases of study; primarily, it is being considered for its potential application in the medical field. It will take many more years of laborious effort to make nanobots a viable answer. Injecting nanorobots into the body of a patient in order to diagnose and treat illnesses is one of the potential applications of nanorobots.
-***Microrobots, millibots, and minibots*** are all examples of robots that are significantly bigger than nanobots. These robots are already in existence. Microbots, millibots, and minibots are correspondingly smaller than one millimeter, one centimeter, and ten

centimeters. RoboBee, which has a wingspan of 1.2 centimeters and weighs 80 milligrams, is the smallest flying robot that has ever been created. A remote control can be used to operate the robot, and its wings have the ability to flap 120 times per second. The purpose of such a little apparatus is to create a flying swarm for the purpose of artificial pollination or search and rescue operations.

- ***Robots that are little and medium-sized,*** these robots are often less than 100 centimeters (small) or almost the same size as a human being (mid-sized, 100–200 centimeters). This is the size of the majority of robots that are used in homes, toys, and social robots, humanoids (robots that have an appearance that is comparable to that of humans; the Transformers from comic books and movies are a typical example), and digital personal assistants. The majority of the time, whether in movies or in real life, we encounter and interact with robots that are of both small and medium size.
- ***Huge robots:*** these machines are far larger than we are. Some humanoid robots are rather enormous, reaching heights of up to eight to ten meters. However, humanoid big robots are often constructed for the aim of study or just for the goal of having fun. As a matter of fact, the majority of huge robots do not resemble people; rather, they are designed to automate various tasks, such as manufacturing, construction, agriculture, autonomous driving, and navigation.

Robots may also be classified according to the application domain in which they are used, with personal robots and industrial robots being the two categories that can be achieved.
- ***Robots that are meant to be beneficial for individuals or families*** are employed in our everyday lives and are referred to as personal robots. Personal robots can be operated by those who are not technically savvy to carry out duties that are repetitive and possibly monotonous in order to save time or to entertain us. Among the various types of personal robots, the most frequent types are social robots, digital personal assistants, toys, and household robots.

- ***Robots designed for use in manufacturing, construction, or agriculture***, for example, are built to withstand harsh conditions and are designed to carry out certain duties in accordance with a predetermined set of instructions. Assembly, disassembly, mounting, screw tightening, welding, painting, visual inspection, and other applications are just some of the many uses for this tool. There is one particular activity that industrial robots excel at, and that is working as machines that are quick, accurate, and dependable. We would not be able to achieve the degree of technical growth that we have today if it were not for industrial robots.

The function of robots is yet another classification that might be chosen. Both particular and generic functions are possible for robots to do. So, what exactly does that imply?

-Task-specific robots: these machines are designed to carry out a single task or a series of activities that might be performed independently. Depending on the level of complexity, it might be as straightforward as a robot arm that transports things from point A to point B, or it could be as intricate as a social robot that has an advanced natural language interface. The architecture and conduct of these robots cannot be altered; they have predetermined programming that they follow in accordance with the purpose for which they were established. These types of devices include industrial robots as well as robots used in households.

- General purpose robots: When it comes to general-purpose robotics, the task that the robot is supposed to perform is not predetermined. There are a variety of components of the robots that can be purchased individually, and these components may be joined in a variety of different ways in order to accomplish certain projects. There is a possibility that the components will consist of robot arms, wheels, cameras, step motors, and more sensors and actuators. Another possibility is that these robots are equipped with wireless connections, such as Bluetooth and Wi-Fi. The "brain" of the robot, which is often a tiny computer, may be "trained" to carry out a variety of activities using a variety of components by utilizing specialized programs that are written in computer programming languages. The Nvidia Jetson and Jetson Nano, Raspberry Pi, and Arduino are examples of popular programmable tiny computers, which are often referred to as embedded systems. Through the use of a common communication interface, these embedded systems are equipped with general-purpose input and output connectors, often known as GPIOs. These connections allow for the connecting of actuators and sensors. There are also general-purpose robots that have a prebuilt body that is comprised of sensors (such as cameras and microphones) and actuators (such as arms and legs). It is possible for the robot to carry out a variety of distinct duties thanks to the development of various computer programs. Among the robots that fall under this category are Softbank Robotics' Nao, Pepper, and Romeo, as well as Spot, the robot 'dog' that Boston Dynamics has developed.

In addition, robots can be classified according to the number of instances of each type:
- Single robots: a single robot accomplishes its tasks independently. It is responsible for carrying out a task in accordance with a predetermined program. It is possible that the established program may incorporate cutting-edge technologies that will enable the robot to adjust to its surroundings. Additionally, the robot may be connected to the internet; yet, the robot will still be operating independently. Due to the fact that they are unable to interact with one another, even if there are many single robots in the same location, they are still considered to be "alone."

- ***Swarm robots:*** robots are able to collaborate with one another in a group setting. Within the context of this scenario, a large number of simple robots are controlled and collaborate with one another. Despite the fact that the individual robots that comprise the swarm are not particularly useful, the swarm as a whole is capable of doing substantial tasks. Take, for instance, bees that are found in their natural habitat. If millions of bees were to collaborate in swarms, it is quite possible that they accomplish huge tasks. This is because a single bee is only capable of accomplishing a small amount of work. There is the possibility that swarm robots could be utilized in a wide range of sectors, such as microbiology, surveillance, pollination, as well as exploration and rescue. Despite this, the vast bulk of research on swarm robots is still being carried out at the time that this book is being presented.

Nevertheless, an additional cause for concern arises whenever the degree of realism of robots is increased. Individuals are typically receptive to robots that are designed to mimic humans. In the same way that we identify industrial robots in the manufacturing industry, our brain is able to quickly categorize humanoid robots that resemble robots. This is similar to how we classified industrial robots. It is possible for individuals to suffer uncertainty and even frustration when they come into contact with a robot that is artificially lifelike. We are aware that it is a robot given the facts that have transpired. However, the brain is unable to deal with this reality since it seems to be so accurate. This is because the brain is unable to process the information. Despite the fact that its skin, movement, and even voice are strikingly similar to those of a person, our brain has a difficult time recognizing it as a robot.

This book provides a good beginning for people interested in knowing more information about robots, and includes several chapters ranging from, robots main concepts, robots functioning basics, advances in robotics technologies and implementations, robots in education, and advanced topics in robotics.

Dina Darwish

Contents

1 The fundamental ideas behind robots……..……...……..…..1
Dina Darwish

2 Techniques for the functioning of robots ……..14
Dina Darwish

3 Advances in robotics technologies and implementations……..…39
Ravi Singh, Sukhvindar Singh, Vidyalakshmi. K

4 Robots in education……...……..…81
Jaspreet Kaur, Sukhpreet Singh

5 Advanced topics in robotics…….……..…..…..96
Vijaya Kittu Manda, Theodore Tarnanidis, Mohammed Majeed