GENERAL CONCEPTS ABOUT ROBOTS. ROLE OF ROBOTICS IN INTEGRATED AUTOMATION OF PRODUCTION

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Annotation. *This article provides information about general concepts about robots and complex automation of "robotics".*

Key words: *"Robot", automatic systems, manipulation, autonomous robots, algorithms, distance, "Artificial Intelligence", "Robotics", main classes of robots, robot components, actuation of robots, electric motors, network drivers, serial flexible drives, air muscles, skin-like muscles, flexible nanotubes, sensor dimensions, mechanical clamp, vacuum clamps, general purpose robot arms, types of robot motion, two-wheeled balancing robot, single-wheeled balancing robot, spherical Orb-bot robot.*

The word “robot” was first used in 1920 in the play “RUR” (Rossum Universal Robots) by the Czech writer K. Capek. The concept of a robot is associated with a wide range of different systems and devices. The main difference between a robot and various automatic systems and devices is that it has a mechanical arm (manipulators) capable of performing actions similar to human actions, and with its help the robot has the ability to influence the external environment. A robot is a machine that can perform various manipulations instead of a human.

It is the science that studies how to develop and use the latest technical integration of automated technical systems and production processes other than robots.

Automated machines, aka robots, can work instead of people in hazardous areas or in assembly processes in factories. Robots can be very similar to humans in appearance, behavior and perception. Scientists are currently trying to make human-like robots as human-like as possible.

Autonomous robots have been thought about since ancient times, but research on this topic began only in the 20th century.

The word "robotics" (or "robotics", robotics) was first used in Isaac Asimov's science fiction story "Liar", published in 1941.

The word "robot", which forms the basis of the word "robot", was first used in 1920 by the Czech writer Karel Capek in the book R.U.R. The work used (“Russian universal robots”). In this job, the factory director invents humanoid robots and works tirelessly. At first, androids listen well and work with people, but later they rebel against their creators and destroy them.

The ideas that later entered the field of robotics appeared in ancient times. For example, in Homer's Iliad, the god Hephaestus created household servants from horses, endowing them with the ability to speak (in modern language – artificial intelligence), as well as strength and intelligence. According to some accounts, the ancient Greek mechanical engineer Tarentus Archytas built a mechanical pigeon capable of flight (400 BC). In addition, similar information is provided by I.M. Makarova and Yu.V. I. Topcheeva's famous book "Robotics: History and Prospects" describes the role (or played) of robots in the development of the world.

History of robotics. In 1942, science fiction writer Isaac Asimov invented the Three Laws of Robotics. In 1948, Norbert Wiener developed the principles of cybernetics, which formed the basis of experimental robotics. Fully autonomous robots appeared only in the second half of the 20th century. The first programmable numerically controlled robot was Unimate. It is designed to grab and collect hot iron robot parts from the smelting machine. Today, commercial and industrial robots are widespread. These robots get the job done cheaper, more compactly, and more efficiently than humans. Some of the jobs that robots do in this industry are dirty, dangerous, and boring for humans. Robots are widely used in assembly, assembly, delivery, earth and space exploration, medical surgery, instrumentation, laboratory research and security.

Main classes of robots. There are many types of robots available today, and they are used in different ways in different environments. Although the purposes of use and appearance are different, when it comes to structure, they all have three common areas:

1. Each robot consists of a mechanical support – a device, a frame. The type of frame varies depending on the purpose. For example, if the robot moves through mud and sand, tracked tractors can be used. From a mechanical point of view, the inventor's solution to a particular problem depends on the environment in which the robot moves. The shape of a robot is directly related to its functions.

2. Each robot consists of electrical components. These parts completely control the robot's systems. For example, if we take a robot that walks on chains, force is required to move those chains. This power comes in the form of electricity, travels through wires and is stored in a battery (this is the basic circuit). Gas powered cars also require electricity to operate the gas. That's why cars like petrol ones have a battery. The electrical system is used to move the robot (the motor), for sensing (electrical signals to sense heat, sound, position, and energy),

and for general use (the robot needs to transfer some energy to its motors and sensors). general basic operations).

3. All robots require computer code. The same algorithm shows how the robot works. The person who writes the code writes how and when the robot makes decisions and acts within the program. The robot, which moves in the same way, due to its mechanical design and design, molds clay perfectly and, although it receives the necessary amount of energy from its battery through the wires, does not move without a computer program, because the program tells the robot when and where to move.

The program creates the basic value of the robot. If the mechanical and electrical parts of the robot are perfect, but the program is poorly written, the robot will behave in two ways. There are three main types of algorithms: remote control, artificial intelligence and hybrid. Remote controlled robots have a number of commands. It executes commands only after receiving a signal from the remote control. Typically, a person controls a remote robot through the same device. Robots using “artificial intelligence” make their own decisions depending on the environment. The robotic system records various reactions to environmental factors and objects. “Artificial intelligence” takes these reactions into account and influences environmental factors. Essentially, “artificial intelligence” should be similar to or close to human thinking. A hybrid is a combination of remote control and “artificial intelligence”.

Robot components. The most widely used battery (lead-acid) is currently used as the power source. Many types of batteries can be used as a power source for the robot. They range from heavy but safe and long-lasting lead-acid batteries to small but expensive silver-cadmium batteries. When designing a battery-powered robot, safety factor, duty cycle, and battery weight must be considered. Internal combustion engine type generators can be used. However, such designs are heavy, mechanically complex, and require fuel and heat dissipation techniques.

The limiter that connects the robot to the power source cuts off the power completely. One of its advantages is that the energy generation and storage parts are located in a different location from the robot, reducing weight and increasing available space. However, this approach also has disadvantages. One of them is that wires permanently attached to the robot make it difficult to control and move the robot. Potential power source:

- Pneumatic (compressed gases);
- Solar energy (using solar energy and converting it into electricity);
- hydraulic (liquid);
- Energy storage flywheel;
- Organic waste (from anaerobic digestion);
- Waste (human and animal feces);
- From a military perspective, the excrement of small battle groups can be reused as energy (see how the DEKA Slingshot Stirling engine works).

Start the robot. The moving parts of the robot are human muscles. The "muscles" of this robot use stored energy to move. By far the most common types are the electric motor, which drives a wheel or gear, and the linear actuator, which drives industrial robots in factories. However, there are now alternative ways to move the robot's muscles, including electricity, chemicals or compressed air.

Electric motors. Most robots use electric motors. Handheld robots often have brushless and brushless DC motors or industrial AC robots and CNC machines. Such motors are often used in rotating systems with light loads and dominant motion.

Network drivers. Most types of linear actuators move back and forth rather than rotating, changing direction quickly and frequently. Industrial robots are often used when more power is required. The main types use compressed air (pneumatic) or liquid (hydraulic).

Adaptive drivers sequentially. The springs are made as part of the motor drive. Spring has been used in many robots such as humanoid robot.

Air muscles. Pneumatic artificial muscles, in other words, air muscles, are a special type of tube that expands when the wind blows strongly (up to 40%). They are used in some types of robots.

Skin-like muscles. Wire-like muscles are also known as memory fusions. Nitinol® or Flexinol® is a material that stretches slightly (usually less than 5%) as it moves along the wire. This type of muscle is rarely used.

Flexible nanotubes. Flexible nanotubes are a promising technology for creating artificial muscles. It is currently in the early stages of research. Due to the absence of defects in carbon nanotubes, carbon filaments can change their length by several percent. The energy capacity of iron nanotubes is about 10 J/cm3. The human biceps can be replaced with a wire with a diameter of 8 mm made of the same material. In the future, robots equipped with such compact muscles could outperform humans.

Sensor dimensions. Robots can obtain precise information about the environment or internal parts using sensors. It is very important for robots to perform given tasks, perceive changes in the environment and react accordingly. Robots perform a variety of measurements using sensors, sensors provide protection or alerts for violations, and provide real-time information about their tasks as they complete them.

Today's robotic hands and prosthetic hands receive less sensory information than the human hand. In recent research, scientists have developed a set of tactile sensors that mimic the mechanical properties and sensory receptors of human fingers.

In 2009, scientists in a number of European countries and Israel developed and released SmartHand prosthetic hands. The left hand was a real human one - amputees could write, type on a keyboard, play music and perform other tasks using a prosthetic hand. The patient was able to feel real finger sensations thanks to sensors in the prosthetic hand.

The ability to see. Computer vision is the science and technology of machine vision. Computer vision as a scientific subject is the theory of extracting information from images using an artificial system. Image data comes in several forms, such as a series of images such as a video, or a camera image.

In computer vision applications, computers are pre-programmed to solve a specific problem, although the machine is now developing the ability to learn on its own.

Computer vision is a huge field, and one of those fields is fine-tuning human biological systems to mimic behavior and behavior at different levels of complexity. Machine learning methods in computer vision have roots in biology.

Another. For sensing, robots use lidar, radar and sonar systems.

Manipulation. Robots must lift, move, transform, break, or do something else. Robot arms are called end effectors in the field of robotics. The tips of the robot's arms, specifically the part that holds the object, are interchangeable. Each type is designed for a specific type of work. However, some robots have a fixed tip that only works with one type of grip without sharpening, and some have a humanoid robot arm (like a human hand) that is stable but can perform multiple tasks.

Mechanical clamp. One of the most common types. In its simplest form it has only two fingers. It can open, close, receive and send small items with two fingers. It is made in the form of a chain with an iron wire between the fingers. Moderately complex hands are Delft's Broken Hands, and more complex hands that act like human hands are Shadow Hand and Robonaut's Broken Hands. Mechanical clamps come in many forms, including friction jaws and gripping jaws (clamps). A friction grip attempts to hold an object motionless using friction without exerting any force on it. And the included clamp grips the object but requires less friction.

Vacuum clamps. Although vacuum clamps are easy to make, they are capable of lifting heavy objects. If the outer surface of the object being lifted is smooth, the pump will pump the liquid and lift the object.

Robots designed to lift large, heavy objects, such as electronic components and car windshields, typically use clamps similar to regular vacuum cleaners.

General purpose robotic manipulators. Some advanced robots have begun to use fully humanoid arms, such as Shadow Hand, MANUS and Schunk. The left hands are very dexterous, and the left handles have about 20 DOF (degrees of freedom) and hundreds of touch sensors.

Types of robot movement. Wheeled robots. For simplicity, most robots are equipped with a four-wheeled continuous platform. Some scientists are trying to create more complex types of mobile robots, including robots that walk on one or two wheels. This reduces the number of robots and also allows one- or two-wheeled robots to move around limited areas, which a four-wheeled robot cannot do.

Two-wheeled balancing robot. Balancing robots typically use a gyroscope. Using a gyroscope, the robot determines at what speed and in what direction it will fall, and directs the wheels in the direction of the fall. The robot then tries to balance itself hundreds of times per second, depending on the dynamics of the inverted pendulum inside the robot. There are many balancing robots produced today. If we consider a robot as an automated device, then Segway is not a robot, and the mobile platform of a regular robot can be considered RMP (Robotic Mobility Platform). If we look at NASA's Robonaut as an example, we can see that the robot is built on the Segway platform.

Robot for balancing one wheel. The two-wheeled balancing robot extension can move in any direction in 2D using only one wheel. However, this type of robot uses a ball as a wheel. Recently, several single-wheeled balancing robots have emerged, one of which is Carnegie Mellon University's Ballbot. It is the same as the height and width of a person. The other is the BallIP robot from Tohoku Gakuin University. These robots are often tall, thin, and able to maneuver in small spaces. Therefore, such robots find their place among people compared to other robots.

Spherical robot "Sphere-bot". Another idea scientists have is to put robots in a full balloon. According to the researchers, the robot rotates, or the outer shell of the sphere in which the robot is located rotates, but the inner shell does not move. These types of robots are called spherical bots or ball bots.

Six-wheeled robots. The decision to use six wheels instead of four provides the robot with better traction and road stability when moving through mountainous terrain and meadows.

Mobile robot. Tracked robots provide better traction. A chain mechanism holds the rod, made up of hundreds of wheels, as it moves. That is why it was used abroad. One of the most widely used areas is the military sphere. Military operations are often carried out outdoors, and the crawler robot can easily reach places that are difficult to reach with conventional wheels. However, using this type of robot on flat or level areas inside the house will be difficult. One such robot is NASA's urban robot Urby.

Walking robots. The theft process is a complex and dynamic problem. Some robots can walk on two legs like humans, but none can walk as firmly as humans. There have been many studies on human walking ability, one of which was conducted at the AMBER laboratory, which opened in 2008 at Texas A&M University. Other robots have more than two legs. Although they had more legs than bipeds, they were easier to build. Therefore, they began to create robots that have more than two legs, but which can walk normally. One of the robots is made in the shape of a dog. The walking robot's motor system could walk on any uneven terrain compared to other robots, and was also more mobile and energy efficient. Hybrid robots have been featured in films such as I, Robot. The robot first runs on two legs, then on four legs (two legs, two arms). Typically, a bipedal robot can walk on a flat surface, and sometimes even climb stairs.

Other types of movement. Flight. In general, a modern passenger aircraft is a flying robot controlled by two people. When airplanes have autopilot enabled, the computer can control the airplane throughout the entire flight (takeoff, takeoff, and landing). Another type of flying robots is unmanned aerial vehicles (UAVs).

There will be no people at the airport, so it will be smaller and lighter than conventional planes. These aircraft fly into dangerous areas to perform military surveillance missions. Some start shooting on orders from headquarters. Some robots start shooting automatically, without human command. Other types of flying robots are cruise missiles, entomopters, and Epson microhelicopter robots. Robots such as Air Penguin, Air Ray and Air Jelly have lighter-than-air bodies, paddles and sonar control.

Swirling movements. Several snake-like robots have been produced. These robots can imitate the movement of a snake and reach limited areas. Therefore, snake-like robots will one day help search for people under destroyed buildings. The Japanese snake robot ACM-R5 will be able to swim not only on land, but also in water.

Flying robots. There are not many gliding robots in the world, one of them is a multi-mode walking and gliding robot. The robot has four legs, each leg has one wheel (no force is applied to the wheels). The robot can walk or spin these wheels normally. Another type of robot, the Plen robot, can ride on a small skateboard or ice skates.

Mountaineering. In order for the robot to climb a mountain with a vertical surface, scientists spent a lot of effort and used various methods. One approach was to reproduce the movements of a person climbing a mountain; aligning the body's center of mass and gaining leverage with every movement. One example of such robots is the capuchin robot created by Dr. Ruixiang Zhang from Stanford University in California. Swimming robot (like a fish). It has been estimated that some fish can achieve propulsion efficiency of over 90% while swimming. They also accelerate better than a man-made boat or submarine; They make less noise and disturb the water less. For this reason, scientists studying underwater robots want to reproduce this type of movement. The best examples of such robots are at the University of Essex. Doctor of Computer Science G9 Robot Fish and Robot Tuna from the Institute of Field Robotics. These robots are designed to analyze the movement of fish in water and create a mathematical model. The Aqua

Penguin robot from the German company Festo replicates the pointed body of penguins and uses penguin “paddle feet” to move. Festo has created the Aqua Jelly robot, which imitates the movement of a jellyfish.

Sailboat. Sailboat-like robots were launched to take measurements on the ocean's surface. One such robot is the Vaimos robot, developed by IFREMER and ENSTA-Bretagne. Since the movement is driven by the wind, the battery charge is only needed to operate the computer, communicate and turn the steering wheel. If a robot has a solar panel, that robot can theoretically run indefinitely. Sailing robot races are held. The two most important of these competitions are the WRSC and Sailbot competitions, which are held annually in Europe.

Communication and navigation with the environment. Most modern robots work on human commands or work in one place. However, humanity is increasingly interested in robots that can work autonomously in dynamic environments. These robots need navigation to move through the environment without obstacles. If unexpected situations arise (for example, people and other objects move instead of staying in place), the robot may fight and create problems. Advanced robots such as ASIMO and Meinu robot also have powerful navigation systems. Ernst Diekmann himself or his self-driving cars can sense their surroundings and make navigation decisions independently. Many of these robots use GPS in combination with sensors such as radar, sometimes lidar, video cameras and inertial navigation systems to navigate between waypoints.

Human speech recognition. Often, the variability of human speech makes it difficult for computers to recognize human speech in real time. For reasons such as local acoustics, room size, or a person's condition (illness or behavior), the same speech from the same person may be heard differently. And if a person has an impulse, the situation is even worse. However, in 1952, Davis, Biddulph and Balaszek made significant advances in voice recognition and invented the world's first "voice input system" that could recognize 10 digits by one person with 100% accuracy. Modern systems can recognize up to 160 natural continuous speeches per minute with 95% accuracy.

Robot voice. There are obstacles to getting robots to talk like humans. For social reasons, it was decided not to allow the use of a synthetic voice, so it was noted that the emotional components of the voice should be developed in different ways.

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