

METHODOLOGY OF TEACHING THE SUBJECT OF "ROBOT CONTROL SYSTEMS" TO A STUDENT OF TECHNOLOGICAL EDUCATION IN AN INFORMATIONAL EDUCATIONAL ENVIRONMENT**Kucharov Sardor Akmalovich**

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Annotation: This article explores the essence of robotic control systems, their structure, and areas of application. The development of robotics enables high efficiency in industry, medicine, military, and everyday life. Control systems play a crucial role in allowing robots to move autonomously, make decisions, and facilitate human activities.

Key words: Robotics, control system, automation, artificial intelligence, sensors, algorithm, independent control.

Anotatsiya: Mazkur maqolada robotlarni boshqarish tizimlarining mohiyati, ularning tuzilishi va qo'llanish sohalari yoritilgan. Robototexnika rivoji sanoat, tibbiyot, harbiy va maishiy sohalarda yuqori samaradorlikka erishishga imkon bermoqda. Ayniqsa, boshqaruv tizimlari robotlarning mustaqil harakatlanishi, qaror qabul qilishi va inson faoliyatini yengillashtirishi uchun asosiy omil bo'lib xizmat qiladi.

Kalit so'zlari: Robototexnika, boshqaruv tizimi, avtomatlashtirish, sun'iy intellekt, sensorlar, algoritim, mustaqil boshqaruv.

Аннотация: В данной статье рассматривается сущность систем управления роботами, их структура и области применения. Развитие робототехники обеспечивает высокую эффективность в промышленности, медицине, военной и бытовой сферах. Особенно важную роль играют системы управления, которые позволяют роботам самостоятельно двигаться, принимать решения и облегчать деятельность человека.

Ключевые слова: Робототехника, система управления, автоматизация, искусственный интеллект, датчики, алгоритм, независимое управление.

INTRODUCTION.

Nowadays, robotics is deeply penetrating all aspects of human life. Automated robots are widely used in production lines, surgical robots in medicine, and various auxiliary devices are widely used in everyday life. In this case, one of the most important factors that ensure the efficient operation of robots is the control systems.

The main types of robot control systems:

- Programmed control systems - robots work based on pre-written algorithms.
- Remote control systems - controlled by the operator through a computer or a special remote control.
- ✓ Autonomous control systems - robots can make independent decisions based on sensors and artificial intelligence.
- ✓ Mixed control systems - includes programmed and autonomous control elements.

The main components of robot control systems:

- ✓ Sensors - for perception of the external environment.
- ✓ Actuators - to perform mechanical actions.
- ✓ Management module – for decision-making and execution of tasks.
- ✓ Software - to develop algorithms and control commands.

In the 21st century, technological development has a profound impact on human life. The field of computer technologies, artificial intelligence, automation and robotics is developing at an unprecedented level. Robot control systems are the heart of this development. Because robots are not just mechanical devices, they are intelligent systems capable of solving a specific problem, perceiving the environment, and performing a task. The issue of effective control of robots has become relevant since the second half of the last century. At first, they were used as simple programmed devices, but today they have become complex systems with autonomous decision-making and artificial intelligence. Therefore, in-depth study of robot control systems is important not only theoretically, but also from a practical point of view.

Historical development of robot control systems:

Robotics has been a dream of mankind since ancient times. Ancient Greek scientists made simple mechanical "automata". For example, during the time of Archimedes, simple mechanical mechanisms were used to pump water or transmit motion. In the Middle Ages, Muslim scientists - brothers Al-Jazari and Banu Musa - created mechanical devices. In the middle of the 20th century, the industrial revolution and the need for automation accelerated the introduction of robots. In 1961, the first industrial robot called "Unimate" was used in production lines. Since then, robot control systems have been formed as a new scientific direction. Today, management systems are enriched with modern technologies such as artificial intelligence, machine learning, deep neural networks, and big data processing.

Types of robot control systems:

1. Programmed control systems.

Robots move based on pre-written algorithms. For example, manipulator robots working on assembly lines perform the same actions over and over again.

2. Remote control systems.

A human operator controls the robot through a special remote control or a computer. For example, space vehicles, drones and underwater robots.

3. Autonomous control systems.

The robot perceives the external environment with the help of sensors, processes information and makes independent decisions. For example, Google and Tesla are developing self-driving cars.

4. Mixed management systems

Systems that combine elements of pre-written programming and independent decision-making. This approach ensures safety and efficiency.

Robot control is closely related to mechanism kinematics and dynamics. The position of the robot arms and legs can be described in different coordinates. The reference coordinate system should be selected according to specific needs and the appropriate coordinate transformation should be performed. Solutions of forward kinematics and inverse kinematics are often needed. In addition, the effects of inertial force, external force (including gravity) and centripetal force must be taken into account. Even a simple robot needs at least 3~5 degrees of freedom, while a more complex robot needs more than ten or even dozens of degrees of freedom. Each degree of freedom usually includes a servo mechanism, which must be coordinated to form a multivariable control system. The computer performs coordinated control of several independent servo systems, makes the robot move according to human will, and even gives the

robot a certain "smart" task. Therefore, the robot control system must be a computer control system. At the same time, computer programs perform demanding tasks. Since it is a non-linear mathematical model to describe the robot's position and movement, its parameters change with the change of position and external force, and there is a relationship between the variables. Therefore, it is not enough to use only closed loop position, but also velocity or even acceleration. The system often uses drag compensation, feedforward, decoupling, or adaptive control. An "optimal" problem since the robot's movement can often be performed in many different ways and paths. For more sophisticated robots, it is possible to create a huge information base with the help of a computer with the help of artificial intelligence, and with the help of the information base, it is possible to control, make decisions, control and exploit. According to the sensor and pattern recognition method, the operating conditions of the object and the environment are obtained, and the best control law is automatically selected according to the given index requirements. In summary, the robot control system is an integrated and nonlinear multivariable control system closely related to the principles of kinematics and dynamics. Due to its uniqueness, neither classical management theory nor modern management theory can be copied and used. So far, the theory of robot control is not complete and systematic.

The main components of control systems:

- Sensors - collect information about the external environment (distance, light, sound, pressure, temperature).
- Actuators – perform mechanical movement (motor, hydraulic systems).
- Control module – central processor, algorithm and decision-making mechanisms.
- Software - algorithms, artificial intelligence modules, control programs.

The main functions of the industrial robot control system are the motion state, attitude and trajectory, operation sequence, and motion time of the industrial robot in the workplace. Controlling the movement position, attitude and trajectory, operation sequence and movement time of the industrial robot in the workplace is the main function of the industrial robot control system, some of these projects are very complicated to manage. Teaching the multiplication function. The function of teaching and reproduction means that the control system can teach through the teaching box or the handle and teach the movement sequence, movement speed, position and other information to the industrial robot in a predetermined way. The memory device of the industrial robot automatically records the learned operation process in the memory. When a playback operation is required, the content stored in the memory can be replayed. If you need to change the content of the operation, teach it again. Motion control function. The motion control function refers to the control of the position, speed, acceleration and other elements of the final manipulator of the industrial robot.

The control system of an industrial robot consists of appropriate hardware and software.

The equipment mainly includes the following parts:

- 1) Sensor device. It can be divided into internal and external sensors. The first one is used to sense its position and its function is to determine the position, velocity and acceleration of each joint of the industrial robot; The latter is used to sense the working environment and the state of the working object. External sensors include vision, force, touch, hearing, sliding and other sensors.

2) Control device. It usually consists of a microcomputer or minicomputer and suitable interfaces. Its task is to process various sensory data, execute control programs and generate control instructions.

3) Integrated servo drive unit. The main function of this part is to drive each joint according to the requirements of the performance tasks based on the instructions of the control device. The software mentioned here mainly refers to the control software of the robot. The control program consists of a trajectory planning algorithm, a joint servo control algorithm, and a corresponding action program. It can be programmed in all programming languages, but the main stream of industrial robot control software is a special industrial language formed by modularizing a common language.

Robotics is the design, creation and programming of "intelligent" mechanisms, i.e. robots. They are used in the aerospace industry, healthcare, e-commerce, space development, transportation and other fields. The name "robot" comes from the Czech language, which has the appearance of "robota". This term was used by the writer Karel Chapek in 1920 in the play RUR (Rossum's Universal Robots) when he named the machines artificially created in factories that look like living people. Even today, we think of androids or humanoids in the same way. A new industrial era began in 1959. The world's first industrial robot, Unimate, was created in the USA. Today robotics has become one of the fastest growing areas, and these developments from the pages of Czech fiction are divided into different fields in real life.

There are several options for programming robots.

A pipeline approach.

This scenario involves the following steps that make up the process:

- Monitoring data from the robot's built-in sensors. All the information received is converted into input that the machine receives to perform its tasks.
- Analysis of the situation. Using the input data obtained in the previous step, a description of the main characteristics of the system is created. The robot's speed, direction, etc. are evaluated.
- Model building and forecasting. This phase is a dynamic work that periodically helps to estimate the state and motion model of the robot.
- Planning. At this stage, the set of actions required to complete the task is defined.
- Management. Commands are changed and the program that controls the robot's behavior can be modified.

A biological approach:

Robotics often uses technologies such as artificial intelligence and neural networks. Their task at the present stage is to imitate the activity of the human biological neuron brain. An important achievement of these technologies is the ability to catch and understand in 2016. Robots can now be trained in the same way that pets are trained to follow commands. Biological and conveyor belt approaches are largely at odds with each other. But the decent results of the first are commendable.

Mixed approaches:

This is where technology merges. It uses the positive experience of biological and conveyor method approaches. As a result, robots programmed in this way show superior results compared to classical robots.

Popular languages in robot programming

The several hundred programming languages available today are divided into two groups according to their low level and high level. In the early 1950s, machine code was replaced by low level languages. They make programming easier. They are still used today, especially useful

when robot movements need to be strictly controlled. These languages have an important drawback: separate programs are required to be written for the same actions of machines of different designs, that is, one program is needed for an excavator-robot handle, and another for a robot-arm. This is not a problem when working with high-level languages. They are very advanced and easy to use. At the same time, construction aspects are not important: the same command can be executed by any robot. But in such languages, the program can be written only for a device with a large amount of memory, because it takes up a lot of space. If the control is transmitted through a translator, then the robot needs to be programmed in a low-level language.

If the microcontroller has an Arduino-type board, high-level languages can be used, which are easier to work with. When programming a robot with multiple control types, different languages are often used for different tasks. Such a machine can be considered a polyglot. Below is a collection of the most popular languages used by roboticists. To study programming languages in detail, it is necessary to read a lot of literature. Here are just the main features of each to give an overview and to explain why they are on the leaderboard. For each language, an example of the same program written in it is provided. Basic training usually begins with this program. As a result, the text Hello, world appears on the screen of the monitor or controller. Different programming environments are used to control robots. They are divided into two main groups: visual and textual. There is also a difference in universality. There are programming environments specialized for controlling a particular robot and compatible with different robots manufactured by different companies. Almost every manufacturing company in the field of robotics develops its own programming language and supporting software tools.

Among them, those who introduce robotics into production processes are primarily interested in the development of auxiliary software that can be adapted to existing conditions. Also, efforts are being made to create new technologies that help to improve product quality, to improve old technologies, and to introduce measurement systems. Industrial robots are usually equipped with a comprehensive software shell to which various additional extension modules can be added depending on the task to be performed. For example, it is possible to connect communication modules with external monitoring devices (video surveillance, load, torque measurement system) and this allows the robotic mechanism to respond appropriately to changes in external conditions. There are two types of industrial robot programming: online and offline programming. Usually both types are used at the same time. There are differences in programming methods, language capabilities, and robot features.

The robot controller remembers the position reached and it repeats until all required operations are completed. This set of points determines the movement trajectory of the mechanism. Each point has its own variable parameters, movement speed and angular rotation, accuracy, axis configuration. The disadvantage of online programming is that it is impossible to run the production process while it is being implemented. In addition, high accuracy cannot be guaranteed, and it is difficult to make changes to the program. The robot is first manually guided along the desired path of movement, and then it accurately repeats the specified trajectory. Robots for painting or varnishing are often programmed with this method. Programming consists of describing the flow of the program in text form in one of the languages, that is, the logic of the program is written - trajectories and their sequence, reading data from peripheral devices, communication with service personnel, compliance with security requirements. The main task in creating a robot is to write the program code. In order for the machine to demonstrate all its capabilities in the best possible way and to perform its assigned tasks correctly, the program must be properly structured. Although even children can learn the basics of programming robots these days, it's important to remember that it's different from writing a regular computer program.

Fields of application of robot control systems.

1. Industry

- Assembly robots in automotive industry.
- Metal welding, cutting, assembly.
- Logistics and warehouse robots.

2. Medicine

- Surgical robots (for example, "Da Vinci").
- Rehabilitation robots.
- Diagnostic and laboratory robots.

3. Military sector

- Intelligence robots and drones.
- Robots used in places where there is a risk of explosion.
- Autonomous combat systems.

4. Domestic life

- Robot vacuum cleaners.
- Smart assistive devices.
- Autonomous vehicles in the transport service.

XULOSA.

Robot control systems are one of the most relevant areas of modern science and technology. They are important in easing human labor, automating dangerous and complex processes, and increasing production efficiency. Control systems provide robots with responsiveness, independent decision-making, flexible working with the environment, and high-precision performance of tasks. In the future, control systems based on artificial intelligence, machine learning and neural networks will guarantee that robots will operate more intelligently, independently and efficiently. Therefore, the study and development of robot control systems is one of the most important areas of technological development. Robot control systems are the foundation of future technologies. They not only increase production efficiency, but also play an important role in improving the quality of human life.

In the future, the following areas will be given priority:

- Creating smarter management systems based on artificial intelligence.
- Development of energy-efficient robots.
- Ensuring that robots work in safe cooperation with humans.
- Effective use of robots in education and healthcare.

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