THE ROLE OF SOFTWARE IN CONTROLLING ROBOTIC SYSTEMS

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Abstract. The aticle develops a method for synthesizing motion programs for robotic systems (RS) with arbitrary structures. The focus is on improving motion control using inverse dynamics, adaptive algorithms, and sensor integration. The study includes the creation of mathematical models for multi-link and biped robots and the implementation of a prototype control system. The study highlights the growing importance of software in controlling complex autonomous robotic systems with applications in various industries such as logistics, healthcare, and agriculture. The results lay the foundation for future advances in robotics driven by artificial intelligence and computing technologies.

The relevance of the aticle is justified, the goal is formulated, and the scientific novelty of the research is argued. The practical significance of the obtained results is demonstrated, and the scientific positions to be defended are presented. The first chapter presents a study of the subject area of motion control algorithms for robotic systems (RTS). The structures of modern RTS are considered. Contemporary approaches to motion control, as well as key mathematical methods, are reviewed. Existing methods for synthesizing the motion programming of RTS are discussed. It is shown that to achieve good trajectory tracking, the dynamics of the robot and the inertia forces arising during motion must be taken into account. This means that the full dynamic model of the RTS must be considered during the control synthesis. The method chosen for motion programming synthesis is based on solving the inverse dynamics problem. The second chapter addresses the problem of motion control for RTS based on solving the inverse dynamics problem. The applicable mathematical model is described, and the derivation of equations is shown. The control method is explained, along with algorithms for adaptive selection of kinematic parameters for the motion of a walking robot.The control system has a hierarchical structure, which can be divided into the following levels. The aim of the dissertation is to develop a method for synthesizing the motion program of the links of a robot with an arbitrary structure, as the central element of the system for motion control of the robot.

1. A method for generating motion programs for robots with arbitrary structures has been developed, based on solving equations with redundant constraints.

2. Three mathematical models of multi-link and bipedal robots for spatially controlled motion have been created.

3. A prototype of a control system for a mechanical system with redundant constraints has been implemented.

The relevance of the topic "The Role of Software in the Control of Robotic Systems" lies in the fact that modern robotic systems (RS) are becoming increasingly complex and multifunctional. In such systems, software (SW) plays a key role in ensuring their effective operation, as it is responsible for managing all processes, including movement coordination, sensor data processing, decision-making, and interaction with external devices. Given the rapid development of robotics and automation technologies, software has become a core component that determines the capabilities and limits of RS. In particular, SW ensures:

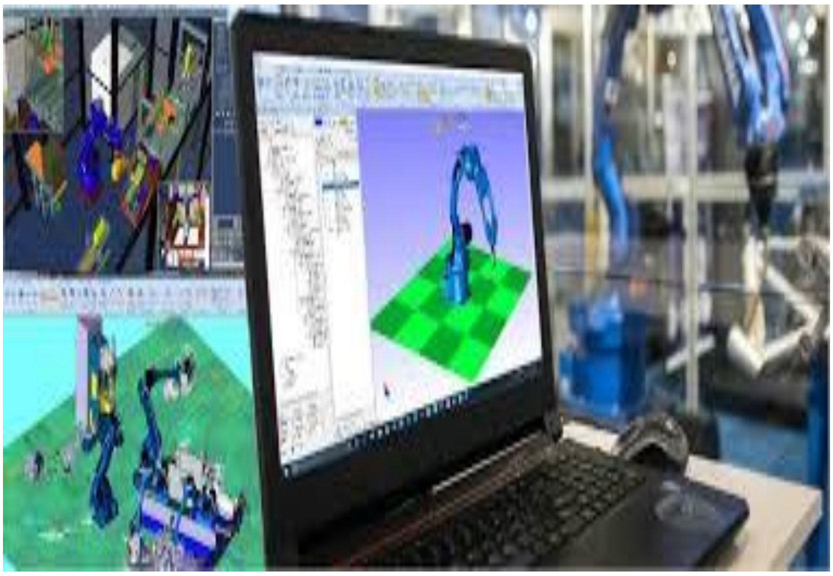

Figure 1 - The impact of 5G technology on the Internet of Things

One of the main areas is the development of algorithms for robot motion control. These algorithms ensure coordination of the robot's movements, trajectory management, and stability during motion. Most modern solutions use feedback and adaptive control methods, which allow robots to adapt to changing conditions and overcome obstacles. The most commonly used algorithms are based on control theory (PID, LQR, optimal control), as well as artificial intelligence methods (neural networks, machine learning algorithms) that improve the accuracy and efficiency of robot movement.

Another important aspect is the integration of sensors and processing of data obtained from various sensors (such as cameras, lidars, ultrasonic sensors). The software must ensure precise processing of environmental information, which is critical for autonomous robots, for example, in logistics or agriculture. Modern solutions include perception algorithms and **SLAM** (Simultaneous Localization and Mapping) for mapping and navigating robots in complex and dynamic environments.

Conclusion. The development of software for controlling robotic systems (RS) is crucial for enhancing their efficiency, functionality, and autonomy. Recent advancements in algorithms for precise and adaptive motion control, as well as integration with various sensors and external devices, have significantly improved task execution and expanded the capabilities of robotic systems. Modern software solutions for RS address key areas such as motion control, environmental perception, navigation, and decision-making, enabling robots to be applied in diverse fields, including industry, healthcare, agriculture, and services. Software has become an essential part of all contemporary robotic systems, providing high levels of autonomy and adaptability to changing conditions. As computing technologies and artificial intelligence continue to advance, software will play an even greater role in robotics, driving the development of smarter, more flexible, and efficient robots for a wide range of applications.

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