MODELING OF A MATHEMATICAL MODEL OF ROBOT MOVEMENT TRAJECTORY

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Annotation: The article explores methods for developing a mathematical model of robot motion and its simulation. Various mathematical functions, differential equations, and simulation tools are used to determine the robot's trajectory. The study results indicate the importance of these methods in optimizing motion and improving robot efficiency.

Key words: Robot trajectory, mathematical model, modeling, simulation, motion optimization.

Introduction. Robotics in the field movement trajectory determination and modeling issue modern science and of practice current from directions one is considered, because of robots' effective performance their movement clear planning and to optimize directly is related. Action trajectory mathematician model using working exit robot targeted to the point reach, energy spending reduces and safe movement to provide service does. This for the purpose different mathematician approaches, in particular, differential equations, parametric functions, vector and matrices through robot movement descriptive models working is issued, this and trajectory analysis automation and forecast opportunity gives. In research also, robot movement modeling in the process simulation of tools role big that is emphasized because they movement parameters realistic to the conditions close under the circumstances try see and mistakes determination opportunity gives. This with together, movement trajectory mathematician model robot kinematics and dynamics features into account received without is optimized, this and engineering and scientific in research important importance has. This at work robot movement trajectory create and modeling processes, various mathematician approaches, simulation methods and their practical application wide in scope studied, robotics systems efficiency increase opportunities analysis will be done.

Robotics in the field movement trajectory determination and modeling issue modern science and of practice the most current from directions is one, because of robots effective performance their movement clear planning and to optimize directly is related. Robot trajectory mathematician model using working exit through robot targeted to the point reach time reduction, energy spending optimization and safe the movement provision possible It will be. for the purpose different mathematician approaches, in particular, parametric functions, differential equations, vector and matrices using robot movement descriptive models working Modeling in the process simulation tools using trajectory different under the circumstances try It is seen that and mistakes determination and realistic to move close results to take opportunity It also provides a description of the robot's movement. mathematician model kinematics and dynamics parameters into account received without is optimized, this and robot stability and accuracy to increase help This gives in research, the robot's motion trajectory create and modeling process, various mathematician approaches, simulation methods and their practical application wide in scope studied, robotics systems efficiency increase and the movement optimization opportunities analysis This approach is in the future complex robotic systems design, management and automation processes develop for scientific and practical basis creates.

Literature analysis. Research this shows that the robot's trajectory using a mathematical model determination robotics systems efficiency increase and energy spending optimization opportunity gives, this and trajectory stability and accuracy in providing important role plays [1]. Modeling in the process parametric functions and differential from equations use robot position, speed and acceleration determination opportunity gives, that with together trajectory different under the circumstances simulation to do to real action through close results to take possible [2]. Simulation tools using the robot trajectory in a virtual environment trial and error determination and correction opportunity gives, this and robotics systems design and in management security and efficiency increases [3]. Kinematics and dynamics parameters into account received without optimized trajectories robot targeted to the point fast achievement, efficiency of action and stability to increase service [4] Optimization algorithms robot trajectory using targeted to the point to deliver and energy spending reduce opportunities expands, this and complex robotic systems management in the process practical importance has [5]. Research this shows that mathematics   modeling and simulation approaches Combine robot movements forecasting, analysis to do and in management effective tool become service does that   with together robotics systems design and from the test in transfer scientific basis creates [6]. Thus together, the robot trajectory mathematician modeling and simulation to do methods not only scientific in research, but practical robotics effective in systems approach as is being used, this and in the future complex robotic systems create and management for promising direction is [7].

Materials and Methods. In this study, the process of developing and modeling the robot's motion trajectory through a mathematical model requires the use of a number of scientific and technological materials and methods. First, a set of parameters was developed to determine the kinematic and dynamic characteristics of the robot, including the weight, dimensions, number of joints and motion ranges of the robot. Also, a system of differential equations was created for trajectory models, in which the position, velocity and acceleration of the robot were expressed in terms of time. Matlab and Simulink programs were used to calculate the trajectory parameters, creating the opportunity to simulate the robot's motion under various conditions. Gradient methods, parametric functions and interpolation techniques were used to optimize the robot's trajectory during the research process, which helped to reduce the time to reach the target point

and optimize energy consumption. In addition, test models and a virtual environment were used during the modeling process to ensure that the robot's motion corresponded to real conditions, which allowed validating the simulation results and identifying errors. Thus, the materials and methods used in the study served to provide accurate, efficient, and realistic modeling of the robot's motion trajectory, enabling a systematic approach that combines kinematics, dynamics, and mathematical optimization methods.

Table 1. Robot movement in modeling used parameters and their description

Parameter	Description	Measurement unit	To the model impact	Application field
Position	Robot's every one joint or general point	m (meter)	Trajectory accuracy	Kinematics, trajectory analysis
Speed	Action speed	m/s	Action dynamics, optimization	Dynamics, energy expense
Acceleration	Action acceleration	m/s²	Trajectory stability	Kinematics, safety
Corner status	Of syllables corner coordinates	degree	Action accuracy and management	Robot design, management
Energy expense	Robot movement during expendable energy	J (joules)	Action efficiency	Optimization, simulation

Above cited two table robot movement trajectory mathematician model and modeling process systematic to explain service Table 1 robot movement in modeling used main parameters, their descriptions, measurements units, model the impact and application field shows. This table through robot position, velocity, acceleration, joints corner status and energy expense such as of parameters trajectory accuracy, movement dynamics and optimization in the process importance clear It seems. With this together, table robotics in systems parameters choice and modeling process in planning comfortable tool as is used.

Research discussion. The results of this study demonstrate the effectiveness of the process of developing and modeling the robot's motion trajectory through a mathematical model. Using the differential equations and parametric functions constructed during the study, it was possible to determine the position, velocity, and acceleration of the robot, which serves to optimize the trajectory and reduce energy consumption. The simulation results showed that modeling the robot trajectory under different conditions gives results close to real-time motion and helps to identify errors in advance, which is important in the design and control of robotic systems. At the same time, taking into account the parameters of kinematics and dynamics in the modeling process increases the stability and accuracy of the robot's motion, and also allows for real-time trajectory updates. The study also showed that it is possible to reduce the time for the robot to reach the target point and increase the efficiency of the movement by using optimization methods. The results show that the combination of mathematical models and simulation tools provides an effective approach for analyzing, predicting, and optimizing robot motion, which can be used not only in scientific research but also in practical robotic systems. In this regard, the combination of sensor data, mathematical models, and simulation methods allows for accurate and stable modeling of robot motion trajectories and shows promising future applications in the design and control of complex robot systems.

The results show the robot's motion trajectory. through a mathematical model working exit and modeling process efficiency wide in the field confirms. Research during differential equations, parametric functions and simulation tools using robot position, speed and acceleration determined, the trajectory accuracy and stability provided. Modeling results this shows that real

time in mode trajectory update and different under the circumstances from the test transfer robotics systems effective performance increases, errors in advance determination and correction opportunity gives. With this together, kinematics and dynamics parameters into account received without optimized trajectory robot targeted to the point fast energy spending to reduce and efficiency of movement increase Research also, simulation and optimization methods harmony robot movement forecast and management processes noticeable at the level improve shows. Results this confirms that the mathematician modeling and simulation approaches robotics systems design, trajectory planning and the movement in management not only scientific, maybe practical also large in terms of importance has. This point of view visually, sensor data, mathematical models and simulation of tools integration complex robotic systems create and management in the process new opportunities opens and in the future robotics in the field efficiency to increase service does.

Conclusion. In this study, the process of developing and modeling a robot's motion trajectory using a mathematical model was extensively studied. The study results this shows that the differential equations, parametric functions and simulation from the means use robot movement accuracy with forecast and optimization opportunity gives. Modeling in the process kinematics and dynamics parameters into account to take robot stability, purposeful to the point reach speed and energy efficiency increases. With this together, real time in mode trajectory update and different under the circumstances from the test transfer robotics systems effective performance Research results mathematician modeling and simulation robot movement of methods management, optimization and design in the processes important importance has that shows and in the future complex robotic systems working exit and management for scientific and practical basis creates.

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