Synthesis of the motion of a mobile robot with mecanum wheels

Abstract

This work presents the results of the analysis and synthesis of control for a nonholonomic, overactuated mobile robot with mecanum wheels ($MRKM$). It includes a description of the robot's kinematics, based on which the inverse kinematics task was solved, adopted as a given trajectory of motion for the tracking control system of the robot. Dynamic equations of motion were adopted in the form of Maggi's equations. The identification process was carried out using an adaptive and batch procedurę based on experiment on a real object. The best mathematical model in the given class of models described by Maggi's equations was selected. The tracking control task was realized through the synthesis of robust and neural control algorithms. In the class of robust control, the theory of variable structure systems was utilized, while in neural control, the theorem of nonlinearity approximation universality by a neural network was used. The determined laws of tracking motion control ensure the stability of the designed control systems, confirmed based on Lyapunov's stability theory. The analyzed robot has 3 degrees of freedom and 4 drive systems, making it a overactuated system, to determine the missing control signal, a modified equation of power equality of the drive systems was used. Results of simulation studies of the discussed tracking control algorithms on typical $MRKM$ motion paths of a selected point, i.e., a straight path and an arc-shaped path, are included. Simulations were conducted without disturbances and with occurring parametric disturbance related to the change in the robot's motion resistance. Simulations with occurring disturbance were verified on a real object, which is the four-wheeled mobile robot Husarion Panther equipped with mecanum wheels. Verification experiments were carried out in real-time on the dSpace 1103 card. The applicative possibilities of the applied methods of analysis and synthesis of $MRKM$ in industrial solutions were demonstrated.

Keywords: mobile robot, mecanum wheel, tracking control, robust control, neural control