An Adaptive Trajectory Tracking Controller of a Multi-joint Snake Robot Considering Non-holonomic Constraints

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Abstract

Multi-joint snake robot is a vital reconnaissance, surveillance and attack weapon in national defence and military in the future. To study the trajectory tracking problem of a multi-joint snake robot with high redundancy and multi-degree of freedom in the plane, an adaptive trajectory tracking controller of a multi-joint snake robot considering non-holonomic constraints is proposed in this paper. The adaptive trajectory tracking controller replaces unknown parameters in the environment with estimated values, which effectively solves the negative effects caused by uncertain and time-varying environmental parameters in the process of the robot movement and realizes the stability of the controller. Firstly, a new dynamical model of a multi-joint snake robot is established through coordinate transformation. Secondly, the control objective of the controller of the multi-joint snake robot is established. Thirdly, the proposed controller of the multi-joint snake robot is designed by the Backstepping method to realize the control of the joint angle tracking error, link angle tracking error, actuator torque error and motion speed error of the robot. Then, a suitable Lyapunov function is found to verify the stability of the controller. Finally, through the MATLAB simulation and prototype experiment, the motion process of the multi-joint snake robot is observed, the trajectory tracking performance of the robot is analyzed, and the effectiveness of the adaptive trajectory tracking controller is verified.

Full-text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

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Dynamical model of a multi-joint snake robot

Figure 2

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Figure 8

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Figure 13

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