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INTEGRATING KINEMATIC ANALYSIS AND AI-DRIVEN OPTIMIZATION FOR SUSTAINABLE ROBOTIC ARM OPERATIONS IN PLANETARY MISSIONS

Abstract

This paper demonstrates how the simulation environment accurately replicates each joint movement, thereby enabling the testing of mission-critical parameters through AI-driven feedback loops. By integrating rigorous kinematic analysis with advanced AI methodologies, the research illustrates how both kinematic precision and operational sustainability can be achieved in future planetary missions. The study begins with the design of parameters aligned with the robot's operational requirements, followed by the derivation of forward and inverse kinematics using the Denavit–Hartenberg (DH) convention. A MATLAB-based three-dimensional simulation environment is then implemented to showcase trajectory-planning algorithms. By the generation of a continuous and precise sine curve that tests the robotic arm's ability to follow a smooth, complex trajectory, validating the accuracy of both forward and inverse kinematic solutions, as well as any AI-based refinements, under realistic motion conditions.

Keywords: Kinematics, AI-Driven Feedback Loops, Planetary Missions, Denavit–Hartenberg (DH) Convention, Trajectory Planning