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Research Article

Output Feedback Nonlinear H∞-Tracking Control of a Nonminimum-Phase 2-DOF Underactuated Mechanical System

Luis T. Aguilar

Centro de Investigación y Desarrollo de Tecnología Digital, Instituto Politécnico Nacional, Avenida del Parque 1310 Mesa de Otay, 22510 Tijuana, BC, Mexico

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Abstract

Nonlinear H∞ synthesis is developed to solve the tracking control problem restricted to a two degrees-of freedom (DOF) underactuated mechanical manipulator where position measurements are the only available information for feedback. A local H∞ controller is derived by means of a certain perturbation of the differential Riccati equations, appearing in solving the H∞ control problem for the linearized system. Stabilizability and detectability properties of the control system are thus ensured by the existence of the proper solutions of the unperturbed differential Riccati equations, and hence the proposed synthesis procedure obviates an extra verification work of these properties. Due to the nature of the approach, the resulting controller additionally yields the desired robustness properties against unknown but bounded external disturbances. The desired trajectory is centered at the upright position where the manipulator becomes a nonminimum-phase system. Simulation results made for a double pendulum show the effectiveness of the proposed controller.