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Stability Analysis of Nonlinear Telerobotic Systems with Time-varying Communication Channel Delays Using General Integral Inequalities

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Abstract

Existing controller synthesis schemes for teleoperation of nonlinear master-slave systems with time-varying communication channel are subject to conservative stability criteria. This paper presents a new stability criteria for bilateral teleoperation systems with proportional-derivative, position-position and position-force control architectures, considering both passive/non-passive human operator. The communication channel pertains unknown asymmetric time-varying delays with given lower and upper-bounds. **Using the Lyapunov Krasovskii approach, the stability analysis of the dynamic system is examined and the stability conditions are derived in the form of Linear Matrix Inequalities (LMIs).** Advanced techniques have been employed to find less conservative integral inequalities in the process of stability analysis of the closed-loop teleoperator. Illustrative numerical examples and simulation results emphasize the effectiveness of the proposed stability criteria in enlarging the stability bounds and providing efficient control performances.

Keywords: Bilateral teleoperation, Linear Matrix Inequality, Passive teleoperator, Position-Position and Position-Force control architectures

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