International Journal of Innovative Computing, Information and Control
Volume **7**, Number **7(B)**, July **2011**

pp. 4129–4137

ROBUST CONTROL OF ROBOT MANIPULATORS USING DYNAMIC COMPENSATORS UNDER PARAMETRIC UNCERTAINTY

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Received February 2010; revised July 2010

Abstract. *In this paper, a new robust feedback controller for trajectory control of n-link robot manipulators under parametric uncertainties is suggested. The proposed controller using dynamic compensation scheme leads to improvement in the transient response and fast convergence of tracking error to a neighborhood of zero in the steady-state. The uniformly ultimate boundedness of the closed-loop system is proved by using the Lyapunov method. The performance improvement by the proposed method is demonstrated with experiments on a 5 link industrial robot with two degrees of freedom.*
Keywords: Robust control, Robot manipulator, Dynamic compensator

1. Introduction.

Robust control for robot manipulators is a typical control scheme to achieve good tracking performance in the presence of model uncertainties such as an unknown payload and unmodeled friction [1,2]. Model uncertainties to be frequently encountered in manipulators working under an unstructured environment or handling variable payloads must be taken into account to solve the tracking problem of robot manipulators. The bounds of uncertainties are required in the design of the robust control system, and however, cannot be exactly estimated. The estimated uncertainty bounds are often very conservative, leading to degradation of control performance due to unnecessarily high feedback gain selection.

In recent papers [1-4], several robust control strategies for robot manipulators have been introduced. Spong [5] suggested a robust control strategy for robot manipulators with uncertainty bounds to depend only on the inertia parameters of the robot. The proof of the uniformly ultimate boundedness of the tracking error is derived from the Leitmann approach [6]. A robust control law using auxiliary polynomials in position and velocity tracking errors was proposed [7]. This controller with a PD (Proportional-Derivative) feedback term and a nonlinear auxiliary polynomial part ensures that the tracking errors are bounded under bounded parametric uncertainties. An approximate Jacobian feedback control law for set point control of a robot with uncertainties in the entire kinematics and Jacobian matrix from joint space to task space and in the dynamics was proposed [8]. A task space robust control scheme with suitable tracking performance under the imperfect transformation was suggested [9]. This approach cancels the effect of imperfect transformation. Liu [10] proposed a separate robust compensator based on dynamics decomposition that distinguishes between uncertainties and gives the precise estimation of uncertainty bound. The fine tuning capability of this method can achieve performance improvement. Even though model uncertainty bounds are exactly estimated, robust control still requires high feedback gains to maintain small tracking errors. However, control gains can be limited because of hardware structure such as digital implementation or