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ROBUST CONTROL OF ELECTRICAL MANIPULATORS BY JOINT ACCELERATION

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Abstract. *So far, feedbacks of joint accelerations have not been used in the control of robot manipulators since acceleration sensors are noisy and introduce additional cost. However, recent experimental results confirm that an optical encoder can measure position, velocity and acceleration with acceptable accuracy. This paper was motivated to develop a novel robust control approach for electrical manipulators by using joint acceleration feedbacks. The proposed control law is a high-gain linear differential equation with the same order as manipulator dynamics. As a result, a highly nonlinear and disturbed system such as a robot manipulator is controlled by reducing the effect of uncertainties. In comparing with the robust switching control laws, solving some challenging problems such as chattering of control efforts, saturation of actuators and determining the uncertainty bound parameter will become easier. Utilizing the computed acceleration is also proposed in replace of the measured acceleration if the measured acceleration is not available. Performance of the control system is justified by stability analysis and illustrated by simulations.*
Keywords: Joint acceleration, Electrical manipulator, Robust control, Stability analysis, Uncertainty bound parameter

1. **Introduction.** We can see the art of control in literature to overcome uncertainties, nonlinearities and couplings from different aspects in the robust control of robot manipulators. The robust control deserves a high theoretical presentation because of using the Lyapunov methods. However, it may face some practical problems such as saturation of actuators, chattering of control signals, unavailable feedbacks and computing limitation. Chattering is a side effect of using switching control laws, which may degrade performance of a control system by exciting the un-modeled dynamics [1]. Moreover, to design a robust controller, the uncertainty bound parameter should be known in advance [2] or estimated by an updating law [3]. In addition, control laws were frequently presented as torque control commands [4] whereas we cannot apply them directly to the inputs of electrical manipulators driven by electrical motors. Moreover, the torque control laws are involved with complexity of the manipulator dynamics.

Based on the used feedbacks either from the joints or the end-effector, robot control can be classified into the joint-space control and the task-space control. Many joint-space control approaches have been developed for industrial robots [5]. Although these approaches show satisfactory performances, they cannot work well on an inferior robot under uncertainties. In this case, the task-space control is superior to the joint-space control either as a torque control law [6] or as a voltage control law [7]. It was confirmed that the voltage control strategy is preferred for being free of manipulator dynamics [8].