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ROBUST VOLTAGE CONTROL OF ELECTRICAL MANIPULATORS IN TASK-SPACE

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Abstract. *This paper presents novel robust voltage-based tracking control approaches for electrically driven robot manipulators in the Task-Space (TS). The proposed control laws are simple, fast response and robust with ignorable tracking errors. They are superior to torque-based control approaches due to be free of manipulator dynamics. In addition, the TS control is preferred to Joint-Space (JS) control under imperfect transformation from TS to JS. Moreover, the feedback linearization technique is applied on the electrical model of motors instead of the mechanical model of manipulator to cancel the nonlinear dynamics of manipulator. These advantages are due to a particular attention to the role of motor control in manipulator control, which is a novelty of this paper as compared with existing works. The performance of the control system is then improved by using a disturbance observer to overcome uncertainties. A robust PI controller is then proposed and a fuzzy controller is designed based on the proposed PI controller. The stability of control system is analyzed and the performances of control laws are compared by simulations.*
Keywords: Electrical robot, Voltage control, Robust control, Task space control

1. **Introduction.** Industrial robots are commonly controlled in JS to perform position control. They follow the desired trajectory in the JS, which has already recorded in the learning process called "teach and play back" technique. Actually, the transformation from TS to JS is realized perfectly by this technique for planning the desired trajectory in JS. This performs well because an industrial robot is constructed with a high quality, good repeatability, precision and resolution. Feedbacks from JS are then given to controllers for tracking control. Thus, the robust JS control can operate well on industrial robots.

The robust JS control of robot manipulators was extensively presented in literature [1-6]. However, a robot with uncertain kinematics and dynamics cannot be controlled well by a JS control approach in the case of variations in model. In JS control, the tracking errors of the end-effector cannot be detected and compensated due to lack of feedbacks from the end-effector. In addition, the desired trajectories in JS are not provided precisely under imperfect transformation from TS to JS. Therefore, TS control is preferred to JS control under imperfect transformation of control space. To deal with this problem, the TS control was developed. An adaptive Jacobian controller was proposed for trajectory tracking control of robot manipulators in TS under parametric uncertainties [7].

In order to overcome both structured and unstructured uncertainties, a robust torque-based TS control approach was developed to control robot manipulators [8]. Many of developed control approaches are torque-based. Although, the robust torque-based control laws deserve a high grade from theoretical point of view, they might have some drawbacks from practical point of view. A torque control law cannot be given directly