

io-port 01294877**Matyukhin, V.I.****Universal continuous laws for controlling the manipulation robot.**

Autom. Remote Control 58, No.4, Pt. 1, 542-553 (1997); translation from Avtom. Telemekh. 1997, No.4, 31-44 (1997).

This paper defines continuous manipulator's joint trajectory tracking algorithms that use bounded controls. A standard Lagrangian model of the manipulator's dynamics has the form

$$(*) \quad A(q)\ddot{q} + B(q, \dot{q}) = u,$$

where $q, \dot{q}, \ddot{q}, u \in \mathbb{R}^n$, and $B(q, \dot{q})$ may contain a friction term depending smoothly on joint positions and/or velocities. The controls are assumed to be bounded, $|u_i| \leq K_i$, $i = 1, 2, \dots, n$. Given a desirable joint trajectory $q^*(t)$, a control u is designed enabling a trajectory $q(t)$ of system $(*)$ to track $q^*(t)$ asymptotically. Tracking algorithms introduced in this paper have the form

$$(**) \quad u_i(t) = u_i^*(t) - \alpha_i L_i(s_i),$$

where α_i – a constant, $i = 1, 2, \dots, n$, and include a component $u_i^*(t)$ corresponding to the desirable trajectory, and a saturation function $L_i(s_i)$ that depends on the composed tracking error $s_i = \dot{\xi}_i - \lambda_i \xi_i$, $\xi_i = q_i - q_i^*$, and is defined as

$$L_i(s_i) = \begin{cases} \gamma_i s_i & \text{for } \|\gamma_i s_i\| \leq 1, \\ \text{sgn}(s_i) & \text{for } \|\gamma_i s_i\| \geq 1. \end{cases}$$

The main result of the paper shows that the control algorithm $(**)$ makes the tracking error system exponentially stable, semiglobally with respect to the design parameters λ_i, γ_i . A proof of stability presented in the paper is based on a vector Lyapunov function. The most interesting result establishing in this paper says that $L_i(s_i)$ can be replaced by a suitably growing continuous or smooth bounded function $C_i(s_i)$.

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Keywords: manipulator's joint trajectory tracking algorithms; bounded controls; friction; saturation; vector Lyapunov function