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A new efficient adaptive control of torsional vibrations induced by switched nonlinear disturbances. (English) Zbl 1430.93123

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Summary: Torsional vibrations induced in drilling systems are detrimental to the condition of the machine and to the effectiveness of the engineering process. The cause of vibrations is a nonlinear and unknown friction between a drill string and the environment, containing jumps in its characteristics. Nonlinear behaviour of the friction coefficient results in self-excited vibration and causes undesirable stick-slip oscillations. The aim of this paper is to present a novel adaptive technique of controlling vibrating systems. The scheme is based on the linear quadratic regulator and uses direct measurements of the friction torque to synthesize its linear dynamic approximation. This approach allows generating a control law that takes into account the impact of the friction on the system dynamics and optimally steers the system to the desired trajectory. The controller's performance is examined via numerical simulations of the stabilization of the drilling system. The proposed solution outperforms the comparative LQG regulator in terms of the minimization of the assumed cost functional and the overall stability of the control system under the nonlinear disturbance.

MSC:

93C40 Adaptive control/observation systems
93C73 Perturbations in control/observation systems
74H50 Random vibrations in dynamical problems in solid mechanics

Keywords:

vibration control; adaptive control; linear-quadratic-regulator; drilling control

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