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New Approaches for On-line Tuning of the Linear Sliding Surface Slope in Sliding Mode Controllers

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Abstract: The main objective of this study is to propose new approaches for on-line tuning of the linear sliding surface slope in sliding mode controllers. The new approaches are developed for a class of second order systems on new coordinate axes, one of which is the classical sliding surface and the other one is naturally chosen to be orthogonal to it. The control input of the sliding mode control law is then modified accordingly by applying the Lyapunov stability condition. The adjustment of the linear sliding surface slope defined in the new coordinate axes is achieved by tuning a new parameter using different methods. First, an adaptive sliding surface with a rotation scheme is constructed by interpreting the classical delta neighbourhood approach. Next, the rotation process is achieved by using a fuzzy tuning mechanism that uses the new coordinates as its input variables and generates an incremental change in the new parameter value as an output. Numerical simulations are performed on a second order nonlinear system model with parameter uncertainties and bounded external disturbance. The two newly proposed on-line tuning approaches are then compared with the rotation mechanism that uses an empirical function defined on the same new coordinate axes. Moreover, the new approaches are compared with classical sliding mode controllers having a constant sliding surface and the delta neighbourhood approach developed in the classical coordinate axes. Results have shown improved performances of the proposed approaches in terms of a decrease in the reaching and settling times and robustness to disturbances as compared with the classical sliding mode controller.

Key Words: Sliding mode control, sliding surface design, time-varying sliding surface

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