New methodology of online sliding surface slope tuning PID like fuzzy sliding mode controller for robust control of robot manipulators

ABSTRACT

Designing a robust controller for uncertain multi input-multi output (MIMO) nonlinear dynamical system (e.g., robot manipulator) can be a challenging work in this research. Robot manipulators are set of links which connected by joints, they are multiple-input and multiple-output (MIMO), nonlinear, time variant, uncertain dynamic systems and are developed either to replace human work in many fields such as in industrial or in the manufacturing. According to the dynamic formulation of robot manipulators, they are uncertain and have strong coupling effects between joints. To solve this challenge, sliding mode controller is selected since it is robust, stable and it works very well in certain and fairly uncertain condition. Although this controller works incredibly efficient, but still, it has two important challenges, namely the high frequency chattering and working in uncertain situation. To reduce the chattering with respect to stability and robustness; linear controller is added to discontinuous (switching) part of sliding mode controller. In this methodology linear controller is used in parallel with discontinuous part to reduce the role of sliding surface slope and switching (sign) function. To modify chattering free sliding mode controller in uncertain situation PID like fuzzy logic theory is recommended in estimating the robot manipulator's nonlinear dynamic formulation and on-line tuning sliding surface slope. As a result, this controller improves the stability and robustness, reduces the chattering as well and reduces the level of energy due to the torque performance as well.

Keyword: PID like fuzzy controller; Robust sliding mode controller; Online tuning; Chattering phenomenon; Robot manipulator