

# **Adaptive MIMO Fuzzy Compensate Fuzzy Sliding Mode Algorithm: Applied to Second Order Nonlinear System.**

## **Abstract**

This research is focused on proposed adaptive fuzzy sliding mode algorithms with the adaptation laws derived in the Lyapunov sense. The stability of the closed-loop system is proved mathematically based on the Lyapunov method. Adaptive MIMO fuzzy compensate fuzzy sliding mode method design a MIMO fuzzy system to compensate for the model uncertainties of the system, and chattering also solved by linear saturation method. Since there is no tuning method to adjust the premise part of fuzzy rules so we presented a scheme to online tune consequence part of fuzzy rules. Classical sliding mode control is robust to control model uncertainties and external disturbances. A sliding mode method with a switching control law guarantees the stability of the certain and/or uncertain system, but the addition of the switching control law introduces chattering into the system. One way to reduce or eliminate chattering is to insert a boundary layer method inside of a boundary layer around the sliding surface. Classical sliding mode control method has difficulty in handling unstructured model uncertainties. One can overcome this problem by combining a sliding mode controller and artificial intelligence (e.g. fuzzy logic). To approximate a timevarying nonlinear dynamic system, a fuzzy system requires a large amount of fuzzy rule base. This large number of fuzzy rules will cause a high computation load. The addition of an adaptive law to a fuzzy sliding mode controller to online tune the parameters of the fuzzy rules in use will ensure a moderate computational load. The adaptive laws in this algorithm are designed based on the Lyapunov stability theorem. Asymptotic stability of the closed loop system is also proved in the sense of Lyapunov.

**Keyword:** Adaptive Fuzzy Sliding Mode Algorithm; Lyapunov Based; Adaptive MIMO Fuzzy Compensate Fuzzy Sliding Mode; Chattering Phenomenon; Fuzzy Logic Controller, Adaptive Law