Parameter Selection in the Sliding Mode Control Design
Using Genetic Algorithms
Ching-Chang Wong and Shih-Yu Chang
Dept. of Electrical Engineering, Tamkang University ·
Tamsui, Taipei, Taiwan 25137, R.O.C ·
E-mail: wong@ee.tku.edu.tw

Abstract
In this paper, we propose a parameter selection method by using the genetic algorithms in the sliding mode control of the variable structure system. The proposed method can efficiently choose the appropriate gain parameters based on a proposed fitness function to increase the speed of system response in the reaching phase and reduce the chattering in the sliding phase so that a high performance can be achieved. Some simulation results prove the validity of the proposed Method.

Keywords: Sliding mode control, hitting time, chattering, genetic algorithms.

1 Introduction
The sliding mode control theory of the variable structure system provides a method to design a system in such a way that the controlled system should be insensitive to parameter variations and external disturbances [6, 13]. Essentially, the sliding mode control uses discontinuous control action to drive the state trajectory toward a specific hyperplane in the state space, and then the state trajectory is maintained to slide on the specific hyperplane until the origin of the state space is reached. In the sliding mode control, the hitting time of the system state reaches the switching plane will affect the speed of the system with the desired dynamic behavior. One advantage of the sliding mode control is that when the system enters the sliding mode, it is insensitive to plant parameters uncertainty or external disturbance. If the hitting time is reduced, the time of the system with the desired dynamic behavior can be reduced and the uncertainty of the system can be attenuated. Furthermore, the chattering in the switching plane will affect the stability of the controlled system. Therefore, the hitting time reduction and the chattering attenuation are two important requirements in the slide mode control design. Hence, most effort is focus on the problem of minimizing the hitting time and the chattering phenomena [11, 14]. To minimize the hitting time, Young et al. [15] used a high-gain feedback to speed up the transient response toward the switching hyperplane, but this method causes high chattering along the switching hyperplane which is undesirable in the physical system. To alleviate the chattering phenomena, Slotine [12] and Yeung and Chen [16] used the boundary layer or sliding sector approach to cope with it. However, a time-varying boundary layer width may result in sophisticated systems and cause a difficult implementation. Bartolini [1] and Bengiamin and Kauffmann [2] suggested to insert an integrator to the system such that the chattering can be smoothed, but this slows down the system response. On the other hand, Hwang and Lin [5], Lin and Kung [9], and Lin and Chen [10] applied the fuzzy set theory to handle the chattering problem. The control scheme of the fuzzy sliding mode control can smooth the chattering, but this also slows down the system response. The hitting time reduction and the chattering attenuation are two essential requirements in the slide mode control. The problem of the mentioned methods is that most of them are difficult to simultaneously take into account both the hitting time and the chattering. To remedy this problem, we propose a selection method to choose the appropriate gain parameters so that the controlled system can simultaneously have small hitting time and small chattering in the sliding mode control design by