THESIS INFORMATION

Title	:	Adaptive Sliding Mode Control of Non-linear Dynamical Systems
Major	:	Automatic Control
Code	:	6252600
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Abstract:

Variable Structure Control with sliding mode or Sliding Mode Control is well-known as a simple but effective robust non-linear control method. This method has many advanced features such as good performance and robustness against parameter variations. However, because of the switching of the control signal, there is a high frequency oscillation of the phase portrait around the sliding surface. Furthermore, designing SMC requires an upper bound of the model uncertainty. The model uncertainty often consists of the non-model dynamic and the variation of the plant parameters. If the actual modelling error exceeds the uncertainty upper bound used to design the controller, the system stability will not be guaranteed. In addition, like traditional control methods, designing SMC requires a mathematical model of the plant. The control performance may be deteriorated in case of imprecise or time varying model parameters.

This work aims to study a neural network based adaptive sliding mode controller for uncertain non-linear dynamical system. It consists of three main points:

- The combination of neural networks and the sliding mode control theory to design an adaptive sliding mode controller for uncertain non-linear dynamical systems. This new controller can be characterized by: (i) it is a direct neural network controller; (ii) the controller is identified on line without need of initial model, (iii) it has the ability to adjust itself to cope with the variations of the upper bounds of the uncertainty and it is noise insensitive.

- The development of the adaptive sliding mode controller mentioned above to the Decoupled Adaptive Sliding Mode Controller DANSMC for multivariable non-linear systems.

- The proposed controller has been successfully tested with an inverted rotary pendulum and an inverted two-dimensional pendulum through simulations and experiments.

Main results

- The proposed sliding mode controller consists of two components: the equivalent controller and the robust controller; it has a smooth form, it can overcome the chattering phenomenon and it is appropriate for training the neural network.

- The update-law for one hidden layer feed forward neural network has been carried out based on Lyapunov stability theory, which involves two feedback signals: sliding surface signal and its derivative. The neural network can be trained online without need of plant model nor its uncertainty upper bound.

- It is shown that the proposed neural network controller can completely replace the traditional sliding mode controller. By using the system states as inputs instead of sliding surface signals, DANSMC exploits the ability of neural network. Simulation results also show that the system can self-develop to improve the control performance.

- Theories and simulations show that the DNSMC controller can adjust itself to adapt to the variations of the plant as well as its uncertainty.

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