New Methodology for Chattering Suppression of Sliding Mode Control for Three-phase Induction Motor Drives

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Abstract: - Chattering is undesirable phenomenon when dealing with sliding mode control. This paper proposed a new method for addressing chattering with a simple and easy implementation in Digital Signal Processor (DSP). This is realized by replacing the discontinuous function in conventional sliding mode control with state-dependent auto-tuning of boundary layer in fast sigmoid function and state-dependent switching gain, for three-phase induction motor speed control. This method allows chattering reduction in control input, while keeping the robustness characteristics of sliding mode control. The performance of the proposed control is verified in emulation induction motor drives using Digital Signal Processor TMS320F2812 board, with different speed command and load disturbances.

Key-Words: - Sliding mode control, chattering, induction motor, digital signal processor

1 Introduction

The most significant property of sliding mode control (SMC) is its robustness [1-2]. However, ever since the sliding mode control have been introduces, the chattering phenomenon that include in sliding mode control has irritated and sometimes led to rejection of the technique. Fig.1 illustrates the chattering phenomenon that occurs in sliding mode systems. The solution of the chattering problem is of great importance when exploiting the benefit of sliding mode controller. This is because without proper solution in the control design, chattering can be a major obstacle in implementation of sliding mode control. To surmount with chattering phenomenon, one must know the source of chattering in sliding mode control scheme. In [3], summarized that chattering phenomenon is due to three main causes namely; unmodelled dynamics, switching gain value, and discontinuous function in sliding mode control. Unmodelled dynamics may refer to sensors, actuator data processor neglected in the principles modelling process since they are generally significantly faster than the main system dynamics.

For analyzing the influence of mismatch in modelling due to neglecting the small time constant of actuators and sensors, the describing function method can be used to estimate the amplitude and frequency of the chattering [4]. Intuitively, the amplitude of chattering will be related to the value of constant switching gain. The switching gain is employed in sliding mode as upper bound of uncertainties. These uncertainties value is difficult to obtain [5-6]. In order to reduce this high frequency oscillation, the discontinuous function is replaced with a smooth function. One of the techniques is replace the discontinuous function with smooth sigmoid function. In [7-8] hyperbolic tangent function and saturation function is used to alleviate the discontinuous function and applied to position servo systems. In [9-10] modified hyperbolic tangent function is designed with self-tuning law algorithm. However, most of these algorithm is involves complex algorithm and need special treat when applying in digital signal processor by using look-up-table or logarithm function.

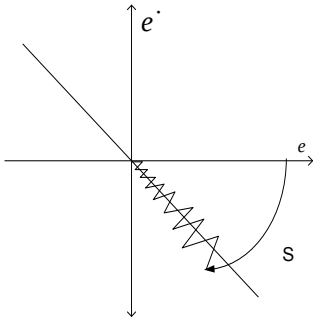

Fig.1: Chattering phenomenon encountered using the discontinuous control law

Another technique to smooth the discontinuous function that widely used, is utilized boundary layer [11-12] with linear saturation function Fig. 2 shows the smoothing out control discontinuity in a thin