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SMC Strategy for Torque Ripple Mitigation in Permanent Magnet Synchronous Motor

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ABSTRACT

This paper presents a new extended control of the sliding mode of the permanent magnet synchronous motor with various uncertainties. This extended scroll mode control can dynamically adapt to changes in the controlled system and maintain high tracing performance of the extended scroll mode controller. The extended control of the sliding mode is proposed to compensate for strong disturbances and obtain high servo precision. Sliding mode control is proposed for estimating rotor speed and stator resistance, assuming that only stator currents and voltages are available for measurement. The results validate the effectiveness of the proposed method through simulation.

KEYWORDS: Disturbance observer, permanent-magnet synchronous motor (PMSM), Sliding-mode control (SMC), sliding-mode reaching law (SMRL).

I. INTRODUCTION

In the permanent magnet electric motor (PMSM) system, the classical proportional integral management (PI) technique remains popular thanks to its direct implementation [1]. However, during a sensitive PMSM system, there are huge quantities of disturbances and uncertainties, which can return internally or externally, for example unmodeled dynamics, parameter variation, frictional force and load disturbances. It will be terribly problematic to quickly limit these disturbances if linear administration modules are adopted as an IP administration rule. Therefore, different forms of non-linear management are adopted to increase management performance in systems with totally different perturbations and uncertainties, for example adaptive sliding management (SMC) adaptive management intelligent management forecast management intelligent management and therefore on. In these forms of non-linear management, the SMC technique is recognized for its invariable properties of limiting variations in internal parameters and external disturbances, which can guarantee excellent tracking performance despite the model's parameters or uncertainties. It has been successfully applied in several fields. In the sliding mode approach it was applied to a six-phase induction machine. During a hybrid terminal scroll mode, it was observed that the observer supported the non-singular terminal scroll mode and, therefore, the higher order scroll mode for the rotor position and the speed estimate in a PMSM system. As part of the performance of a slider mode controller, it has been studied using a hybrid controller applied to induction motors through closed sampled representations. The results have been terribly conclusive regarding the effectiveness of the sliding approach. A controller in slider mode applied to the induction machine is also found in

[15]. However, SMC's lust will only be ensured by the choice of large management gains, while huge gains can lead to the well-known development of chatter, which can excite the dynamics of high frequencies. Therefore, there are some approaches to overcome chatter, such as continuation management, high order scrolling technique, complementary scrolling technique [18] and law enforcement technique. The scope law approach deals directly with the scope method, since the chatter is caused by the non-ideal scope at the top of the scope part. In [3], the authors have granted some scope laws, which can limit chatter by decreasing gain or creating discontinuous gain on a sliding surface. In [12], a single exponential scope law was granted to design the integrated speed and current controller. To eliminate the inconvenience of chatter, the system variable was used in this area law. However, within the same interval laws, the discontinuous gain decreases rapidly attributable to the variation of the sliding surface functions, which reduces the lust of the controller near the sliding surface and further increases the interval time. To solve the same problems, a single-scope law is projected during this work, which is based on the selection of the associated exponential term that adapts to changes in the surface of the sliding mode and system states. This scope law is ready to eliminate the gossip / scope dilemma. In support of this scope law, a PMSM sliding mode speed controller is developed. Then, in order to improve the noise rejection performance of the SMC technique, a noise observer in extended sliding mode (ESMDO) is projected and, therefore, the computable noise of the system is taken into account because the advance compensation of half to compensate the speed regulator in sliding mode. Therefore, a composite management technique is developed that combines the associated SMC half and an advance clearing ESMDO half, known as the SMC + ESMDO technique. Finally, the effectiveness of the planned management approach was verified by simulation and experimental results.

II. Permanent Magnet Synchronous Motor Drive

The motor drive consists of four main components, the PM motor, inverter, control unit and the position sensor. The components are connected as shown in Fig. 1

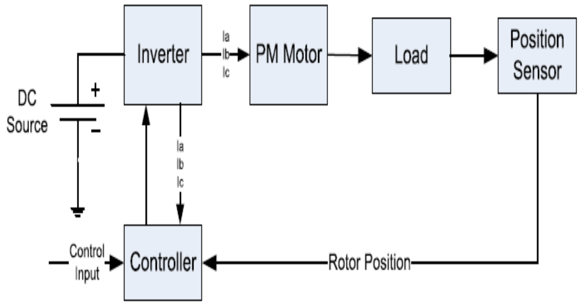

Fig. 1 Drive System Schematic

Descriptions of the different components are as follows

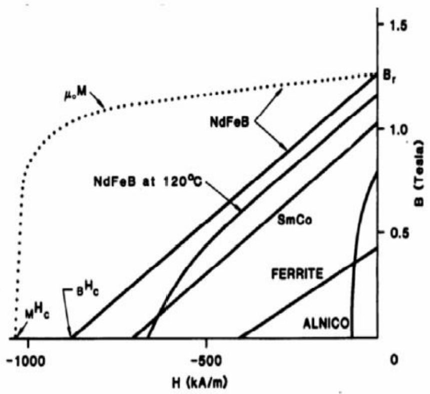

Fig. 2 Flux Density versus Magnetizing Field of

III. Permanent Magnetic Materials

The most punctual manufactured magnetic materials were solidified steel. The magnets made of steel have been effectively polarized. However, they may have had little vitality and it was far from difficult to demagnetize. In recent times other magnetic materials, for example aluminum compounds, nickel and cobalt (ALNICO), strontium or barium ferrite (ferrite), samarium cobalt (rare earth magnet of the first era) (SmCo) and iron-boron neodymium (rare earth magnet of the second era) (NdFeB) was created and used to create perpetual magnets.

Earth's uncommon magnets are classified into two classes: cobalt samarium magnets (SmCo) and iron boron neodymium magnets (NdFeB). SmCo magnets have higher transition thickness levels, but are excessively expensive. NdFeB magnets are the most common ground magnets most used in today's motors. A transition thickness is shown in Fig. 2 as opposed to the polarization field for these magnets.

IV. Simulation and Experimental Results

In this area, to demonstrate the feasibility of the proposed SMC + ESMDO approach, recreations and examinations of the PI strategy and the SMC + ESMDO technique were conducted in a PMSM framework. The reproductions are made in MATLAB / Simulink and the research phase is developed by the TMS320LF2812 processor.

1) Simulation results: the PI recreational parameters of the two current circles are equivalent: the corresponding sum Kpc = 10, the necessary gain Kic = 2.61. The recreational parameter PI of the speed circle is the corresponding sum Kps = 0.5 and the basic gain Kis = 20. The parameters of the speed circle SMC + ESMDO are: k = 20, δ = 10, ε = 0.1 and x1 = e. The consequences on the reproduction of the PI controller and the SMC + ESMDO controller are shown in Figs. 7 and 8. From the results of the recreation, it can be seen very well that the SMC + ESMDO technique has a shorter exceeding and a shorter settling time in contrast and the PI strategy when the reference speed is 1000 r / min Furthermore, when the tightening torque TL = 4 N • m is suddenly included in t = 0.1 if it is evacuated in t = 0.2 s, the SMC + ESMDO method provides less speed and hesitation than an attractive electrical torque. The disturbing influence of the ESMDO assessed battery and the direction of aggravation of the load are shown in Fig. 9. Note that the ESMDO can evaluate the influence of concern accurately and quickly with a low grumble.

2) Experimental results: to evaluate the execution of the proposed technique, the test frame for PMSM speed control was assembled. The PI parameters of the two current circles are equivalent: the relative gain Kpc = 8 and the essential gain Kic = 3.3. The PI parameter of the speed circle is that relative gain Kps = 1 and the basic gain Kis = 15. The parameters of the speed circle SMC + ESMDO are: k = 18, δ = 10, ε = 0.2 and x1 = e.

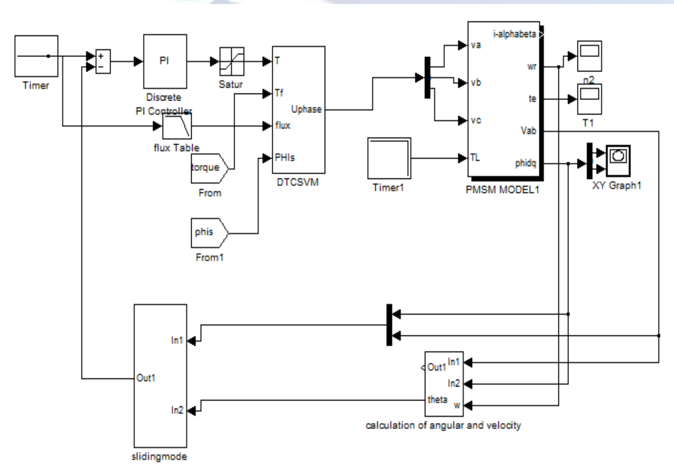

Fig 3: simulation diagram for PMSM drive

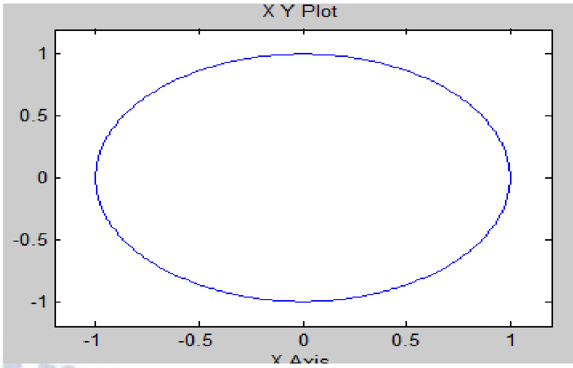

Fig 4: Simulation results for flux linkages

The above graph shows the relation between flux linkages between the direct and quadrature axis.

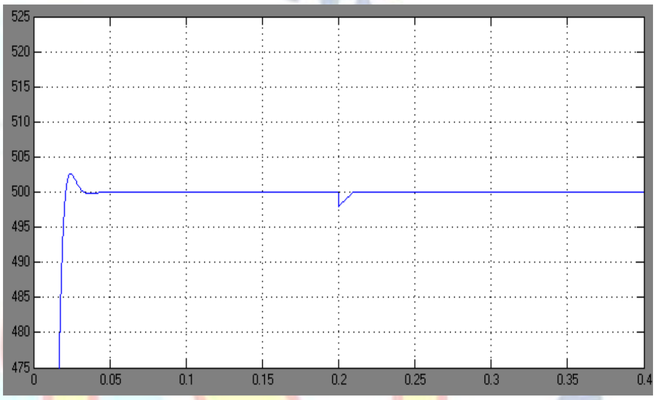

Fig 5: Simulation results for speed of PMSM

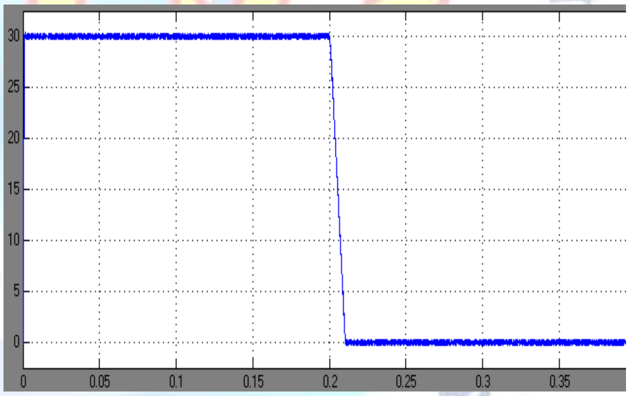

Fig 6: simulation results for torque of PMSM

V. CONCLUSION

In this document, a nonlinear SMC count is proposed and has probably been associated with a PMSM structure, to avoid muttering and cover up agitating impacts. The main responsibilities of this work include: 1) a new SMRL system is familiar with chatter control; 2) to assess the destructive impacts of the structure, an exacerbation observer in expanded cursor mode is shown; and 3) a composite control strategy is created that combines SMC and ESMDO to further improve the noise ejection limit of the SMC system. Deviation and test results supported the proposed system.

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