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# A Review on - MRAS based Sensorless Control of Interior Permanent Magnet Synchronous motor drives using Fuzzy Logic

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## ABSTRACT

Model reference adaptive system (MRAS) is typically employed for rotor position/ speed estimation in sensorless interior permanent magnet motor (IPMSM) drives. There are different ways to improve the performance of IPMSM drives. In previous research PI controller is used to control the speed of Permanent magnet synchronous motor. But in some cases when dynamics of the system varies with operating conditions and time the PI controller will not give better performance. To overcome this problem a new MRAS scheme based on fuzzy logic is proposed. In order to avoid the difficulties involved with manual tuning of the PI control parameters, fuzzy controller is implemented. Fuzzy control scheme consists of two models, namely current model of the IPMSM as the adjustable model, and the motor itself as the reference model. The difference between the outputs of the two models gives the estimated value of the rotor speed through a adaptive mechanism and position can be obtained by integrating the speed. In order to lower the motor speed ripple caused by the cyclic fluctuating load, a feed- forward compensation strategy with the load-matching motor output torque pattern is developed. The proposed system has to be implemented in MATLAB simulink.

**Keywords:** Fuzzy Logic, interior permanent magnet synchronous motor drives (IPMSM), sensorless control, Model reference adaptive system (MRAS).

## I. INTRODUCTION

The usage of interior permanent magnet synchronous motors (IPMSM) has become widespread in industrial applications and in particular to drive compressors in air-conditioning. The characteristics of IPMSM are high performance, high efficiency and weakening of flux. Mounting of position sensor inside compressors is inconvenient due to the strong acids/bases and which also includes cost and performance of the entire drive system. To overcome this problem the sensorless control with positioning of rotor and assessment of speed has to be implemented in the present work. The rough calculation of exact rotor speed and position by the MRAS is unfavourable for IPMSM drives with regularly repeated fluctuating loads so that feed-forward compensation strategy with motor output torque is developed. In MRAS manual adjustment of control parameters of the proportional integral regulator is important in order to achieve high accuracy. When motor operates with cyclic fluctuating loads, manual adjustment of PI Parameters for the user is a difficult task. According to different load conditions the PI parameters must be determined. Several intelligent control algorithms

combined with MRAS are analysed in order to avoid the manual tuning of the control parameters so that Fuzzy controller is implemented in the present work. Fuzzy control shows excellent performance with systems which are nonlinear, time-varying and with uncertain parameters and structure variations. Manual tuning of PI parameters is avoided by implementing MRAS(Model Reference Adaptive System) based Fuzzy Control. Speed adaptive law is derived according to Popov theory.

## II. LITERATURE SURVEY

D.Giaouris et al.[3] this paper describes that Model Reference Adaptive Systems (MRAS) are the most important methods due to their relative simplicity and less computational efforts and also Fuzzy logic control (FLC) has been found to be excellent in dealing with systems. Jianru Wan et al.[1] this paper explains about the problem of PI controller in which difficulty in achieving high accuracy arises due to the change of motor parameters so that fuzzy PI speed controller is proposed. Motor speed is identified based on model reference adaptive theory. Mounting of position sensor inside compressors is impractical, due to strong acids or bases or concentrated solutions of certain weak acids or weak bases. It also includes price and performing of the entire drive system so that the sensorless control with rotor speed and position estimation is a preferable approach. Antti Piippo et al.[6] This paper proposes an online method for the estimation of the stator resistance and the permanent-magnet (PM) flux in sensorless Permanent magnet synchronous motor drives. Sakorn Po-ngam et al. [8] This paper describes about Stability and good dynamic performances of adaptive full-order observers are most important for the sensorless permanent magnet synchronous motor drive. Matthias Preindl et al. [7] This paper describes about the model predictive direct current control (MPDCC) is a promising control approach for high- power converters.

## III. METHODS AND MATERIAL

The Block diagram of the IPMSM drives using fuzzy logic based on MRAS method is shown in **Fig1**.Mamdani-type rule based controller is used in the present work. The voltage and current of the real motor is given as input to the speed and position estimation block. Kc and Ke are the scaling factors. These two scaling factors are multiplied to the inputs. The two dimensional fuzzy rule has to be written with the inputs so that output of the fuzzy controller is obtained then, it is multiplied by Ku (output scaling factor).Integration of estimated speed gives the position of the rotor. Based on the rotor position the load torque values are obtained through a lookup table.

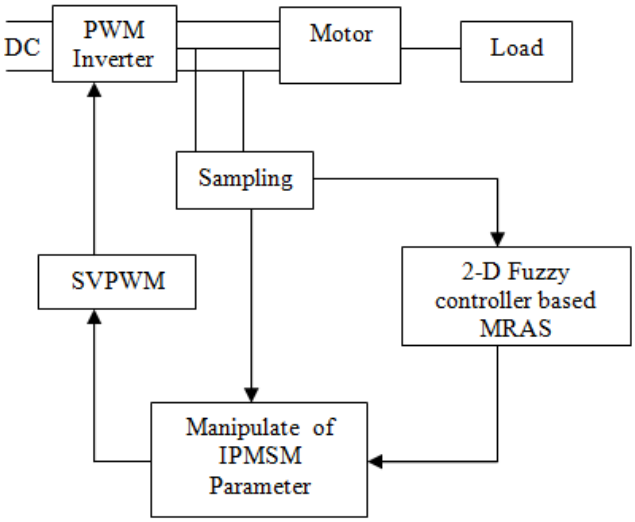


**Figure 1:** Block diagram of the IPMSM drives using fuzzy logic based on Model Reference Adaptive System.

## IV. RESULTS AND DISCUSSION

The proposed system is suitable for speed of the rotor and position assessment of IPMSM drives with regularly fluctuating loads. By implementing MRAS scheme in the present work maximum rough calculation of error values of the rotor position can be reduced. There by improving rotor position estimation accuracy and also avoid manual tuning of PI parameters required in conventional MRAS scheme.

## V. CONCLUSION

In present work based on MRAS scheme a two dimensional fuzzy logic will be implemented for the rotor speed estimation of IPMSM drives for regularly fluctuating loads. Problems faced by manual tuning of PI parameters has been handled by implementing MRAS based Fuzzy control.

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