High Precision Positioning and Very Low Velocity Control of a Permanent Magnet Synchronous Motor

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In applications where high accuracy position and low speed operation is required, it would be desirable to use direct driven synchronous motors. The reason is that they are mechanically less complex than stepper motors with belts and pulleys. This study is done in collaboration with Axis Communications AB and it evaluates two different methods of controlling the motor, [1].

Introduction

A magnetic field is created when current is supplied to the windings of a motor. The direction of this field can be controlled by sending current in specific order through the motor phases. The magnetic field interacts with the permanent magnet rotor in such a way that the rotor aligns itself with the direction of the field.

One of the methods that is investigated in this study is called field-oriented control. This method makes sure that there always is a difference in angle between the rotor direction and the induced magnetic field. The other method, called synchronous control only creates an angular difference when necessary.

Findings

Field-oriented control is a common way to control permanent magnet synchronous motors in high speed operation. When evaluating its performance in low speed or position control applications this study has concluded that it is fast to response to changes in desired position, but it has problems with generating a smooth rotation at low speed due to inherent problems with this type of motor. The problems at low speed makes it very difficult to achieve a steady position control.

It is possible, however, to compensate for the problems associated with the motor. The most promising of these compensation methods is called iterative learning control. It works by memorizing what control signal makes the motor move in a desirable way. This method is refined revolution for revolution.

Synchronous control on the other hand is slower in response to changes in desired position. In return it is stable and is able to overcome problems associated with the motor. However, the way in which the angular difference is set between the created magnetic field and the rotor makes this method less efficient in terms of power consumption.

The conclusion from this study is that synchronous control can readily be implemented for the desired operation. Field-oriented control is an immature technology although its promise of fast actuation and high efficiency makes it a recommended subject for future research.

Possible benefits

Gone are the days when computing power limits technology. In reality production costs are what prevent new technologies from reaching the public on a large scale. Direct-driven motors have the benefit of reduc-

ing material costs as gearings or belts and pulleys are made redundant. This study sheds light upon possibilities and limitations with direct driven motors in the application of low speed and high position control.

References

[1] Isaksson, H. and Önnheim, P. *High Precision Positioning and Very Low Velocity Control of a Permanent Magnet Synchronous Motor*, Master Thesis, LTH, Lund University, Sweden, 2015.