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Internal Model Control For Voltage Disturbance Rejection In Matrix Converter Based Permanent Magnet Synchronous Machine Drive System

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ABSTRACT

This paper represents a system based on internal model control (IMC) for Permanent Magnet Synchronous Machine (PMSM) drive system to reduce the bad impact on drive performance due to non linear output characteristics of matrix converter in case of disturbance of input voltage. Considering duty-cycle space vectors & small signal model, the relationship between the output and input disturbance is obtained in the synchronous reference frame. Also the output characteristics of matrix converter are studied and practical things are taken into consideration for the design of controller. Numerical simulations are carried out. The results show that good dynamic and steady state performance on Permanent Magnet Synchronous Machine speed regulation is obtained under unbalanced input voltage conditions.

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CHAPTER1. INTRODUCTION

The matrix converter is well known for power regeneration, high quality input/output waveform, and controllable input power factor. These features are very important for modern electrical drives. In this paper, a strategy based on internal model control (IMC) is proposed for a matrix converter-based permanent magnet synchronous machine (PMSM) drive system to overcome the unflavored impact introduced by digital filter and guarantee the drive performance under input disturbance conditions. In the presence of input voltage disturbance, under the applied modulation strategy, the actual fundamental output voltages do not agree with the reference voltages due to the nonlinear transfer characteristics of matrix converter. The undesired output voltage disturbances result in stator harmonics current, speed fluctuation, torque ripple, and machine parameter variation, as far as a matrix converter-based PMSM drive System is concerned.

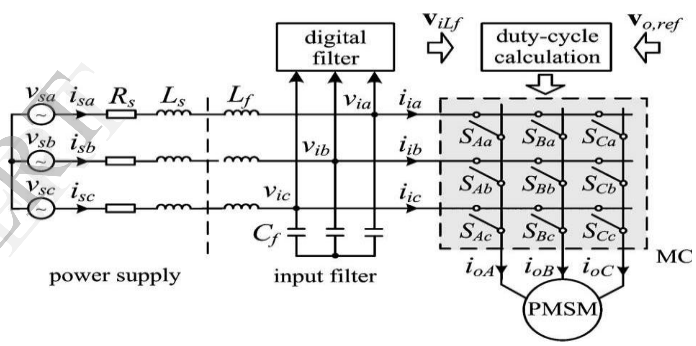
CHAPTER2. LITERATURE SURVEY

A permanent magnet synchronous motor (PMSM) is a motor that uses permanent magnets to produce the air gap magnetic field rather than using electromagnets. These motors have significant advantages, attracting the interest of researchers and industry for use in many applications. The

PM synchronous motor is a rotating electric machine with classic 3-phase stator like that of an induction motor; the rotor has surface-mounted permanent magnets. In this respect, the PM synchronous motor is an equivalent to an induction motor, where the air gap magnetic field is produced by a permanent magnet, so the rotor magnetic field is constant.PM synchronous motors offer a number of advantages in designing modern motion-control systems. The use of a permanent magnet to generate substantial air gap magnetic flux makes it possible to design highly efficient PM motors.

The matrix converter has several advantages over traditional rectifier-inverter type power frequency converters. It provides sinusoidal input and output waveforms, with minimal higher order harmonics and no sub harmonics; it has inherent bi-directional energy flow capability; the input power factor can be fully controlled. Last but not least, it has minimal energy storage requirements, which allows to get rid of bulky and lifetime-limited energy-storing capacitors Internal Model Control (IMC) refers to a systematic procedure for control system design based on Q-parameterization concept that is the basis for many modern control techniques.IMC has been a popular design procedure in process industries particularly for tuning single loop, PID type controllers. The IMC design procedure is quit extensive and diverse. It has been developed in many forms such as SISO, MIMO formulations.

CHAPTER3. MATRIX CONVERTER BASED PMSM DRIVE SYSTEM



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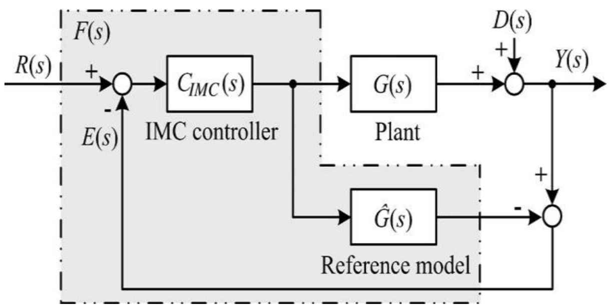
A matrix converter-based PMSM drive system is shown in above fig. It consists of a no ideal supply, a second-order L–C filter, a matrix converter, and a PMSM. For the following analysis, the variables for the input side of the matrix converter are transformed into a reference frame rotating at a supply angular frequency ωi. The output side quantities are transformed into a direct and quadrature reference frame rotating at the electrical angular speed of the PMSM rotor with the d-axis aligned with the rotor flux vector.

CHAPTER4.INTERNAL MODEL CONTROL



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- Extra considerations for controller design to suppress disturbances involve the following aspects.
- The output voltage distortion becomes worse with higher reference value. This characteristic has significant influence on the drive system performance, particularly on the occasions of acceleration, deceleration, and heavy load.
- The impact of input disturbance on output voltage varies with the machine operating condition. Normally, the *d*- and *q*-axis components of output disturbances are diversely affected by the input perturbation.

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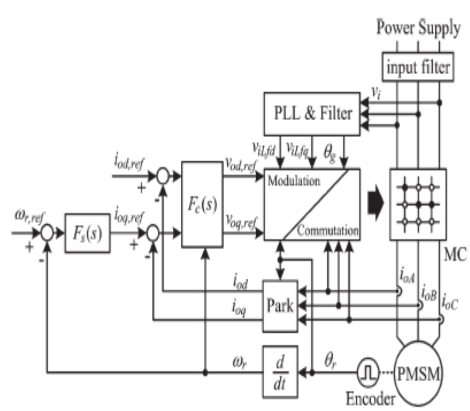
CHAPTER 5. CONTROL SCHEME OF MATRIX CONVERTER BASED PMSMDRIVE SYSTEM:-



The above fig. shows the overall control scheme of matrix converter based PMSM drive system. Under the cascade control, the speed loop generates the reference current *ioq,ref* through the controller *Fs*(*s*) presented in (43), while the reference current *iod,ref* is kept as zero. The differences between the reference currents and the feedback currents generate the voltage references of matrix converter through the controller *Fc*(*s*). The IMC consists of an input filter which is used to improve the quality of the input voltage to the machine. Our proposed scheme consists of a matrix converter which consists of several electronic switches arranged in a typical formation for switching on and off the supply to the machine. The switches are controlled by modulation circuitry which sends signals to the switches for turning on and off. PLL (Phase Locked Loop) is employed for synchronizing and tracking the signals with the disturbances imposed on the system. Now this is open loop control. In order that the performance be monitored the shaft is coupled to an encoder which is calibrated accordingly. The encoder provides the information regarding shaft position at every instant. Thus, by monitoring the shaft position, its speed of rotation and rate of change of speed, we can obtain information regarding the performance of the machine. These parameters are available through feedback systems. When this system is incorporated, it becomes closed loop system. Hence better control and performance are achieved.

CHAPTER6.CONCLUSION

Input voltage disturbances cause apparent harmonics in output voltage of matrix converter and deteriorate speed regulation performance of the matrix converter-based PMSM drive system. According to the analysis of transfer characteristic, the amplitude of output voltage oscillations is proportional to the output references. Therefore, the impact of input voltage disturbances on drive performance varies with machine operating conditions. The worse cases occur under the conditions of acceleration, deceleration, and heavy loading. A practical control scheme based on IMC has been proposed in this paper to improve the performance of matrix converter-based PMSM drive system in such circumstances. The effect of the IMC controller on voltage disturbance rejection has been evaluated by simulation and experiment. The results prove that the proposed strategy has good performance under the input voltage disturbance conditions.

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