PWM based control of room vectors for roundabout force estimation and the board

[1]K.Rajesh , [2]Dr.D.V.V.V.CH.Mouli ,[3]Mrs.G.Pavana Jyothi
[1,3]Assistant Professor, [2] Professor
[1,2,3] Department of Electrical and Electronics Engineering,
[1,2,3] Ashoka Women's Engineering College

Abstract : The study's mathematical model for a permanent magnet synchronous motor includes direct torque control and space vector PWM. Using mathematics, the author discusses the topic in this work. Mathematical models of PSMs in the MATLAB/Simulink environment are used to simulate direct torque control using SVPWM theory. Following a thorough explanation of the simulation model's procedures and processes, the simulation's end result is obtained. It has been shown that direct torque control based on SVPWM theory may greatly minimize torque ripple while also boosting current waveform and flux linkage waveforms during simulation. When it comes to dynamic and static performance, it boosts the system's ability to respond to changes in its environment.

INTRODUCTION

As permanent magnet material improves, power electronics, motor speed regulation theory, and microelectronics create frequency control technology of PMSMs. Due to their simplicity of manufacture, high moment of inertia, and high energy density, PMSMs are gaining popularity. [1] PMSM is often employed in robotic systems as well as CNC machine tools [2].

The hysteresis control of the standard direct torque control approach is used. This is due to the inverter switching frequency limiting the width, which means that only one basic voltage vector may be active at a time during a control cycle. To enhance the dynamic static performance of a system, it is possible to synthesize any required voltage vector for SVPWM control[2,3]. This reduces flux linkage and torque ripple noticeably. It is shown here that PMSM's direct torque control program, built on SVPWM, may be used to stimulate SIMLINK.

1. Modeling of PMSM using mathematics

Assume following prior to developing a mathematical model for easy analysis:

- Toss off any considerations for eddy currents or core saturation;
- Rotors without dampers that are permanently magnetized [5,6];
- There is a full symmetry to the stator's three-phase winding, yet each phase's winding is offset by 120 degrees.
- No matter how high the harmonics of the magnetic field may be, EMF and the magnetic field in the air gap are spread along the sine.

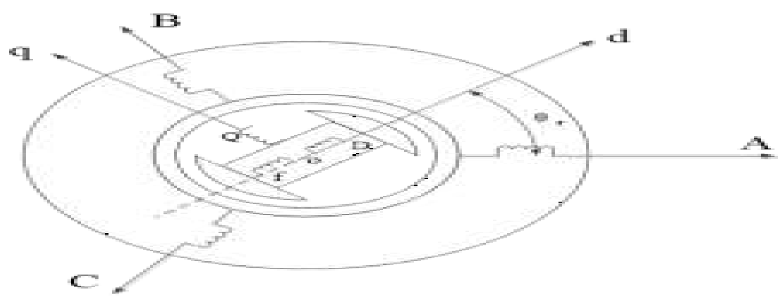


Figure 1.1 synchronous motorschematic

2. Traditional DTC control strategy

Principles of direct torque control may be summarized in this way:

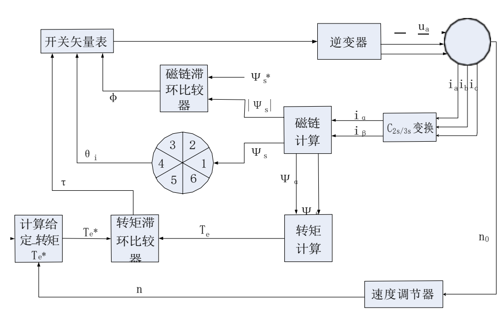


Figure 2.1.1 Diagram of PMSM direct torque control

Vector switch table searches are utilized by DTC to locate the right voltage vector, which is then used to activate meter selection modules and flux linkage directly. Simulink is used to model a DTC-based PMSM in MATLAB (Figure 2.2.1).

Table 1 selector table for switching voltage

Δψ	ΔT	I	II	III	IV	V	VI
1	1	W6	W2	W3	W1	W5	W4
	0	W5	W4	W6	W2	W3	W1
0	1	W2	W3	W1	W5	W4	W6
	0	W1	W5	W4	W6	W2	W3

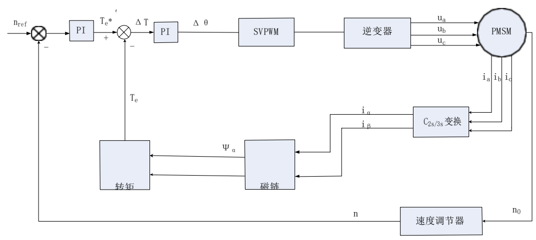


Fig. 3.1.1 SVM-DTC control schematic

It is a significant improvement over the classic direct torque control method in that the SVM-DTC employs PI regulators rather than the usual torque/flux/hysteresis comparators.

SVPWM control simulation experiment

Models of the SVPWM-based permanent magnet synchronous motor are created using MATLAB's Simulink modeling environment.

Results of DTC and SVM simulations: DTC control scheme

Figures 4.1 4.4 illustrate simulation and experimental findings. Figure 4.1 compares the flow trajectories of the stator under two different control strategies. Fig. 4.1 (a) and 4.1 (b) show that the flux trajectories in both instances are roughly circular, However, Smoother flux trajectory and fewer flux linkage fluctuations are seen using the SVM-DTC system. SVM-DTC program has the potential to substantially increase system steady-state performance [9] is shown in this example.

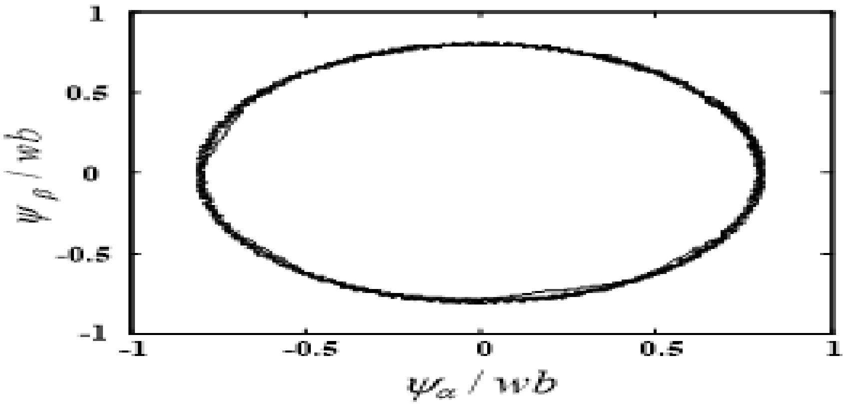
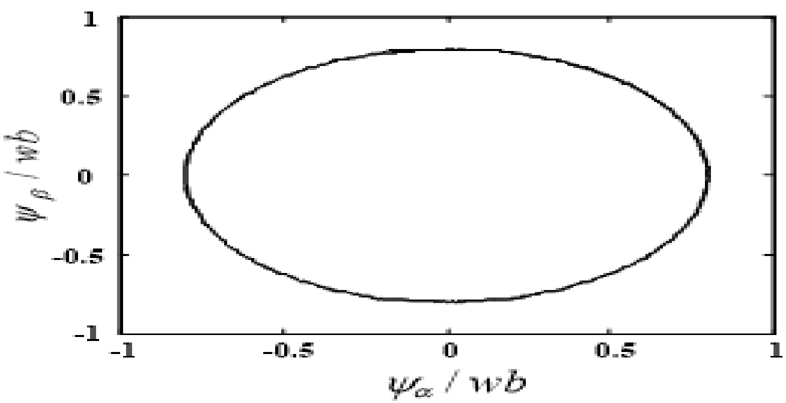


Fig. 4.1 (a) DTC flux linkage

Fig. 4.1 (b) SVM-DTC flux trajectory



- Stator phase current waveform is seen in figure 4.2. Comparing Fig. 4.1 to Fig. 4.2 (a)
- (b) Three-phase current in an SVM DTC stator : Figure 4.2 (b)
- Stable electromagnetic torque waveforms are seen in Figure 4.3 (a), and Figure 4.3 (b). During the first 0.05s, the motor's speed is 0 N•m, and the step load torque is raised by 1 N•m. For example, when we compare the typical DTC method with Figure 4.3b, we find that the torque waveform swings substantially and takes a longer time to respond to changes in the motor's torque when it is started. The dynamic response of the SVM-DTC control method is fast.

3. Conclusion

We can observe from the simulation findings in this work that the static dynamic performance is not especially stable under the standard DTC control technique, with high current, torque, and flux ripple. With reduced flux and torque turbulence in the motor, flux locus and electromagnetic torque monitoring speed up. It still has a fast DTC reaction time.

References and Notes

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