PMSM Control System Research Based on Vector Control

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Abstract. With The development of power electronic technology, microelectronic technology and modem motor control theory, synchronous motor speed control systems are widely used. PMSM plays an important role in AC servo system. Its control strategy research attracts more attention. The speed control system model performance is introduced and introduces the principles of SVPWM(Space Vector Pulse Width Modulation) and CHBPWM (Current Hysteresis Band PWM). Simulation models of PMSM servo system based on SVPWM and CHBPWM are built in MATLAB/SIMULI K, and simulation results are analyzed.

Introduction

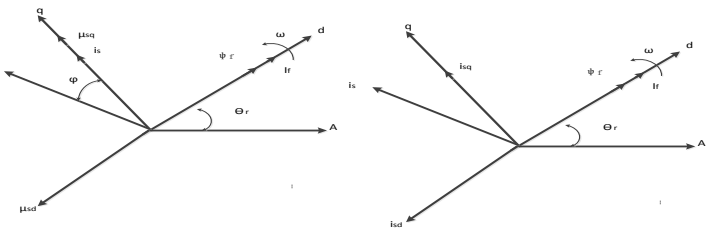
In recent years, with power electronic technology, new motor control theory and rare earth permanent magnet materials' rapid development. PMSM[1] are applied rapidly. PMSM has advantages of small volume, low loss and high efficiency[2], the study of it becomes more necessary. In view of the synchronous motor characteristics' nonlinear, strong coupling and multivariable. To implement its high performance speed control[3], excellent dynamic response, scholars at home and abroad have worked for a long time, having made much results. Since 80s, related technology got rapid development[4], the PMSM vector control system research results appear constantly, and has laid a theoretical[5] basis for the application of high performance PMSM servo system.

PMSM speed control system model

To detect the location of rotor shaft d, the synthesis of three phase stator current vector control inverter in shaft q (ahead $\frac{\pi}{2}$ of the shaft d) is simpler than asynchronous motor vector control[6].

By fig.1space vector diagram, the three phase current for a given value[7]

$$\begin{aligned} i^*_A &= i^*_s \cos\left(\frac{\pi}{2}+\theta_r\right) = -i^*_s \sin\theta_r \\ i^*_B &= i^*_s \cos\left(\frac{\pi}{2}+\theta_r-\frac{2\pi}{3}\right) = -i^*_s \sin\left(\theta_r-\frac{2\pi}{3}\right) \\ i^*_C &= i^*_s \cos\left(\frac{\pi}{2}+\theta_r+\frac{2\pi}{3}\right) = -i^*_s \sin\left(\theta_r+\frac{2\pi}{3}\right) \end{aligned} \quad (1)$$



a)

b)

Fig.1 PMSM rotor flux orientation space vector diagram

a) i_{sd} =0,Constant torque speed regulation b) $i_{sd} < 0$ Weak magnetic constant power speed regulation

θ_r is the Angle between shaft d and shaft A, a given signal i^*_s, A three phase current for a given signal i^*_A, i^*_B, i^*_C [8]， the corresponding vector arithmetic unit as shown in fig.2[7]

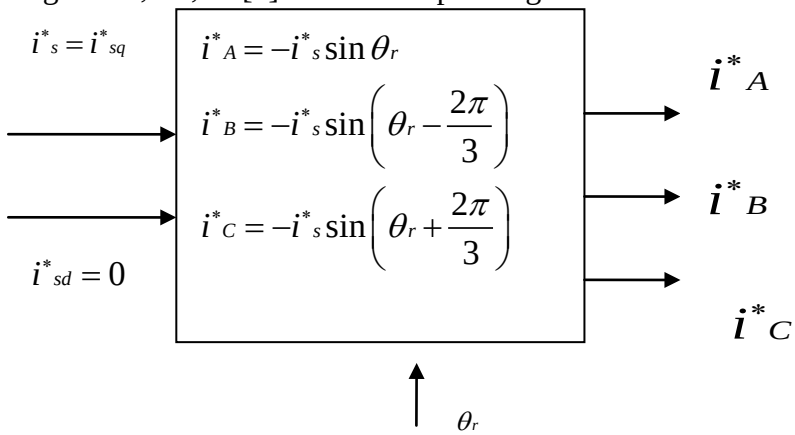


Fig.2 according to rotor flux orientation and make i_{sd} =0 of the PMSM vector arithmetic unit

According to rotor flux orientation and make i_{sd} =0, PMSM vector control system principle block diagram[7] is shown in fig.3, the dc motor speed control system, the output of the speed regulator ASR is proportional to the given value of the stator current of the electromagnetic torque.

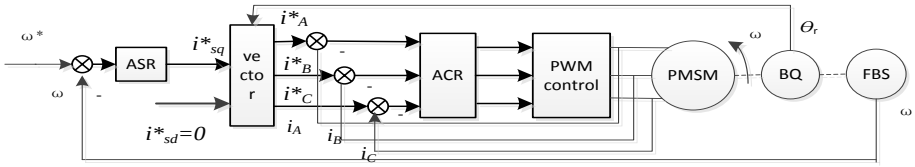


Fig.3 i_{sd} = 0 of the PMSM vector control system

System simulation model[9] as shown in fig.4, system main circuit consists of DC power supply, Universal Bridge and Permanent all Synchronous Machine. PMSM excitation type Sinousoidal choose sine wave. Gain1 is used to adjust the dqo-ABC module output phase modulation signal amplitude, Gain2 used to adjust the stator three phase current feedback signal amplitude, Gain3 very log is used to set the motor, set the pole figure logarithmic p = 1.

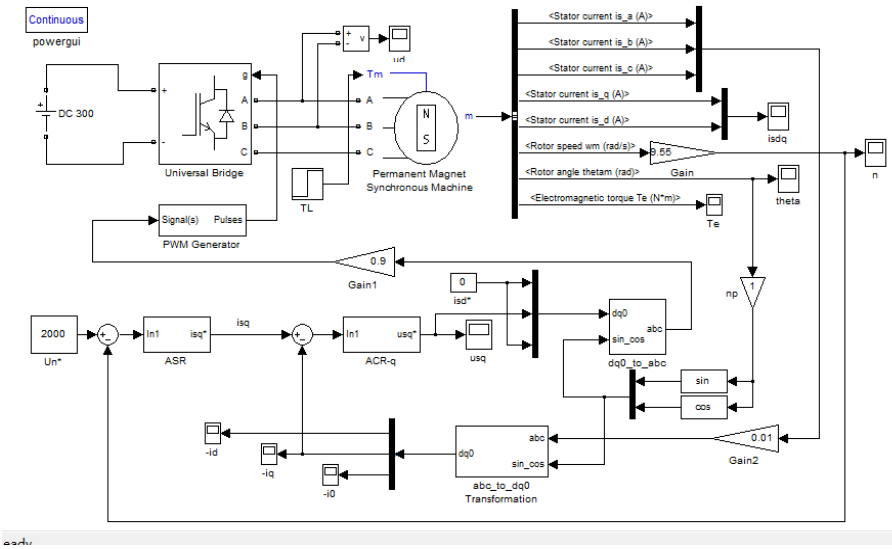
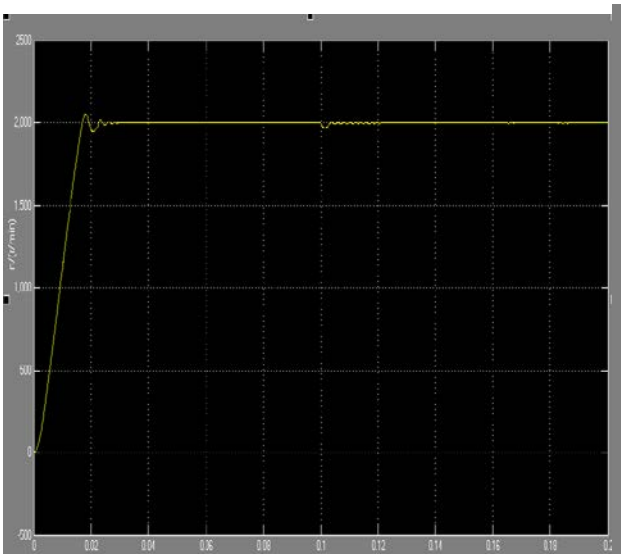
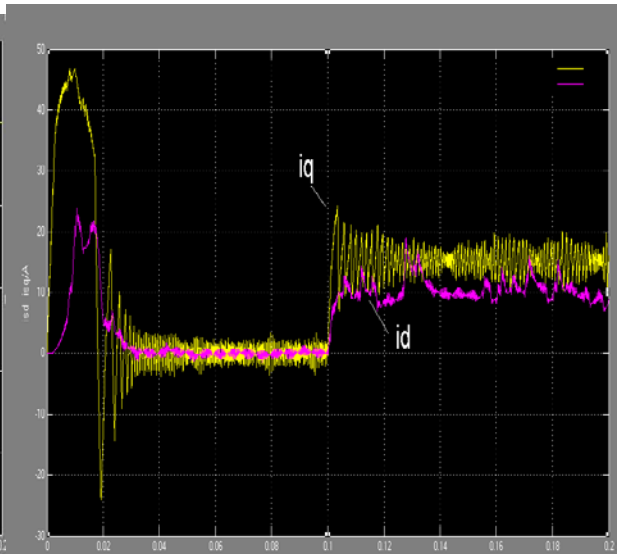


Fig.4 PMSM drive system model

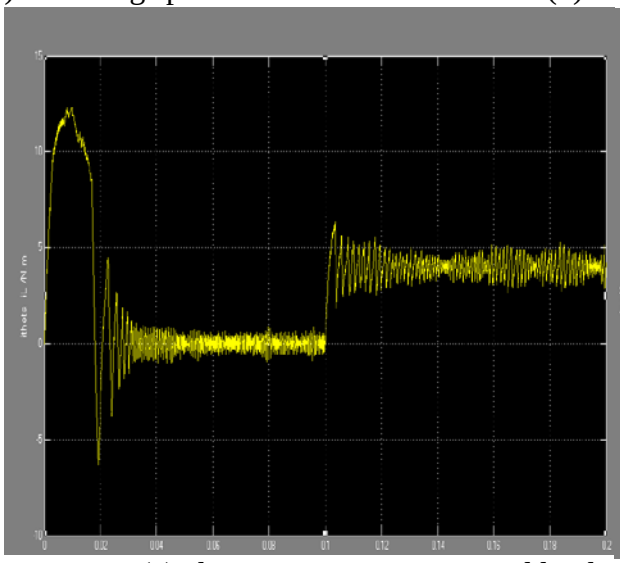
Sinusoidal PMSM drive system simulation results



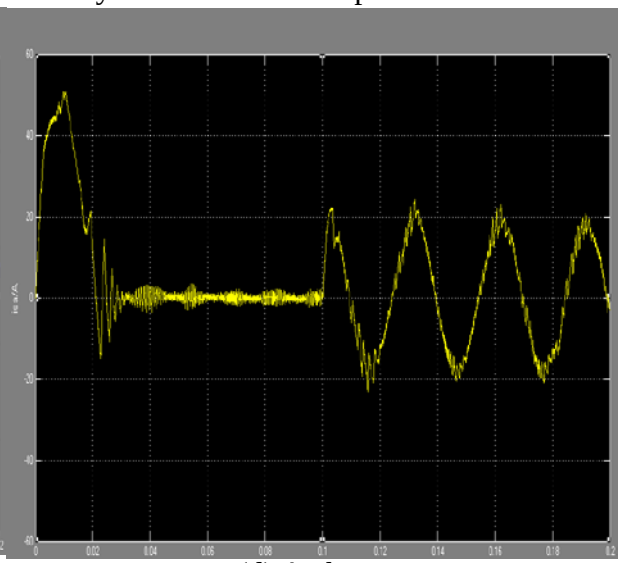
(a) revolving speed



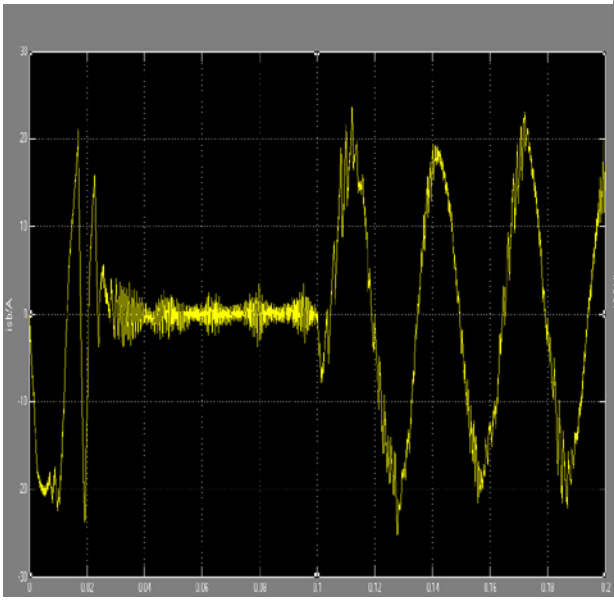
(b) electricity flow moment components and excitation



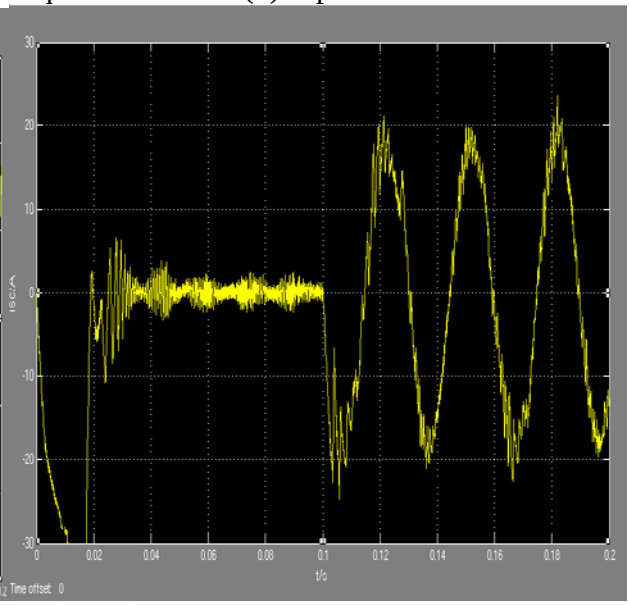
(c) electromagnetic torque and load torque



(d) A phase current



(e) B phase current



(f) C phase current

Fig.5 sinusoidal waveform PMSM drive system

Fig.5(a) as the speed response, motor with no-load startup, 0.1 s load 4 N. m, speed fluctuation. Fig.5(b) for the torque component of stator current i_{sq} and excitation component i_{sd} , Fig.5(c) as the motor torque, Fig.5 (d) - (f), three phase stator current waveform respectively.

When the load increases, stator voltage rises. In order to ensure sufficient power supply, electric control devices need enough capacity, the effective utilization rate is not. The load increases, the stator voltage vector and current vector angle also increases, which reduces the power factor. In normal circumstances, weak magnetic constant power long-term operating range is not big.

Conclusions

Because of rare earth permanent magnet magnetic permeability and air, magnetic resistance is very big, there is a lot of equivalent air-gap between equivalent stator, the method of using the armature reaction of weak magnetic need larger demagnetization straight axis component of stator current, so the conventional sinusoidal PMSM in the weak magnetic constant power running effect is very poor, only in the short run time can be accepted. If you want to long-term weak magnetic work, must adopt special method of weak magnetic, this is the core issue of PMSM design.

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