Volume 6, Issue 1, January 2019 ISSN: 2348-8565 (Online)
IJMERT
International Journal of Modern Engineering and Research Technology
Website: http://www.ijmert.org Email: editor.ijmert@gmail.com

Closed Loop Control of Switched Reluctance Motor

V. Panneer Selvam
PG Research Scholar
Department of Electronics and Electrical Engineering
Sri Chandrasekharendra Saraswathi Viswa Maha Vidyalaya,
Kancheepuram, (T.N.) [INDIA]
Email: vps9666@gmail.com

S. Prabakaran
Associate Professor
Department of Electrical and Electronics Engineering
Sri Chandrasekharendra Saraswathi Viswa Maha Vidyalaya
Kancheepuram, (T.N.) [INDIA]
Email: prabakaran110768@gmail.com

ABSTRACT

The Switched Reluctance Motor (SRM) is a member of the Electric Machines Family. Its simple structure and ruggedness and capability make it more attractive for Industrial applications. These machines have inherent high torque ripple, acoustic noise and difficulty to control. In this work, modeling, simulation and analysis of Switched Reluctance motor has been done. This Switched reluctance motor controlling by simulated in MATLAB/SIMULINK and also verified the output result. Hence in this proposed system, PI Control and voltage control have been implemented. The result obtained from simulation has been presented in the paper.

Keywords:— *Switched Reluctance Motor (SRM), Torque, Segmented SRM, PI Control, Hysteresis Control and Voltage Control.*

I. INTRODUCTION

The electrical drives play an important role on the productivity to any industry. The requirement of drives depends upon the available mains and load characteristics. Brushless variable speed drive using SRM has become popular relative to other drives and represents an economical alternative to PM brushless motors in many applications. In last few years the SRM have gained increasing attention since they offer the possibility of electric drives which are mechanically and electrically more rugged than those built up around the conventional AC and DC motors.

In case of SRM drive, the technical superiority of the AC drive is obtained or even enhanced at a very low cost. This is possible due to the simple motor construction and the requirement of a simple unipolar power modulator for controlling the speed. In order to get performance oriented Drive, the accurate modelling of a Motor is to be done [1]. The performance of machine can be checked with the help of Mat lab / Simulink. This helps to design the Controller for the motor. Modelling can be done with the help of mathematical equations. In Switched Reluctance Motor the torque is developed because of the tendency of the magnetic circuit to adopt the configuration of minimum reluctance i.e. the rotor moves in line with the stator pole thus maximizing the inductance of the excited coil. The magnetic behaviour of SRM is highly nonlinear [2] [5]. But by assuming an idealistic linear magnetic model, the behaviour pattern of the SRM can be adjusted with ease without serious loss of integrity from the actual behaviour pattern. The physical appearance of a Switched Reluctance motor is similar to that of other rotating motors (AC and DC) Induction

Motor, DC motor etc. The construction of 6/4 (6 stator poles, 4 rotor poles) poles SRM has doubly salient construction. Usually the number of stator and rotor poles is even [3]. The windings of Switched Reluctance Motor are simpler than those of other types of motor. There is winding only on stator poles, simply wound on it and no winding on rotor poles. The winding of opposite poles is connected in series or in parallel forming no of phases exactly half of the number of stator poles. Therefore excitation of single phase excites two stator poles. The rotor has simple laminated salient pole structure without winding [4]. This is the advantage of this motor as it reduces copper loss in rotor winding. The stampings are made preferably of silicon steel, especially in higher efficiency applications. For aerospace application the rotor is operating at very high speed, for that cobalt, iron and variants are used. The air gap is kept as minimum as possible, especially 0.1 to 0.3 mm. The rotor and stator pole arcs should be approximately the same. If the rotor pole arc is larger than the stator pole arc it is more advantageous.

II. SRM CHARACTERISTICS

In the Switched Reluctance Motor, only the stator carriers windings, while the rotor is made of steel laminations without conductors or permanent magnets. This very simple structure greatly reduces its cost. Motivated by this mechanical simplicity together with the recent advances in the power electronics components, much research has taken place in the last decade. The SRM, when compared with the ac and dc machines, shows two main advantages. 1) It is a very reliable machine since each phase is largely independent physically, magnthe other machine phases. 2) It can achieve very high speeds (20000—50000 rev/m) because of the lack of conductors or magnets on the rotor. However, the SRM has some limitations.

- It must always be electronically commutated and thus cannot run directly from a dc bus or an ac line.
- Its salient structure causes strong nonlinear magnetic characteristics, complicating its analysis and control.

The SRM shows strong torque ripple and noisy effectively.

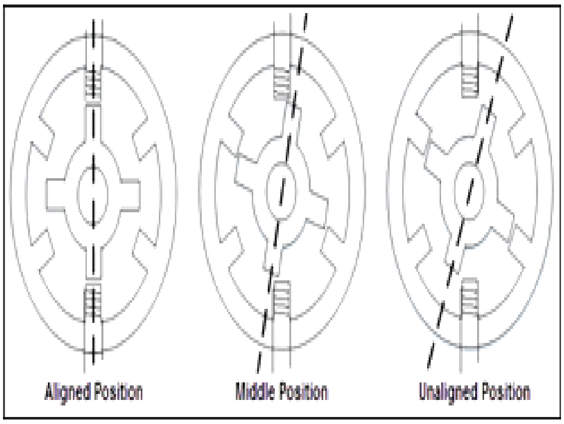

Figure 1. SRM Motor Internal View

The SRM motion is produced because of the variable reluctance in the air gap between the rotor and the stator. When a stator winding is energized, producing a single magnetic field, reluctance torque is produced by the tendency of the rotor to move to its minimum reluctance position. When a rotor pole is aligned with a stator pole, as shown in Figure 1, there is no torque because field lines are orthogonal to the surfaces (considering a small gap). In this position, the inductance is maximal since reluctance is minimum (one neglects the reluctance of the magnetic circuit). If one displaces the rotor of its position, there will be torque production that will tend to bring back the rotor toward the aligned position. If current is injected in the phase when in the unaligned position, as shown in Figure 2, there will not be torque production (or very little). If one displaces the rotor of the unaligned position, then a torque tends to displace the rotor toward the next aligned position.

III. ENERGIZING STRATEGIES

There are several possible configurations to energize an SRM from a converter. The different energizing structures distinguish themselves by their number of semiconductors and passive components. They also depend on the number of phases and the way the stator coils are connected.

The maximum control and flexibility is obtained, however, with the H-bridge asymmetric type converter shown in Figure 3. Each phase has two insulated gate bipolar transistors (IGBTs) and two diodes. The number of semiconductors is the same as for an inverter. However, the structure is completely different. One can also notice that it is not possible to short-circuit the source because the resistance of the coils limits the current. As linearity is assumed, the flux relation is given by (21) □= □()□□ The co-energy is given by 2) = □2/1) □()□□ (22)Resulting in a torque given by =□□□□□T 2 (23) The above expression shows that this converter is unidirectional in current because torque production does not sign. θdepend on the current sign but only of dL/d The simulation curves shown in figures (4) to (11) are those obtained by assuming ideal inductance shape when excited by voltage source.

The control takes place applying on until aθ the voltage source to a phase coil at turn-on angle off. After that, the applied voltage is reversedθturn-off angle d, which allows the θuntil a certain demagnetizing angle return of the magnetic flux toward zero. To apply voltage V in one phase, the two IGBTs Q1 and Q2 in Figure 2 must be ON. On the contrary, to apply the –V voltage and assure the current continuity, the two diodes D1 and D2 are used.

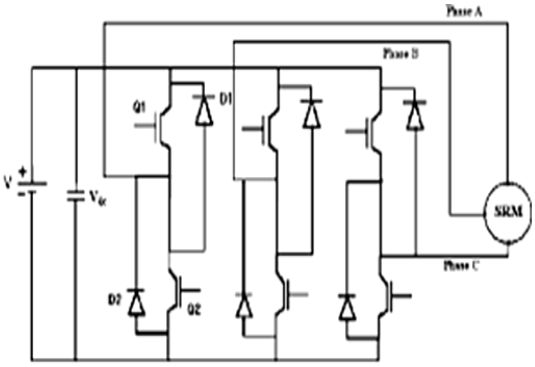

Figure 2. H-Bridge Asymmetric Converter

IV. SIMULATION RESULTS

Based on the SRM drive speed control simulation is presented. In this PI control is used for speed control and simulation view shown figure 3 and Figure 4 to Figure 6 shows different drive models of switched reluctance motor. Figure 5 shows the A phase torque of SRM motor. Figure 5 shows the total torque of the SRM motor in open loop and closed loop control strategies. Speed curves of the SRM motor with and without PI controller are presented in Figure 6 and Figure 7 respectively.

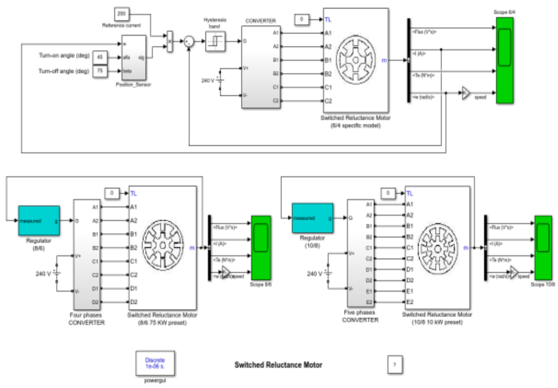

Figure 3. Simulation View of SRM Speed Control

Simulink model of the SRM with modelling Figure 4 shows the Simulink model of the open loop Switched reluctance motor without modelling. Figure 5 shows the Simulink model of the closed loop Switched reluctance motor with modelling. Figure 6 shows the Simulink model of the closed loop Switched reluctance motor without modelling.

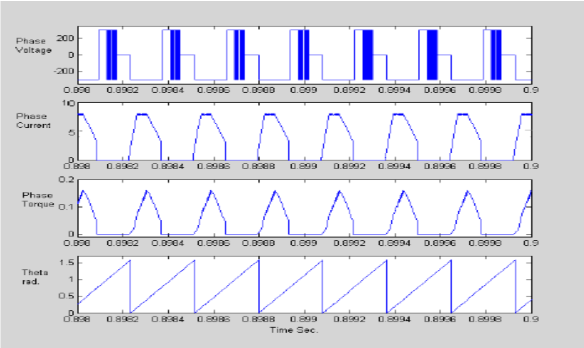

Figure 4. Phase currents of SRM

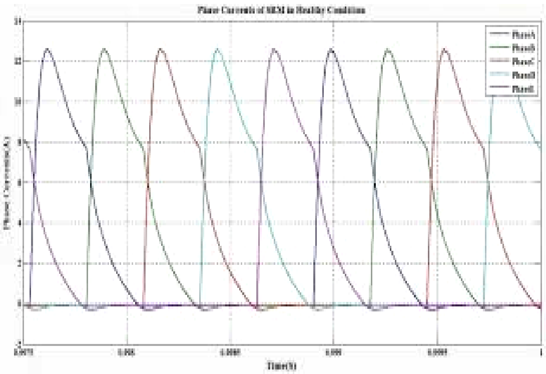

Figure 5. Total torque of the SRM compared with closed loop PI control.

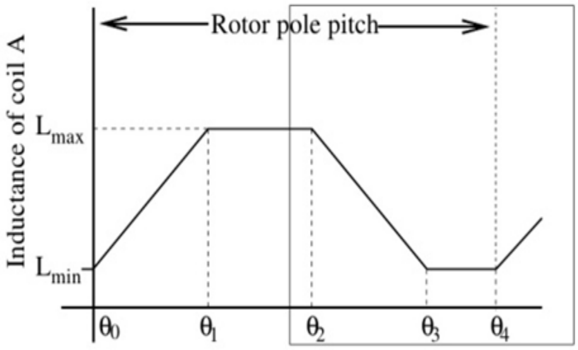

Figure 6. Inductance of SRM

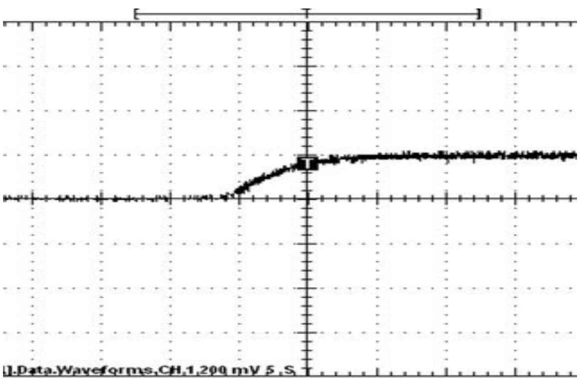

Figure 7. Speed curve of the closed loop SRM

V. CONCLUSION

In this paper a closed loop PI control of the SRM motor is modelled and simulated assuming constant Inductance. Steady state operation of the SRM was obtained with PI control of speed. The system is implemented by using the MATLAB/ SIMULINK and results are obtained.

REFERENCES:

[1] Nascimento, J., Rolim, L., Heidrich, P., et al., Design and simulation aspects of a switched reluctance drive, In Proceedings of the Brazilian Power Electronics Conference (COBEP96), 1996, 79—83.

[2] Miller, T. J. E., Switched Reluctance Motors and Their Control. Oxford, UK: Magma Physics Publishing and Clarendon Press-Oxford, 1993.

[3] Lawrenson, P. J., Stephenson, J. M., Blenkinsop, P. T., Corda, J., and Fulton, N. N., Variable-speed switched reluctance motor, IEE Proceedings Inst. Elect. Eng., 127,vJune 1980, 253—265.

[4] Henao, H., Capolino, G. A., Bassily, E., and Poloujadoff, M., A new control angle strategy for switched reluctance motor. In Proceedings of EPE, 1997, 613—618.

[5] Stephenson, J. M., and Corda, J, Computation torque and current in doubly salient reluctance motors from nonlinear magnetization data. IEE Proceedings, 126, May 1979, 393—396.

[6] Elliot, C. R., Stephenson, J. M., and McClelland, M. L., Advances in switched reluctance drive system dynamic simulation. In Proceedings of EPE, 1995, 622—626.

[7] Rodrigues, M., Suemitsu, W. I., Costa Branco, P. J., Dente, J. A., and Rolim, L. G., Fuzzy logic control for a switched reluctance motor, IEEE International Symposium on Industrial Electronics (ISIE '97), June 1997, 527—531.

[8] Rodrigues, M., Costa Branco, P. J., and Suemitsu, W. Fuzzy logic torque ripple reduction by turn-off angle compensation for switched reluctance motor, IEEE Transactions on Industrial Electronics, 48, June 2001, 711—71.

* * * * *