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Speed Control Drive for Switched Reluctance Motor

KEYWORDS: Motor drives control, Power electronics, and Switched reluctance motor (SRM) drives

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ABSTRACT *Speed control of any rotating machine is essential for different applications. Prototype Switched Reluctance motor (SRM) is considered because it is a high speed domestic motor. The speed of SRM is controlled by proposed controller at no load and load conditions. This proposed method is compared with existing conventional method. This effective method is also used to reduce the consumption energy of SRM. This drive can be used to reduce the cost of the power electronic control components of SRM for increasing the efficiency. It is very helpful to manufacturer for SRM. The drive model is simulated and analyzed by using speed control method. Excess energy in off going phase winding is utilized to increase the efficiency of the motor. The result of the proposed drive is a better choice for effective cost and energy savings.*

1. Introduction

Nowadays, electrical drive is one of the main important roles for any industries. Switched reluctance motor (SRM) is very popular because it's simple construction and absence of rotor windings. Due to lack of switching power devices and control electronics, it is not identified easily. Hence the application of the SRM is limited. But speed of the SRM is very high (40,000 rpm).For different applications like washing machine speed control of SRM are essential. The following factors are considered for controlling the speed of SRM.

- To identify the rotor position of SRM.
- Select the type of SRM like sensor type or Sensor less type.

The speed controller of SRM is based on the above factors. However communicate the pulses from phase winding to another phase winding of SRM for identifying the position of rotor. In this sensor type, rotor position is directly identified by sensor. The same rotor position is indirectly identified in sensor less method. In this paper, a new methodology is used to control the speed of SRM in indirect method of rotor position detection. Mostly sensor less method is based on Magnetic characteristics of Switched reluctance motor (SRM). It based on the stator currents and flux linkages with rotor position angle. Magnetic characteristic is used to explain the relationship between the stator current and rotor angle. It is already proposed by some researchers [1]-[4], which help to sense the rotor position of the SRM. X.D. Xue, K.W.E. Cheng and S.L. Ho explained the [5] Magnetization curves. Interaction between the two phases in the stator winding is not considered in existing system. Hence Magnetic theory has been developed [6] by D. S. B. Fonseca, C. M. P. Cabrita, and M. R. A. Calado, for non linear model of SRM. Disadvantages of this existing method is less accuracy, complex modeling. Hence the proposed method is developed with new algorithm to measure the Magnetizing characteristics of SRM. It helps to sense the correct rotor position with respect to inductance and phase current for controlling the speed of SRM. In literature survey some of the indirect sensor elimination techniques are explained and rotor position methods are identified. It is already proposed by R.Arumugam et-al, [7], [8] the flux current detection technique by Jie Li, Hexu Sun, et-al [9] the modulation techniques by Zhang Hai-Jun, Gao Rui-zhen, et-al [10], [11]. B. Parreira, S. Rafael proposed the mutually induced voltage [12].E. Karakas, S. Vardarbasi et al proposed the resonant method [13].

2. Conventional method:

Voltage across phase winding is proportional to current through it. It is proportional to load condition. It is shown in Figure 1.

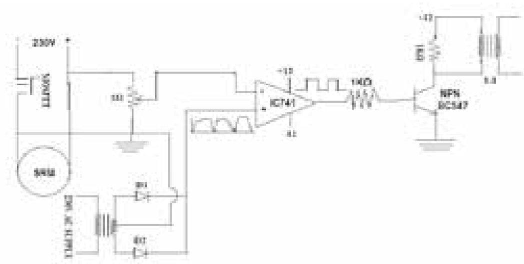

Figure: 1 Circuit diagram for conventional Method

This voltage across winding is coupled to the input of amplifier. The Amplified output is compared with some reference voltage using a comparator. Comparator output can have two voltage levels like high or low. It depends upon amplified voltage of winding above or below the reference voltage. If the comparator output is high, MOSFET is turned OFF and the supply voltage is controlled from higher level to lower level. If the comparator output is low compare to reference voltage when MOSFET is turned ON and supply voltage is increased to SRM. Hence the speed of the motor is increased. The above conventional method is used to measure the sensor less pulse, type of inductance, stator current with load and no load condition. It is also identify the rotor position and speed of the SRM.

3. Proposed speed control Drive

SRM is controlled by correct positioning of the phase current pulses with respect to rotor position. The turn on time and the total conduction period are used to determine the torque and efficiency of SRM. The phase current builds up very quickly after turn due to the negligible back emf.

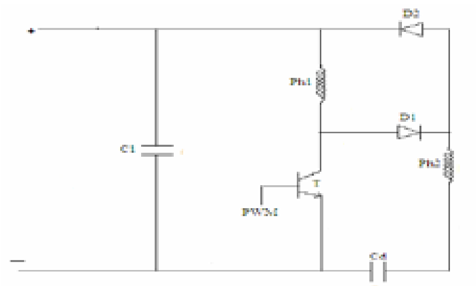

Figure 2 Proposed Speed Controller circuit for SRM

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The current should be limited either by controlling the voltage or by regulating the current. The proposed voltage control drive is shown in Figure 2. In general PWM voltage control with variable duty cycles are very useful for controlling the SRM. Variable speed drive is having voltage PWM with closed loop position control for high efficient operation. More number of blocks is available in voltage controller for high speed operation. Function of angle controller mainly generates turn- on and turn-off angles for each phase winding. It helps to determine the conduction period with respect to rotor position. Control signal which depends upon rotor position, drives the Transistor T. The rotor of SRM is in the aligned position with stator coil, control signal turns on Transistor T and hence motor winding Ph1 is energized.

4. Experimental Setup and Results with Simulation:
The experimental results are obtained and tabulated. The speed of SRM for various turn-on and turn-off are tested. The results are shown in Figure 3.

Table: 2 Analysis of efficiency at different torque of SRM.

S.No	Torque in N-m	Efficiency in %
1.	0	0
2.	0.2	58
3.	0.4	56
4.	0.6	66
5.	0.8	70
6.	1.0	74
7.	1.2	78
8.	1.4	82
9.	1.6	80

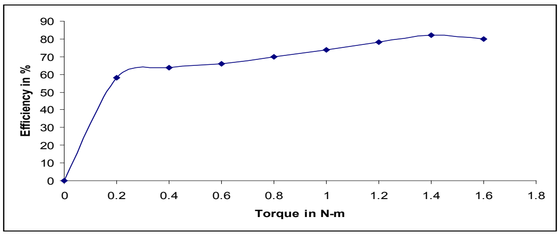

Figure 3: Torque-efficiency characteristics of SRM.

5. Conclusion:
A new proposed speed controller is presented for controlling the speed of SRM with high energy efficient operation. This proposed controller is proved with experimental work. The proposed speed controller also can be easily applied to SRM for determining the rotor position by signals of stator current and flux linkages with respect to voltage across winding. The proposed method proves that efficiency of the motor is increased. Only one switch in controller is also less. Hence cost of the system is minimum.

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