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A Novel Hybrid Control of DTC based Switched Reluctance Motor

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Abstract

The magnetic characteristics of switched reluctance motor yield to vibration, noise, distortion and toque control. This manuscript presents about hysteresis-PID control for torque ripple minimisation. Although lot of controllers have employed, this approach gives an idea of selection of combination of controller for faster torque ripple minimization. The direct torque control focuses on improving torque and speed response.Simulation is carried out in MATLAB/SIMULINK for hysteresis –PID fed direct torque control for a switched reluctance motor and the minimum settling time of speed indicates the robustness of the controller under non-linear conditions.

Keywords: *Switched reluctance motor, Hysteresis, PID, vector control, direct torque, torque ripple.*

1. Introduction

SRM motors are preferred over other drives in industries because of its high speed , simple structure and torque/inertia ratio. The only disadvantage that it faces is high torque ripple which is a non-linear characteristic yielding to vibration, distortion and noise[1]. Various control strategies have been employed to minimize the torque ripple [2,3]. The other aspect is the direct torque control in which new space vectors have been employed to improve the torque. The combination of direct torque control and Hysteresis-PID provides minimization of torque ripple. The Robust-ness of the controller is decided by the settling time of speed.

2. SRM Motor

The working principle of SRMstates as current passes to one of the stator windings; rotor creates torque to line up with stator shaft. The function of the rotor position can generatestorque direction and is free from current flow direction over the phase winding. Considering each phase excitation with rotor positioncan produce continuous torque. By changing the number of phases,stator and rotor poles, numerous SRM geometries can be recognized [4-10].

It is not necessary that the number of phases should be half the number of rotor poles. By increasing the number of phases torque ripple can be reduced, but the usage of electronics will be more to operate the SRM. Minimum two phases are required for starting, and three phases are required to ensure starting direction. The no. of rotor and stator poles vary to insure starting.

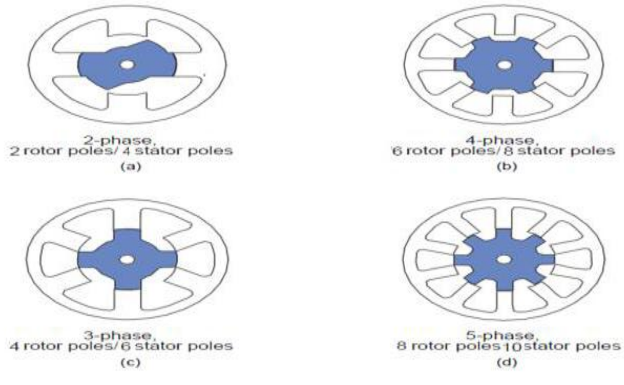

Fig. 2.1. Various SRM Geometries

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3. **Direct Torque control**

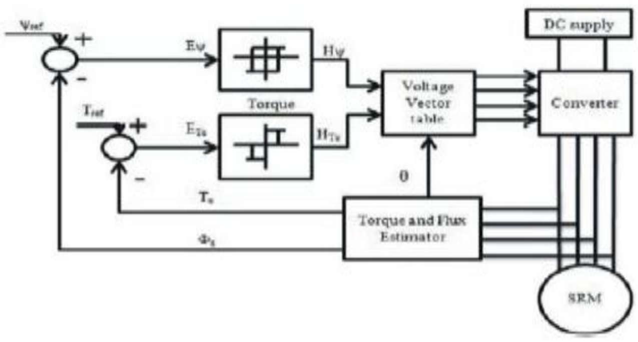

Fig. 3.1. Block diagram of DTC.

Due to non-linear characteristics of SRM, it yields to oscillations thereby increasing more torque ripple. The torque ripple is minimized by selection of suitable switching vectors. The block diagram shows a converter with power supply. Although different controllers are used to decrease the ripple some advanced or novel combination of controllers need to be used to improve the performance of SRM. Generally,in DTC the torque and flux are calculated.Its calculated based on the switching sequence from the look up table.It also gives the initial flux and limits the inverter frequency specified by the user.

Table 3.1: Switching Function Table

Switching stage of Power Converter	Terminal Voltage of winding	Switching Function S
V1, V2 both On	+ve Voltage	1
V1, V2 one On and the other Off	Zero Voltage	0
V1, V2 both Off	-ve Voltage	-1

4. PID- hysteresis controller

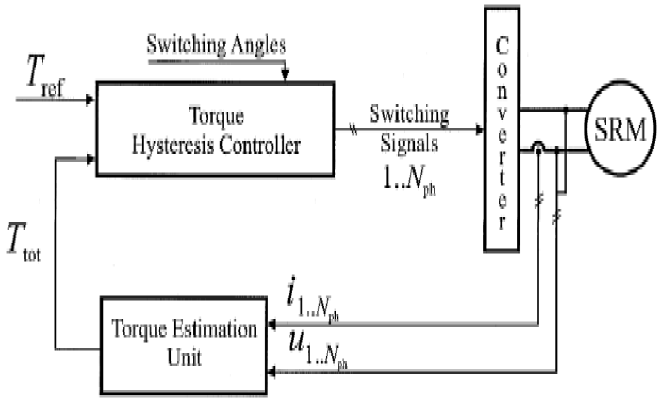

Fig. 4.1.Block Diagram of PID-Hysteresis Controller

The voltage state vectors are kept at centre as each zone possesses a width. One of the possible switching states is selected such that the torque and flux linkage lie within the amplitude of the hysteresis band. The PID controller which does not require any adjustment or tuning is fed to hysteresis an intern fed to SRM.

5. Results & Simulation

5.1. Motor Parameters

Stator resistance
6.9 (ohm)

Inertia
0.05 (kg-m)

Voltage
300 (V)

Initial speed and position
[600.0]

Unaligned inductance (H)
0.67 e^{-3}

Aligned inductance (H)
23.6 e^{-3}

Saturated aligned inductance
0.15 e^{-3} (H)

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Coefficient of friction (B)
0.02 N.m.sec/rad

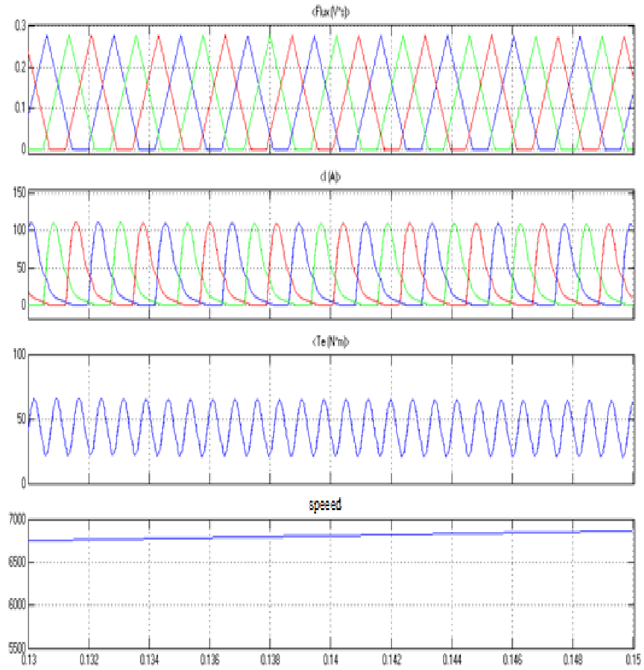

Fig 5.1 Waveforms for flux, phase current ,Torque and speed.

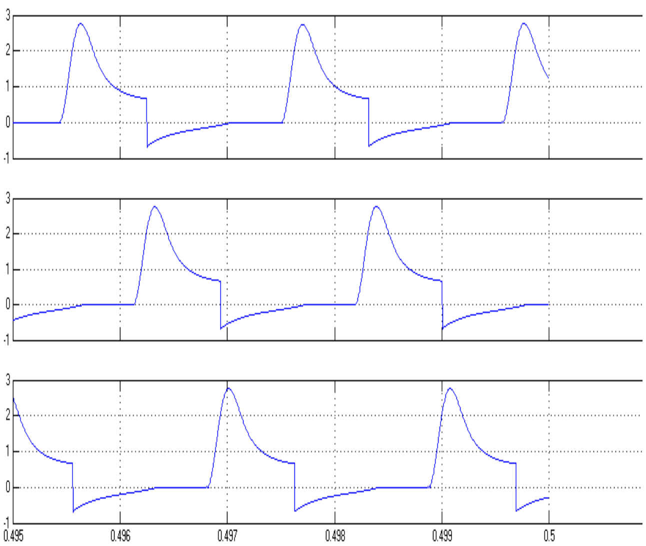

Fig 5.2 Output for torque estimation

6. Comparison

6.1 Controller Comparison

Controller	**Torque ripple minimization**
Hysteresis - PID	11%
PID>	15%
PI	18%

7. Conclusion

The waveforms of current, flux and speed are depicted and the torque estimated waveforms are also projected.Thus the torque ripple is minimized in SRM by Hysteresis-PID controller fed DTC.It clearly shows that when compared to con-ventional controller this inventive combination of the controller gives a better torque ripple minimizing performance.

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