퍼지제어기 기반의 새로운 BLSRM의 축방향지지력 제어

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Suspending Force Control of New BLSRM Based on Fuzzy Controller

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ABSTRACT

A suspending force control based on fuzzy logic control is proposed to apply on a novel hybrid bearingless switched reluctance motor(BLSRM) which has separated torque and suspending force pole. In this paper, two fuzzy controller targeted at x axis direction and y axis direction are adopted to maintain the shaft at center position, which is very necessary for stable operation of BLSRM. Useing the modified fuzzy logic controller, the suspending system can behave a good performance, and the proposed scheme can be verified by simulation results.
Index Terms BLSRM, suspending force control, fuzzy logic controller.

1. INTRODUCTION

Switched reluctance motors(SRMs) have substantial benefits in many applications. Their particular characteristics are simple construction, low cost, fault tolerance, high efficiency, and the ability to operate in a high temperature environment. However, mechanical bearing limits SRMs' highspeed ability. Bearingless switched reluctance motors (BLSRMs) can avoid the contact and the lubrication between motor shaft and bearing, and they can generate radial forces to levitate the rotor by changing the flux density in the motor air gap [1] [3].

The torque production in SRM drive is highly nonlinear due to the dependency of the machine torque on rotor position and phase current. Several methodshave been reported in the literature for fault tolerant SRM drive. Current profiling and extended conduction of the healthy phases are few amongst those methods.

In the proposed control scheme, a simple PI controller is used to regulate the speed of the proposed BLSRM, and two fuzzy logic controller are used to generate the desired suspending force commands to keep the rotor in the center position. The validity of control scheme are verified by the simulation results.

2. A NOVEL 12/14 HYBRID STATOR POLE TYPE BLSRM

2.1 Structure and Operate Principle of Proposed BLSRM

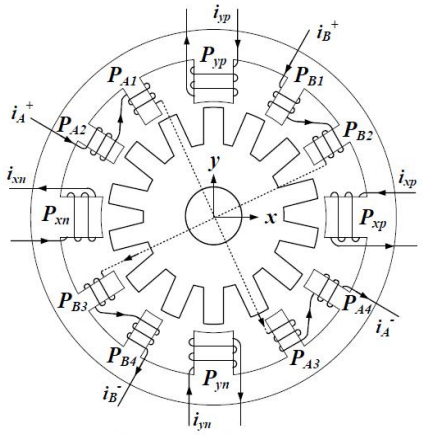


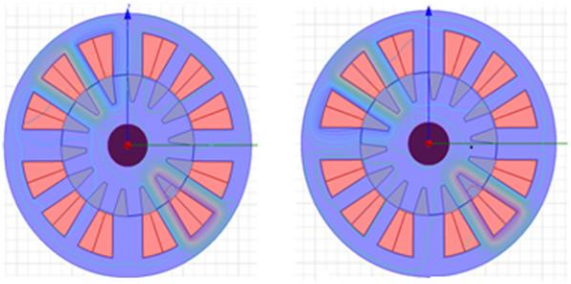
Fig. 2. Basic structure of the proposed BLSRM

A novel 12/14 hybrid stator pole type BLSRM with short flux paths and no flux reversal in the stator is proposed in Fig.2.

The new structure has separated torque and suspending force poles. Windings on the torque poles PA1, PA2, PA3 and PA4 are connected in series to construct phase A, and windings on the torque poles PB1, PB2, PB3 and PB4 are connected in series to construct phase B. The x direction suspending force is generated by currents flowed in the suspending force poles Pxp and Pxn. Similarly, the suspending forces for the y direction can be generated by the currents iyp and iyn which flow in suspending force poles Pyp and Pyn, respectively. .

2.2 Magnetic Flux Distribution

Fig. 3.shows magnetic flux distributions of the 12/14 BLSRM. As shown in the figure, when the motor rotates, the flux path of the 12/14 type is short and there is no flux reversal in the stator core. This will decrease the MMF requirements and lead to lower core losses.



(a) Phase A and Pyp are excited (b) Phase B and Pyp are excited
Fig. 3. Magnetic flux distributions of the proposed 12/14 type

3. CONTROL SCHEME OF THE PROPOSED BLSRM

Based on the torque control decoupled from the suspending force control in the novel structure, a control scheme for the proposed BLSRM is proposed in Fig. 5. As shown in the figure, a PI type speed controller is adopted to regulate the motor speed. Two fuzzy logic controller, one for x direction and the other for y direction, are used to generate the desired suspending force commands Fx* and Fy* .

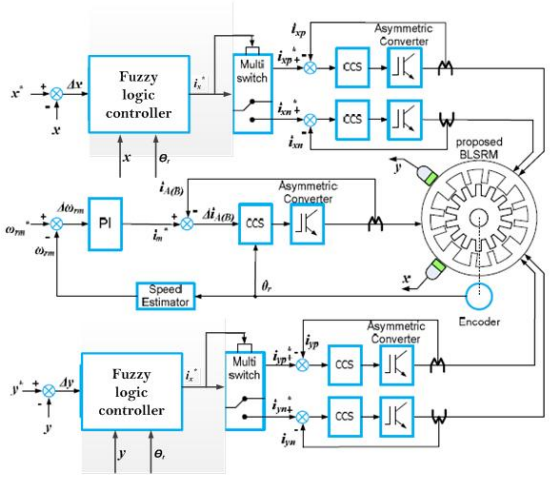


Fig. 5. Control scheme of the proposed BLSRM

4. SIMULATION RESULTS

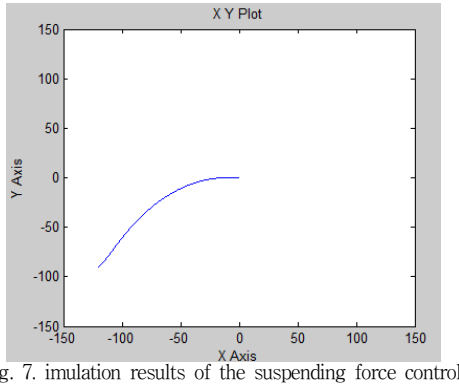


Fig. 7. imulation results of the suspending force control

Figs. 7. show the simulation results of the suspending force control. From the figures, it can be seen that, when the suspending force control is applied, the rotor moves to its balanced position.

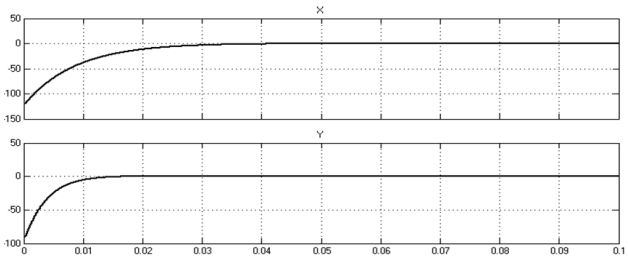


Fig. 8. The displacement ,commend force and real force of X axis

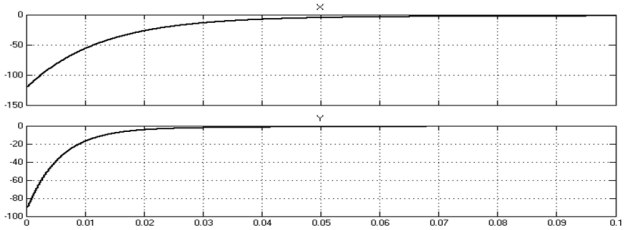


Fig. 9. The displacement ,commend force and real force of Y axis

Figs. 8. and 9. show the simulation results of displacement, commend force and real force of X axis and Y axis respectively of the BLSRM. From the figures, it can be seen that, when the suspending force control is applied, the rotor moves to its balanced position immediately. And the response of the real force follow the commend force is very good.

5. CONCLUSIONS

Based on the torque control decoupled from the suspending force control in the novel 12/14 hybrid stator pole type BLSRM, a control scheme is of fuzzy logic controller proposed. From the simulation results, it can be seen that when the suspending force control is applied, the rotor moves to its balanced position immediately.

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