Analysis of Magnetic Polarity Distribution for a Dual-Rotor Switched Reluctance Machine (Mon-Af-Po1.04)

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Introduction

This paper presents a model for dual rotors switched reluctance motor consisting of two airgap, an outer-stator, a middle-rotor and an inner-rotor. This study achieves optimization in inner-rotor pole-arc coefficient, inner-rotor yoke thickness, outer-stator pole-arc coefficient, outer-stator yoke thickness, middle-rotor inner tooth pole-arc coefficient, middle-rotor outer tooth pole-arc coefficient, and middle-rotor yoke thickness based on the present model. The final geometry size is designed and optimized for enhancing the average torque of middle-rotor in the outer airgap considering the limitation of outer-stator outer radius and laminated thickness of motor, the configuration intensity and manufacture techniques. Comparison of torque on the dual rotors switched reluctance motor and the conventional single inner rotor switched reluctance motor is made. Three kinds of magnetic polarity distribution of outer-stator with four kinds of magnetic polarity distribution of inner-rotor are studied. NSNSNSNSNSNS magnetic polarity distribution of outer-stator with NSNSNS magnetic polarity distribution of inner-rotor is selected for enhancing the average torque of middle-rotor in the outer airgap.

Structure of DR-SRM

DR-SRM consists of an outer-stator, a middle-rotor and an inner-rotor. The outer-stator and the middle-rotor consist of the outer motor with 12/8 structure, and the middle-rotor and the inner-rotor compose of the inner motor with 6/8 structure.

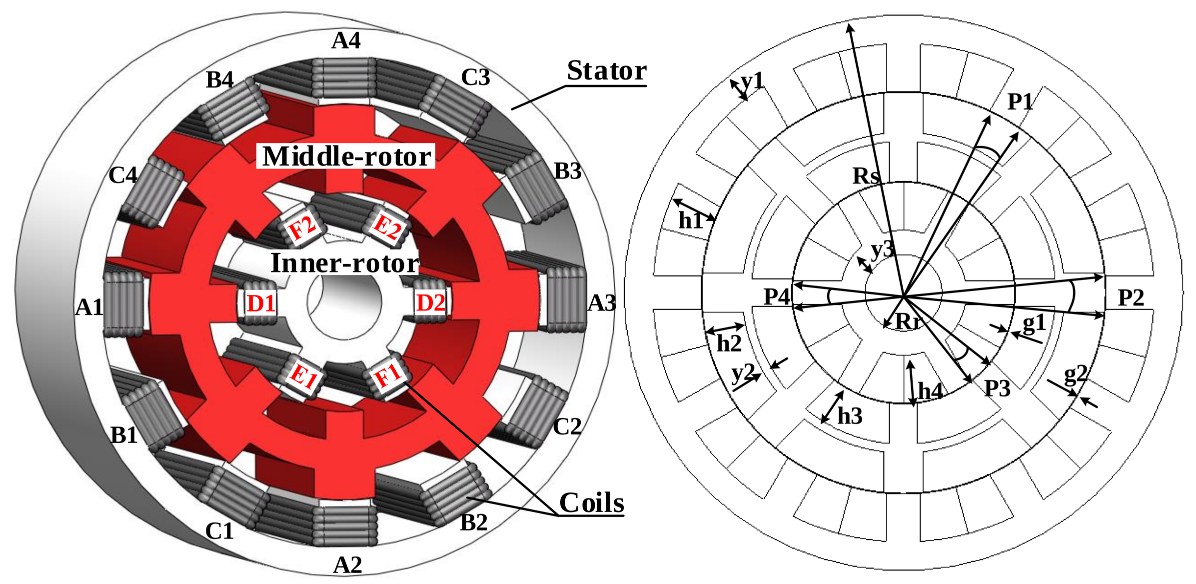

Fig. 1 Sketch structure and geometric parameters of DR-SRM.

Table I Final geometry dimensions of DR-SRM

Name	Parameters	Initial Dimensions
Outer-stator outer radius	*Rs*	145 mm
Laminated thickness	*L*	170 mm
Inner-rotor inner radius	*Rr*	20 mm
Outer airgap	g_1	0.4 mm
Outer airgap	g_2	0.4 mm
Inner-rotor pole-arc coefficient	P4	0.370
Inner-rotor yoke thickness	y3	12.6 mm
Outer-stator pole-arc coefficient	P1	0.320 mm
Outer-stator yoke thickness	y1	15 mm
Middle-rotor inner tooth pole-arc coefficient	P3	0.310
Middle-rotor outer tooth pole-arc coefficient	P2	0.290
Middle-rotor yoke thickness	y2	4.6 mm
Height of the outer-stator pole	h1	25mm
Height of the inner-rotor pole	h4	25 mm
Height of the middle-rotor inner tooth	h3	21 mm
Height of the middle-rotor outer tooth	h2	21 mm

Sensitivity Analyses (1)

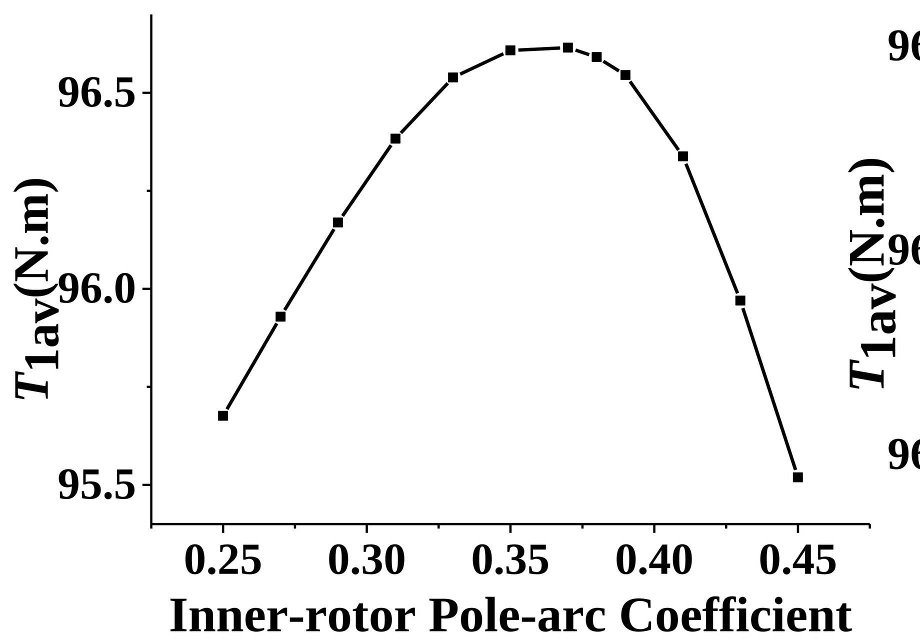

Fig. 2. Different inner-rotor pole-arc coefficient.

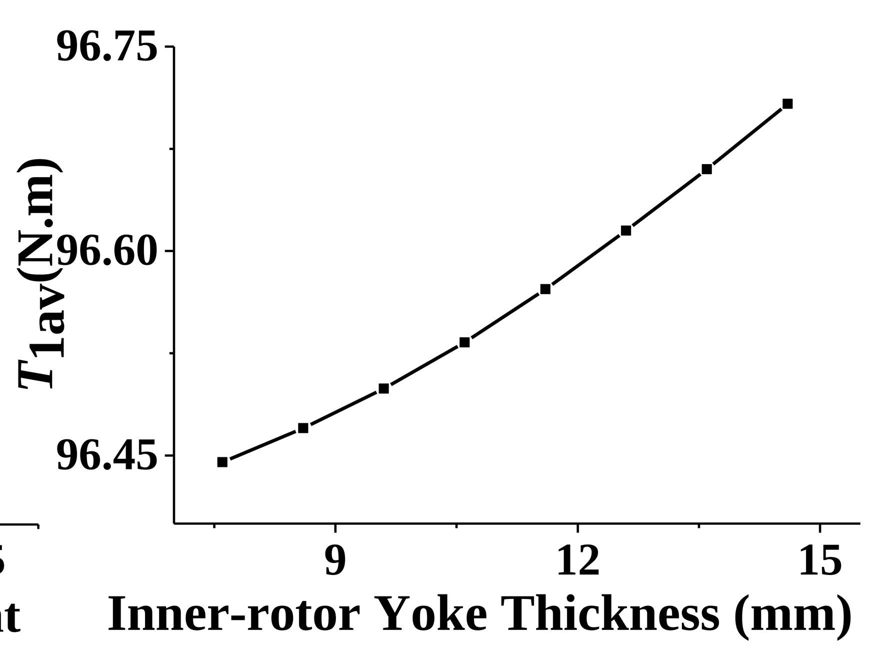

Fig. 3. Different inner-rotor yoke thickness.

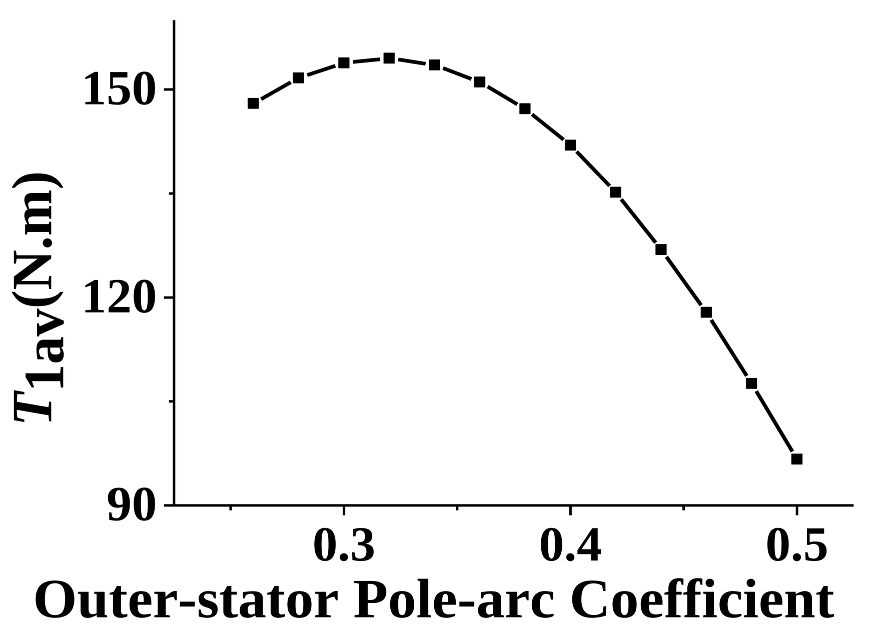

Fig. 4. Different outer-stator pole-arc coefficient.

Sensitivity Analyses (2)

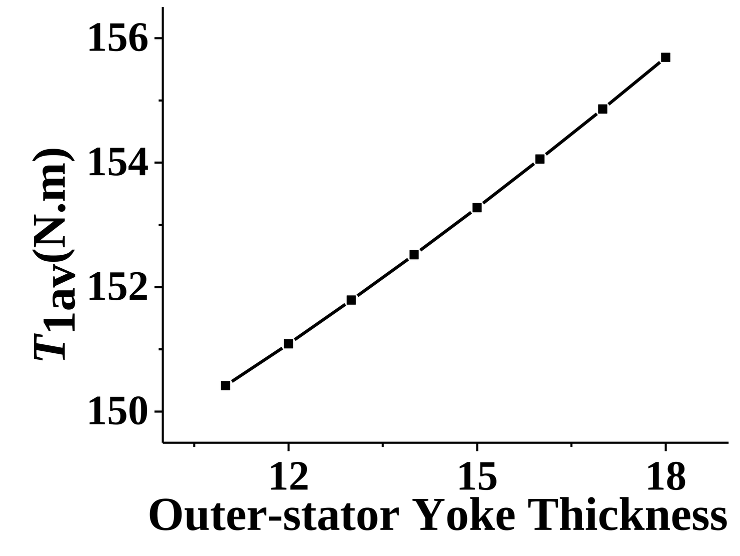

Fig. 5. Different outer-stator yoke thickness.

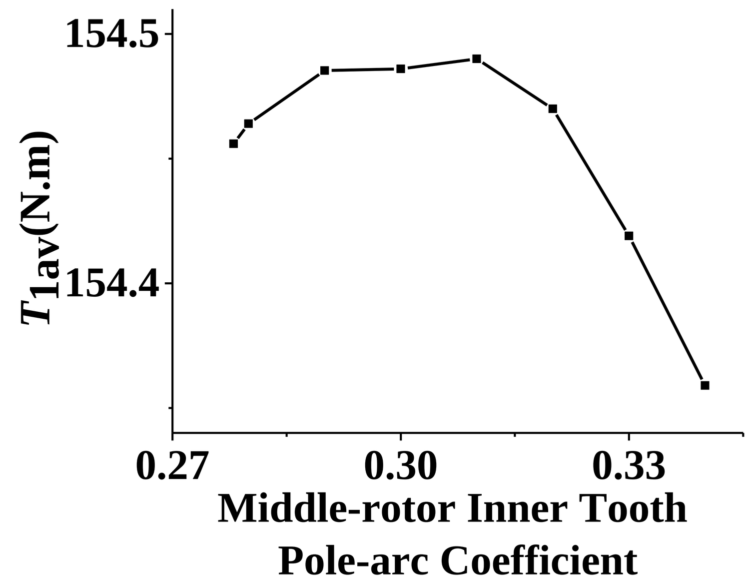

Fig. 6. Different middle-rotor inner tooth pole-arc coefficient.

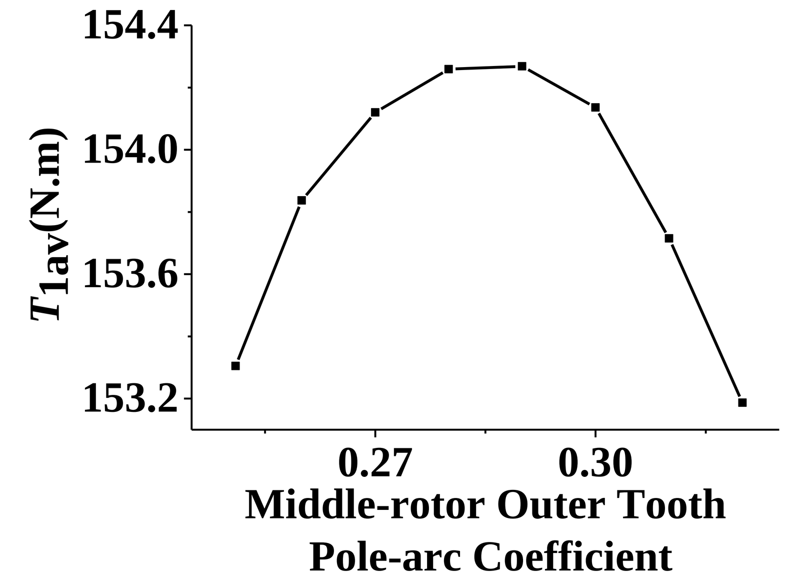

Fig. 7. Different middle-rotor outer tooth pole-arc coefficient.

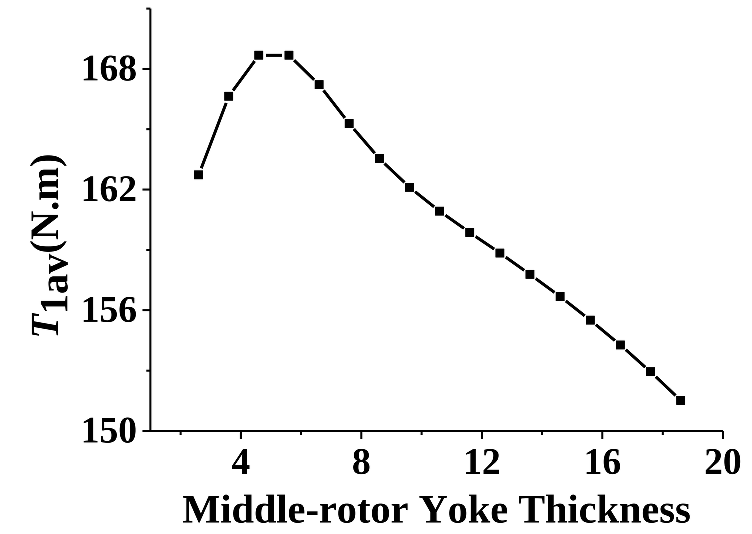

Fig. 8. Different middle-rotor yoke thickness.

Different Polarity Distribution

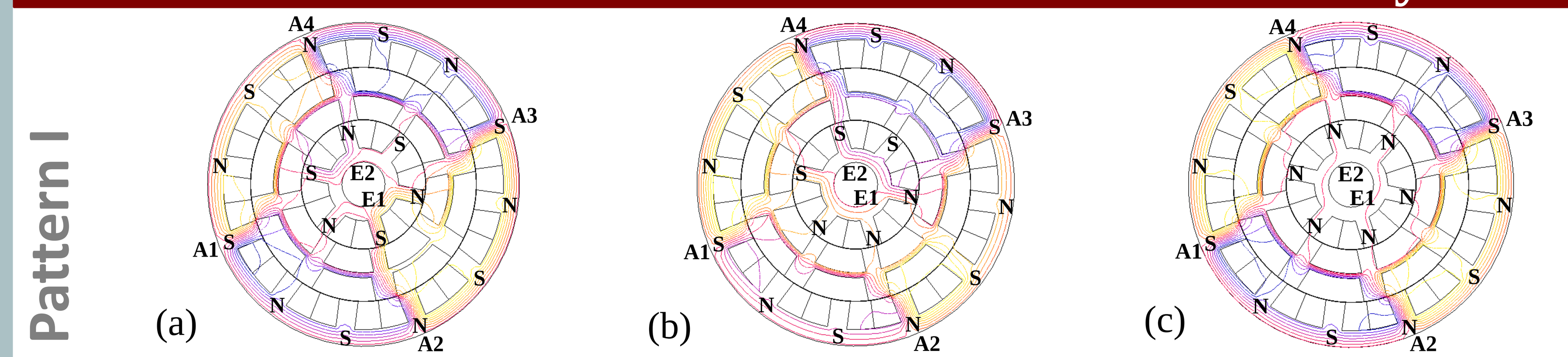

Fig. 10. Polarity distribution and magnetic-flux path distribution on outer-stator pattern I. (a)NSNSNS (B)NNNSSS (C)NNNNNN

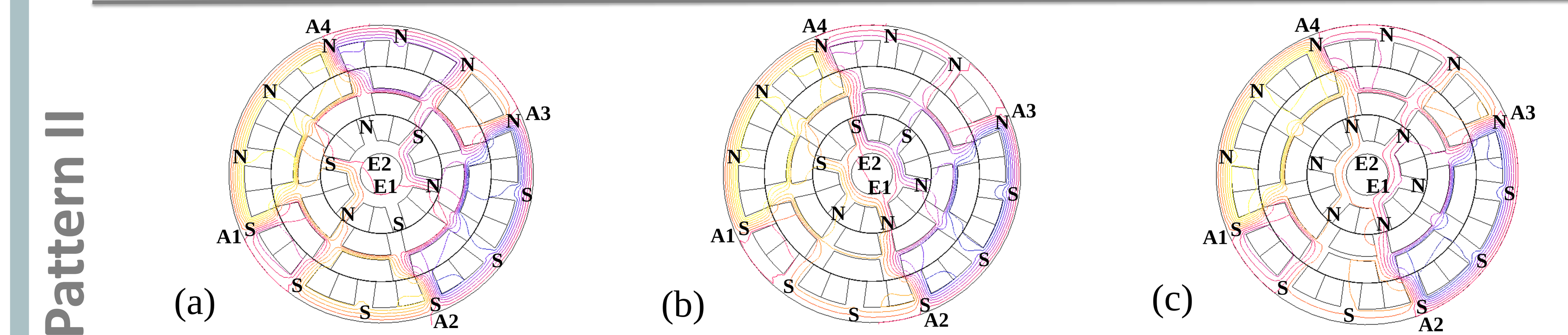

Fig. 11. Polarity distribution and magnetic-flux path distribution on outer-stator pattern II. (a)NSNSNS (B)NNNSSS (C)NNNNNN

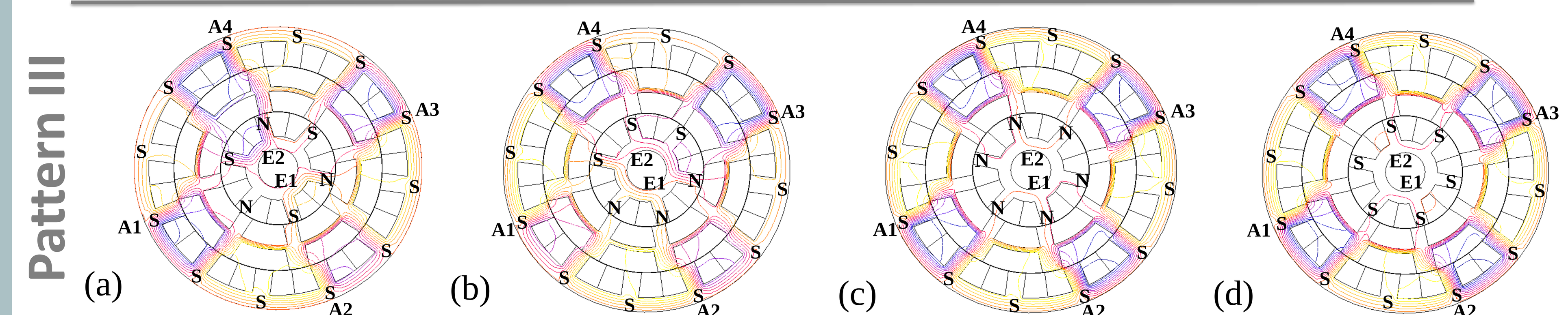

Fig. 11. Polarity distribution and magnetic-flux path distribution on outer-stator pattern III. (a)NSNSNS (B)NNNSSS (C)NNNNNN

Table II Calculated Average Torque on Outer Stator in Different Patterns

Polarity distribution of outer-stator	Polarity distribution of inner-rotor	T_{1av} (N.m)
NSNSNSNSNSNS	NSNSNS	139.389N.m
	NNNSSS	135.881N.m
	NNNNNN	129.105N.m
NNNNNNSSSSSS	NSNSNS	133.322N.m
	NNNSSS	122.014N.m
	NNNNNN	111.361N.m
SSSSSSSSSSSS	NSNSNS	53.679N.m
	NNNSSS	49.012N.m
	NNNNNN	42.121N.m
	SSSSSS	41.838N.m

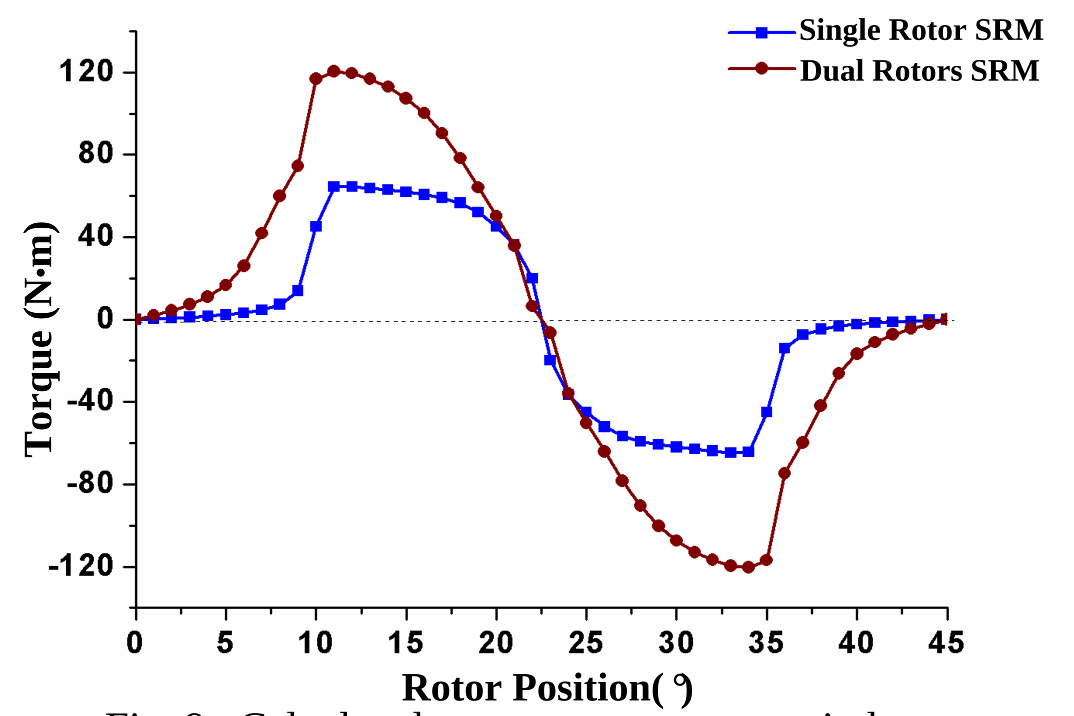

Fig. 9. Calculated torque at one rotor period.

Conclusions

In this paper, a DR-SRM with an outer-stator, a middle-rotor and an inner-rotor has been introduced. The average torque of middle rotor in the outer airgap contributing to the main parts of energy conversion with different geometry size of stator and rotors, different polarity distribution are calculated. The final geometry size, the polarity distribution are designed and optimized for enhancing the average torque of middle-rotor in the outer airgap at certain volume. The comparison results of torque on the dual rotors SRM and the conventional single rotor SRM show that the dual rotors SRM has much better electromagnetic torque performance than conventional single inner rotor SRM.