Tolerance Allocation of Barrier Shape in Switched Reluctance Motor Based on Stochastic Response Surface Methodology

Sung-Il Kim[1], Student Member IEEE, Jung-Pyo Hong[1], Senior Member IEEE,
Young-Kyoun Kim[2], and Ji-Young Lee[3]
[1]Department of Electrical Engineering, Changwon National University, Changwon, 641-773, Korea
ksi1976@dreamwiz.com, jphong@changwon.ac.kr, Fax: +82-55-263-9956
[2]Power Electronics Group, Digital Appliance Business, Samsung Electronics Co. LTD, Suwon, 443-742, Korea
[3]Transverse Flux Machine Research Group, Korea Electrotechnology Research Institute, Changwon, 641-120, Korea

Abstract— This paper proposes tolerance design of a switched reluctance motor with barriers. The shape and dimensional tolerance of the rotor barrier directly influence the motor performance such as torque ripple. Therefore, a manufacturing design guide with respect to the barrier is required, and it can be achieved by the tolerance allocation of the shape of the rotor barrier. In this paper, stochastic response surface method combined with genetic algorithm is introduced to predict more accurately the tolerance analysis and design.

I. Introduction

The dimensional tolerance of electric machines can have an effect on electric performances, and the rigorous tolerance in manufacturing process result in the increase of production cost. Therefore, the tolerance design considering dimensional allowance is required in the design stage of the motor. In fabricating the motor, the design considering the tolerance is helpful to predict the tolerance band of design variables, which is not only to improve the quality but to reduce the production cost.

The usual method for the tolerance analysis and design is Monte Carlo Simulation [1]. However, the major drawback of the method is that it requires a great number of computations to obtain statistically significant results. Accordingly, with a very large computational cost, the number of the samples will be very numerous.

In this paper, a new numerical approach to the tolerance design is introduced. The new method based on stochastic response surface methodology (SRSM) [2] is combined with genetic algorithms (GA).

II. Application Model

Fig. 1 shows the barrier type 8/6 switched reluctance motor (SRM) used in this paper. In the model, the effects on torque characteristics according to the shape and manufacturing tolerance of the barrier are investigated, and an effective manufacturing design guide as regards the barrier is proposed.

III. The Procedure of Tolerance Allocation

The schematized procedure of tolerance allocation is shown in Fig. 2. The objective function is defined as the variance of torque ripple of the barrier type SRM, and the constraint condition is to satisfy the torque performance.

IV. Numerical Results for Tolerance Allocation

Fig. 3. (a) shows the probability distributions of the torque ripple, when the allowance is controlled with the allocated tolerance. At the 10% variation of the torque ripple, the joint probability distributions between with the torque ripple and average torque is shown in Fig. 3. (b).

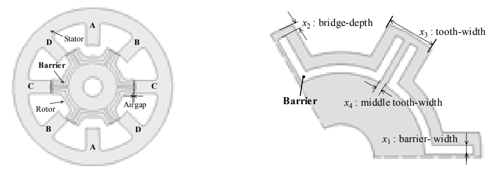


Fig. 1. Cross section and design variables of barrier type SRM

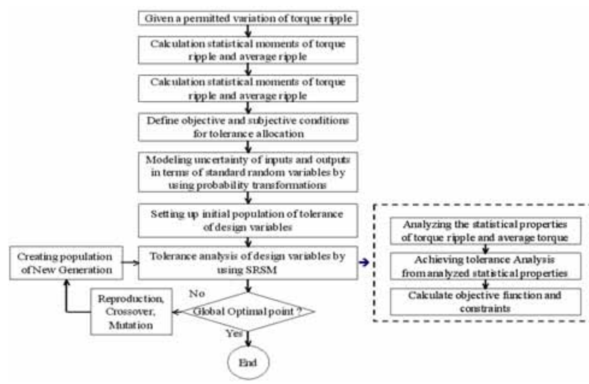
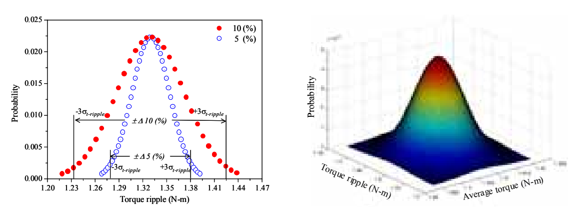


Fig. 2. Procedure of the tolerance allocation



(a) Probability distributions (b) Joint probability distributions at 10% variation of torque ripple

Fig. 3. Distribution of the torque performances

V. References

[1] Y. K. Kim, J. P. Hong, and J. Hur, "Torque characteristic analysis considering the manufacturing tolerance for electric machine by stochastic response surface method," *IEEE Trans. Ind. Applicat.*, vol. 39, no. 3, pp. 713-719, June 2003.

[2] S. S. Isukapalli, A. Roy, and P. G. Georgopoulos, "Stochastic response surface methods (SRSM's) for uncertainty propagation: Application to environmental and biological systems," *Risk Anal.*, vol. 18, no. 3, pp. 351-363, June 1998.

THE TWELFTH BIENNIAL IEEE CONFERENCE ON ELECTROMAGNETIC FIELD COMPUTATION

April 30th - May 3rd, 2006

IEEE Magnetics Society

IEEE

Jointly Sponsored by IEEE Magnetics Society, IEEE Miami Section, Florida International University

POSTER SESSION PF5
Optimization and Design VI
May 3, 2006, Wednesday
13:30 – 15:10