BQ21

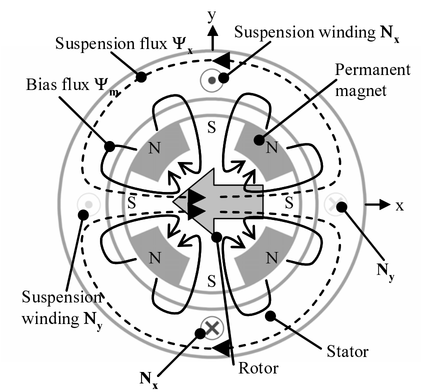
Suspension Characteristics of a Wide Gap Bearingless Motor with Cylindrical Rotor

Naoya Miyamoto[1], Takehiro Enomoto[1], Junichi Asama[1], Akira Chiba[1]*, Tadashi Fukao[1], Satoru Iwasaki[2], and Masatsugu Takemoto[3]

[1]Dept. of Electrical Engineering, Faculty of Science and Technology, Tokyo University of Science Noda, Chiba 278-8501 Japan
[2]Dept. of Electrical Engineering, Faculty of Technology, Musashi Institute of Technology, Setagaya, Tokyo, Japan
[3]Dept. of Systems Science and Informatics, Hokkaido University, Sapporo, Hokkaido, Japan

*Corresponding author: chiba@rs.noda.tus.ac.jp

A bearingless motor has been developed as a compact device with functions of rotation and suspension. The bearingless motor can generate torque and magnetic suspension force in one motor, because motor windings and suspension windings are installed in the same stator slots. Thus, motor magnetic field is used as a bias, then, it realizes downsizing and cost reduction. Generally, PM motors are recognized for high efficiency and high power factor. Consequent-pole type bearingless motors are also one of PM motors, with advantages of high force/current ratio and rotational sensorless operation.



The authors have developed a bearingless motor with wide magnetic gap of 5mm with respect to its rotor radius of 32mm. The gap length is considerably large because pump applications need thick partitions. The structure of the developed bearingless motor is basically consequent-pole motor. The principles of suspension force generation can be explained as shown in the figure. Two-pole suspension windings and eight-pole motor windings are installed in the stator slots. Basic suspension characteristics have been reported.

In this paper, an improved rotor structure has been proposed and developed. The rotor has a cylindrical rotor shaft structure. Static external force has been applied at the shaft end and suspension characteristics have been tested in the experimental setup. The measured values are compared with FEM analysis results obtained at the design stage. A unique test procedure has been proposed to evaluate suspension characteristics.

REFERENCES

[1] Chiba, A., Fukao, T., Ichikawa, O., Oshima, M., Takemoto, M. and Dorrell, D. G., Magnetic Bearings and Bearingless Drives, Newnes Elsevier 2005, Mar. 381pages ISBN 0 7506 5727 8.

BQ22

Geometry Optimization of PM Spherical Motor Using Response Surface Methodology

Zheng Li[1]* and Qunjing Wang[2]

[1]School of Electrical Engineering and Information Science, Hebei University of Science and Technology, 050018 Shijiazhuang, China
[2]School of Electrical Engineering and Automation, Hefei University of Technology, 230009 Hefei, China

*Corresponding author: Zheng LI, e-mail: lzhfgd@163.com

In recent years, the spherical motors with 3 degrees-of-freedom have attracted special interest as novel direct drive type actuators for many modern devices applications, such as robotic joints [1-4]. The PM spherical motor as one of them can provide advantageous features over traditional drive mechanisms which are usually constructed by several conventional drive motors or actuators, each having one degree of freedom and reducing the position accuracy, stiffness, dynamic performance and efficiency of the system. One major task in developing permanent magnet spherical motors is to minimize the detent torque and maximize the output torque. For the complex structure of this kind of motor, the geometry optimization procedure shows different characteristics compared with conventional motors. The RSM has been achieved to use the experimental design method in combination with the FEM results and fit for deriving analytical model with complicated problems considering multiple interactions of configuration variables. The structure of studied two kinds of spherical motors can be shown in figure 1. RSM is applied to make appropriate response models of the average static torque and the ratio of maximum detent torque with maximum torque. A quadratic approximation function of the models is used to construct the fitted response surface. Comparisons are given with the torque characteristics between the fitted response and results obtained from the computed data, which validates the effectiveness of this solution.

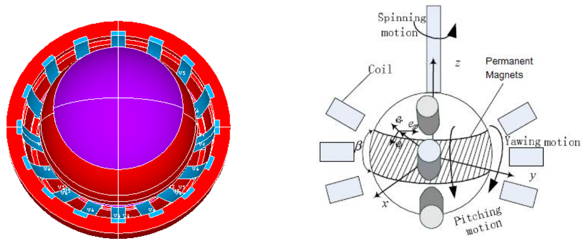


Fig. 1. Structure of two kinds of PM spherical motors.

This work is supported by National Nature Science Foundation of China under contract number 50377010 and 50677013, and Foundation of Hebei University of Science and Technology under Grant no. XL200707.

REFERENCES

[1] Qunjing Wang, Zheng Li, *et al*., IEEE Trans. MAG., 4, 42(2006) : 731-734.
[2] Gregory S Chirikjian, David Stein, IEEE Trans. MACHATRONICS, 4, 4(1999) : 342-353.
[3] Kok-Meng Lee, Hungsun Son, Proc. IEEE Trans. MAG., 10, 43(2007) : 3904-3913.
[4] Yusuf Öner, Sensors and Actuators A : Physical, 137(2007) :200-208.