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Method of Current Compensation for Reducing Error of Holding Torque of Permanent-magnet Spherical Wheel Motor

Dong-Woo Kang[1], Won-Ho Kim[1], Sung-Chul Go[1], Chang-Sung Jin[1], Sung-Hong Won[1], Dae-Hyun Koo[2], and Ju Lee[1]

[1]Department of electrical engineering, Hanyang University, Seoul, South Korea

[2]Industry applications research Lab., Korea Electrotechnology Research Institute, Chang-Won, South Korea

A permanent magnet spherical wheel motor, which consists of magnets on rotor and coils on spherical stator, is able to operate on 3-dimensional space as using magnetic alignment torque generated from between coils and magnets[1][2]. Especially the shaft can be tilted stably by optimized coil position on stator. Because, however, the spherical wheel motor has feature of 3-dimensional structure as relative position between coils and magnets, stable holding torque for rotor position should be analyzed as function of the tilt degree of a shaft. The characteristic of stable holding torque can be changed non-linearly by the alpha and beta degrees of a shaft. Therefore, when reference current is commanded at coils, the shaft cannot be tilted to the reference position exactly for the non-linear characteristic. In this paper, for improving the non-linear phenomenon of holding torque, the authors research and improve a current compensation function to increase stable operating range. Also the compensation function was estimated by using torque ripple computed from torque simulation.

Index Terms-Current compensation, Curve fitting method, Permanent magnets electric machines, Spherical wheel motor.

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Control Based Reduction of Detent Force for Permanent Magnet Linear Synchronous Motor

Yu-wu Zhu and Yun-hyun Cho*

Power Electronics Application Lab.P3203 Dong-A University, Hadan 2-Dong, Saha-gu, Busan, Korea

*Corresponding author: Yun-hyun Cho, e-mail: yhcho@dau.ac.kr

Permanent magnet linear synchronous motor (PMLSM) is the most suitable for high precision and fast dynamic control system. However, the significant drawback of PMLSM is the detent force that will deteriorate the performance of drive system. The detent force is caused by the interaction between the permanent magnet and the iron core of the mover without input current. The optimal constructive design technique can reduced the detent force effectively [1]. However, this technique is complex and cost too much, and usually more than 10 [N] detent force is remained. Furthermore, the PMLSM that is a direct linear motion drive system without any indirect coupling mechanism is sensitive to the force disturbance. Even the remained small detent force will deteriorate the PMLSM performance seriously. Therefore, this paper proposes a control based method to reduce the detent force for PMLSM. The detent force predicted by the finite element method (FEM) can be compensated by injecting an instantaneous current by using the field oriented control (FOC) method shown as Fig. 1 [2]. Fig. 2 shows the comparison of the simulated and the experimental thrust responses for PMLSM with/without current compensation. Both the simulated and the experimental results with current compensation are significantly reduced. This also validates the effectiveness of this proposed method.

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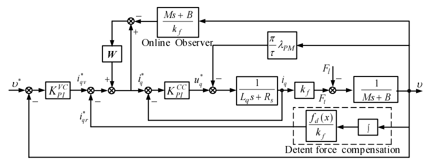

Fig. 1. FOC diagram for PMLSM.

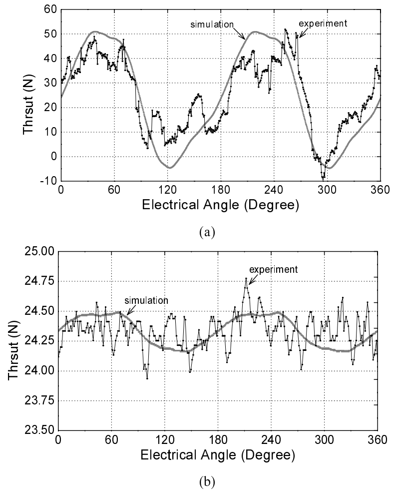

Fig. 2. Simulated and experimental thrust responses for PMLSM with/without current compensation (CC).
(a) without CC and (b) with CC.

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