Analysis and Research of Cogging-Torque Reduction Method for Permanent Magnet Motor

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ABSTRACT

Nowadays, energy shortage is a common problem in our society. Therefore, the research and development of green energy become a critical and important issue. From the view point of mechanical operation, the usage of motor is indispensable. On the other hand, the development of motor also focuses on increasing the efficiency of high power density. In this paper, the development of intelligent motor, namely Brushless permanent magnet brushless DC motor, is proposed. The important characteristics of intelligent motor are its excellent control property, small size, and high efficiency. However, there are some drawbacks associated with it. For instance, the cogging torque can affect the rotation of the motor significantly. Therefore, reducing cogging torque is a vital research issue. This work develops a technique for reducing the cogging torque of a surface-mounted permanent-magnet motor. The method selects appropriate magnet shape parameters, including pole embrace and eccentricity of the outer surface of the magnet that is installed on the rotor of the motor. First, an equivalent magnetic-circuit analysis was performed to develop a six-slot four-pole PM brushless motor design. Then, Fourier series and finite element analyses were carried out to determine the cogging torque, magnetic field, and back-EMF. Based on the results, contours of the cogging torque are plotted for various geometric parameters of the magnet. According to our theoretical analysis, a motor prototype is proposed and developed for measuring the important characteristics of motor. Through our simulation experiments, the performance of the proposed prototype exhibits a highly agreement with the real motor, in terms of its effectiveness and accuracy.

Keywords : Permanent magnet brushless motors, Cogging torque, Pole embrace, Pole arc offset, Equivalent magnetic circuit analysis, Finite element analysis, Back-EMF.

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