# ABSTRACT

## Optimal Flux Barrier Design
## of Interior Permanent Magnet Motor
## for Torque Ripple Reduction under Stress Constraint

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Interior Permanent Magnet(IPM) motor has widely used in industry because of high efficiency and power density. However, high torque ripple caused by the difference of magnetic resistance between d- and q-axis has influence on vibration and noise. The two main approaches to reduce torque ripple are based on the control of current waveform and the configuration change of stator and/or rotor. Regarding on the rotor design, the flux barrier serves as controlling the flux path and plays an important role for torque ripple reduction. In the design of flux barrier, the variation of bridge thickness effects on both the magnetic and mechanical performance. The mechanical stress analysis is generally separated from the magnetic field analysis and it is performed to check the strength of bridge after flux barrier design. Even if they considered

mechanical stress analysis simultaneously, they used the parametric model.

In this paper, the level set based topology optimization is adopted to represent the flux barrier. The objective function is to minimizing the difference between tangential magnetic force wave and target wave which eliminated the amplified harmonics meanwhile maximizing the offset value of tangential magnetic force for insurance of average torque. One of the constraints is the volume which is the amount of ferromagnetic material of the design domain and the other constraint is the stress which is expressed by *p*-norm measure to ensure the structural strength. The optimization problem is solved by the augmented Lagrange multiplier method.

The proposed method is applied to the flux barrier design of V-type and I-type IPM motor. Incorporating with the stress constraint, the ferromagnetic material tends to be distributed to the bridge to lower the maximum stress and it attempts to tradeoff between the magnetic and the mechanical performance. The distance between the bridge and the magnet becomes larger to get the sinusoidal flux density distribution in the air gap. It is confirmed that the proposed method can provide the flexible tool to design the optimal flux barrier of IPM motor satisfying both the magnetic and mechanical performance.