

Optimization design of the electromagnetic torque for surface-mounted PMSM using GA and finite element analysis for electric vehicle

Abstract

This paper presents an optimization design for a three-phase 12 m/s /8 m/p surface-mounted permanent magnet synchronous machine (SMPMSM) with a RM pattern applied in the electric vehicle by using the computing framework of finite element analysis (FEA) and genetic algorithm (GA). The framework is to determine the optimal settings of permanent magnet (PM) motor for higher average electromagnetic torque ($T_{\text{em}\{-}\text{avg}}$) and lower its ripple ($T_{\text{em}\{-}\text{rip}}$). Several motor performances are investigated for the initial and the optimal designs of PM machines during open-circuit and on-load conditions, i.e., magnetic field distribution across the motor, magnetic flux density distribution in the mid air gap, phase back-EMF, electromagnetic torque, and its ripple through FEA. The magnet pole-arc and slot opening angle of the PM motor are taken into consideration. The $T_{\text{em}\{-}\text{avg}}$ and the $T_{\text{em}\{-}\text{rip}}$ are employed to formulate the computing equations to determine the objective function, which is used to search the optimal settings of PM motor in GA framework, where the fitness value produced by the computing framework is further evaluated. The comparison of parameters and motor performances between the initial and the optimal designs of 12s/8p PM motors with the GA framework are validated in terms of electromagnetic torque under BLAC operation using FEA. Therefore, the framework of FEA and GA is verified in reducing the usage of magnet materials and the electromagnetic torque ripple in the design of SMPMSM, which is highly viable for electric vehicle.

Keywords:

Electric vehicle, Electromagnetic torque, Genetic algorithm, Surface-mounted, Permanent magnet synchronous machine