2024 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)
July 15-19, 2024. Boston, MA, USA

Multi-objective Optimization of the PMSM with the Same Number of Poles and Slots Considering Dynamic Response and Torque Performance

Jiutong Yang, Jinhua Chen*, *Member, IEEE*, Wei Liu,
Shuheng Qiu, Guilin Yang, *Member, IEEE* and Chi Zhang, *Senior Member, IEEE*

***Abstract*— For several applications such as robotic joints, it is necessary to simultaneously optimize the torque density, torque ripple, and dynamic response capability of permanent magnet synchronous machines (PMSMs). However, the method for evaluating the dynamic response capability based on the structural parameters of the machine and its co-optimization with the torque performance is not clear. Therefore, this paper takes the PMSM with the same number of poles and slots as the research object and optimize these three objectives simultaneously. Firstly, a generalized electromagnetic performance prediction model for this type of machine with different topologies is proposed based on the improved subdomain model. Additionally, the evaluation model of the dynamic response capability of the PMSM is established by the mechanical and voltage equations. Based on the proposed model, the sensitivity of each parameter to the torque density, torque ripple, and dynamic response capability of the machine is analyzed, and the NSGA-II algorithm is used to optimize these three objectives simultaneously. Finally, the performance of the selected case is verified based on finite elements analysis (FEA), which is improved in all three objectives.**

This paper was supported in part by the Zhejiang Province Leading Goose Project under Grant 2023C01179, in part by the National Natural Science Foundation of China under Grant 92048201, U1913214, U21A20121, and U20A20282, in part by Ningbo Natural Science Foundation under Grant 2022J314. (Corresponding author: Jinhua Chen)

Jiutong Yang, Jinhua Chen, Wei Liu, Shuheng Qiu, Guilin Yang and Chi Zhang are with the Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, Ningbo 315201, China, and are also with the University of Chinese Academy of Sciences, Beijing 100049, China.(e-mail: yangjiutong@nimte.ac.cn, chenjinhua@nimte.ac.cn, lwei@nimte.ac.cn, qiushuheng@nimte.ac.cn, glyang@nimte.ac.cn and zhangchi@nimte.ac.cn)