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Evaluation of Outer Rotor Embedded PMSM using Segmented Stator

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Introduction: To enhance the motor's efficiency, experts prioritize the optimization of the Permanent Magnet Synchronous Motor (PMSM) construction by introducing the consequent-pole (CP) PM rotor which decrease the reliance on PM rotors and decreases the costs by reducing the volume of PM by 30% [1]. Additionally, the external orientation of rotor may have a high torque density, it requires a significant amount of rare-earth PM material. A PM motor with a segmented stator design has the potential to reduce costs, increase flexibility, and minimize windings. Furthermore, the incorporation of a segmented stator can enhance the motor's output torque, elevate both the mean and peak torque, and reduce the cogging torque

Approach: To improve torque characteristics, this study proposes an upgrade over the standard salient pole stator in the PMSM using a segmented stator. The rotor is externally oriented and has a PM incorporated in it. A comparison is made between the simulation findings which found that the proposed design results a higher performance in terms of torque and PM demagnetization.

Results and Discussion: Results shows that the proposed design has a 79.97% increase in average torque, a 90.89% increase in maximum torque, and a 3.02% decrease in cogging torque. The magnetic density of the proposed design is not saturated compared to the conventional design.

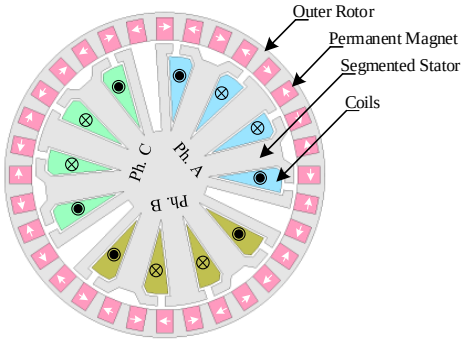


Fig. 1: Structure of the proposed segmented stator.

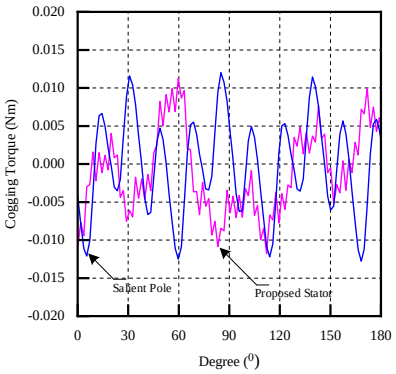
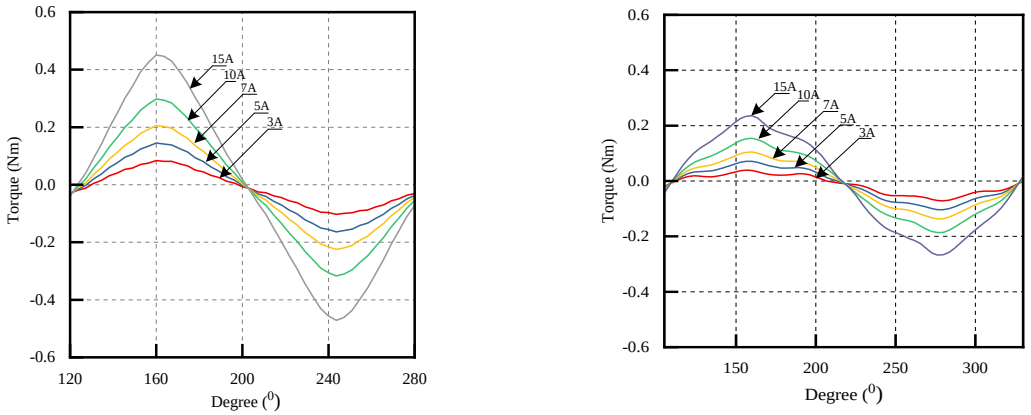


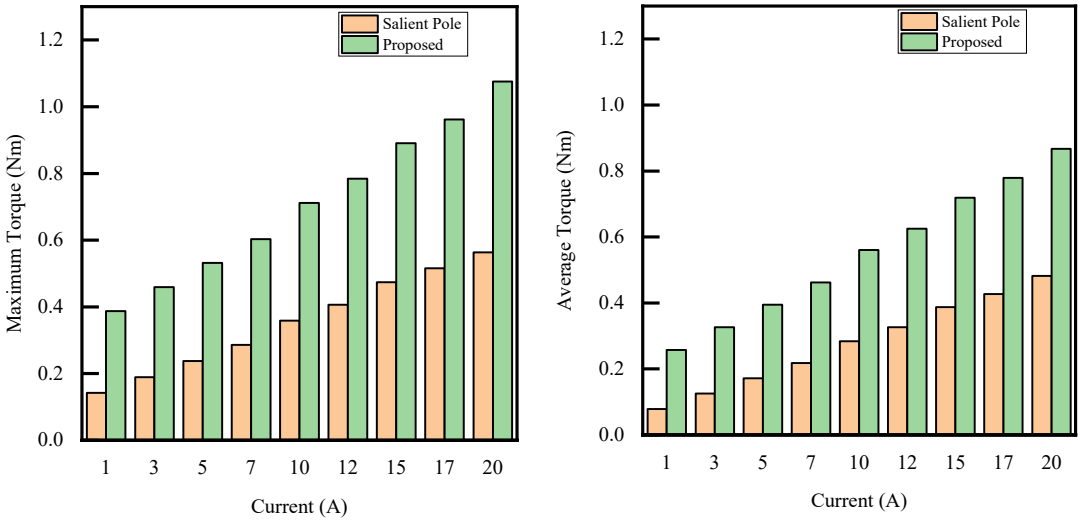
Fig. 2: Cogging Torque profiles of the salient pole stator and proposed segmented stator.

[1] S. U. Chung, S. H. Moon, D. J. Kim, and J. M. Kim, "Development of a 20-pole-24-slot SPMSM with consequent pole rotor for in-wheel direct drive," *IEEE Transactions on Industrial Electronics*, vol. 63, no. 1, pp. 302–309, Jan. 2016, doi: 10.1109/TIE.2015.2472375
[2] Z. Q. Zhu, Z. P. Xia, Y. F. Shi, D. Howe, A. Pride, and X. J. Chen, "Performance of Halbach Magnetized Brushless AC Motors," *IEEE Trans Magn*, vol. 39, no. 5 II, pp. 2992–2994, 2003, doi: 10.1109/TMAG.2003.816717.



(a) (b)

Fig. 3: Static torque profile under different excitations current of 3A, 5A, 7A, 10A and 15A for (a). proposed segmented stator (b) salient pole stator.



(a) (b)

Fig. 4: Comparison of (a) Maximum Torque (b) Average Torque

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