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Design Optimal Analysis of Brushless Direct Current Motor by Fuzzy Logic

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INTRODUCTION & AIM

Brushless Direct Current (BLDC) motors are essential in various applications due to their high efficiency, compact design, and reliability which can be challenging using traditional methods.

Fuzzy Logic provides an innovative solution by handling uncertainties and complex relationships in the design process. This intelligent system mimics human decision-making, offering flexibility in optimizing motor parameters without relying on rigid mathematical models.

This study leverages Fuzzy Logic to achieve an optimal design of BLDC motors, focusing on enhancing performance, efficiency, and reliability. The approach highlights the potential of integrating computational intelligence to address challenges in modern motor design.

FUZZY LOGIC

Fuzzy rules form the core of the system. Rules are expressed in the form:

IF Torque(T) is High AND Efficiency (η) is Low, current is High.

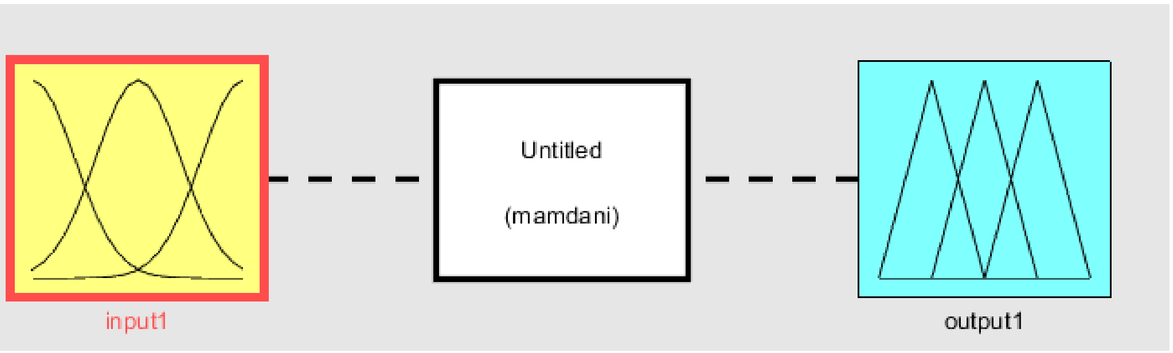
Using the fuzzy inference method the degree of membership (μ) for each rule is determined using a fuzzy operation, such as:

AND Operation (Minimum):

$$\mu_{AND} = \min(\mu_T, \mu_\eta)$$

OR Operation (Maximum):

$$\mu_{OR} = \min(\mu_T, \mu_\eta)$$



ACKNOWLEDGEMENT

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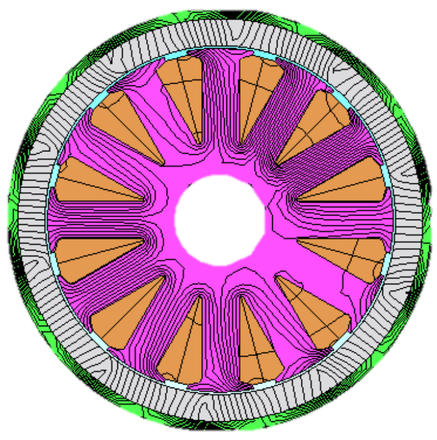
RESULTS & DISCUSSION

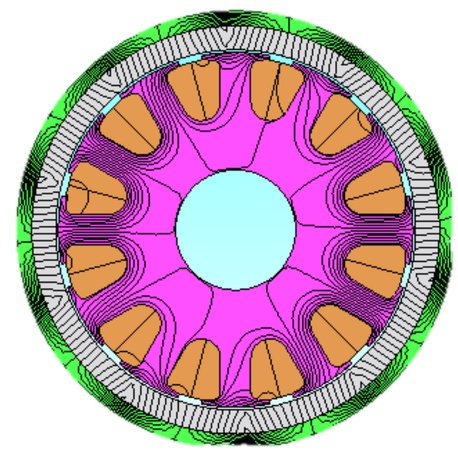
The system defines rules to capture the trade-offs between torque, efficiency.

- IF T is Medium AND η is High, THEN redesign rotor geometry.
- IF T is Low AND η is Low, THEN redesign both stator and rotor.

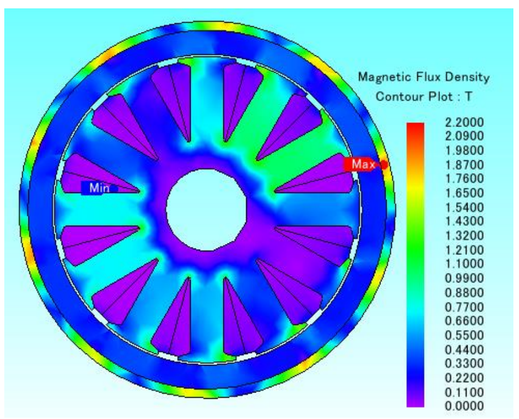
FEM Analysis of Fuzzy Logic for Proposed Improvement Motor Design



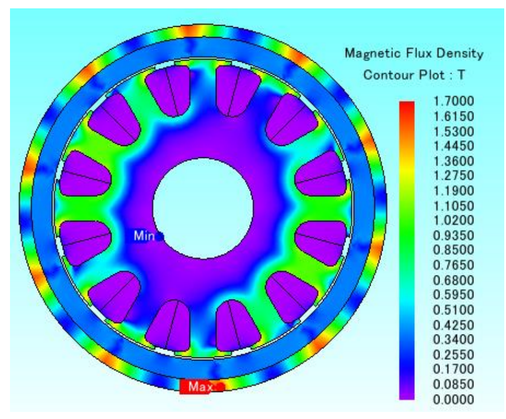
(a) High Efficiency of Proposed Motor



(b) High Torque of Proposed Motor



(a) Magnetic Flux Density of high efficiency



(b) Magnetic Flux Density of high torque

CONCLUSION

The design investigation was conducted using JMAG software, which facilitated the optimization analysis through the Finite Element Method. The proposed model demonstrated significant improvements over the reference model, achieving a 15% higher efficiency, an 8 W increase in output power, and a maximum torque improvement of 0.032 Nm.

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