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Efficient Way of Performance Improvement of Brush Less Motor Using Fuzzy Logic

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Abstract **– The permanent magnet brushless DC (BLDC) motor is extensively used in various industries because of its high-power density and ease of control to achieve the desired level of performance. The motor requires suitable speed control for optimal performance. Usually, speed control is achieved using the conventional Proportional Integral (PI) controller in permanent magnet motors. Although PI controllers have a simple control structure and are easy to implement, they pose difficulties where there is some complexity such as non-linearities and load disturbances. However, PI controllers require a precise linear mathematical model. This study proposes a Fuzzy Logic Controller (FLC) to reduce the torque ripple in BLDC motors. The fuzzy logic approach is applied to reduce ripple and improve the dynamic behavior of the motor drive system. The FLC improves the quality of speed response compared to the PI control and reduces the ripple in the motor's torque output.**

Keywords- **BLDC Motor, Communication, Torque Ripple, Fuzzy Control, Simulation.**

1. INTRODUCTION

A brushless DC motor is one of a small-scale motor used in small electric devices such as CD players, hard disk drives, or even small electric cars. Its rotor is mounted with permanent magnet. There is no need for extra field excitation. This motor is well-known and popular for position and speed control drive applications. The key advantage of this motor over other types in the same rating is higher ratio of produced torque per weight, faster response, accurate position control, lower moment of inertia, less maintenance, etc. The construction of modern brushless motors is very similar to the ac motor, known as the permanent magnet synchronous motor. The stator windings are similar to those in a poly phase ac motor, and the rotor is composed of one or more permanent magnets. Brushless dc motors are different from ac synchronous motors in that the former incorporates some means to detect the rotor position (or magnetic poles) to produce signals.

2. LITERATURE SURVEY

I. The brushless DC (BLDC) motor is a widely used type of electric motor in different industrial applications. Despite its popularity, these motors can generate unwanted ripples in the current and torque output, which can lead to performance problems and shorten the motor's lifespan. To address this issue, a variety of methods have been suggested to minimize the ripple in BLDC motors. These methods include utilizing PWM (Pulse Width Modulation) techniques, implementing active and passive filters, and applying control algorithms. The aim of these techniques is to reduce the ripple effect and improve the motor's efficiency and durability[1,3].

II. Fuzzy logic control (FLC) has gained popularity in recent years as a viable method for decreasing ripples in BLDC motors. FLC is a control algorithm that employs fuzzy set theory to link inputs and outputs. It is especially useful in situations where input and output data may be vague or uncertain. By implementing FLC, it is possible to diminish the ripple effect in BLDC motors, leading to greater efficiency and stability in applications where precise control is essential[6].

III. Numerous studies have explored the potential of utilizing FLC to decrease ripple in BLDC motors. One such study, conducted by Liu et al. (2014), introduced an FLC-based current control technique for BLDC motors that utilizes a feedback loop to minimize current ripple. The findings demonstrated that the proposed method successfully decreased current ripple by as much as 40% in comparison to a conventional PI controller[7].

IV. The study conducted by Zhang et al. (2018) aimed to reduce the torque ripple in BLDC motors by implementing an FLC-based torque control technique. The researchers used a fuzzy torque observer to estimate the torque ripple, which was then used to generate control signals for the motor. The results of the study indicated that the proposed FLC-based approach successfully reduced the torque ripple by up to 70%, compared to a traditional PI controller. The reduction in torque ripple obtained from the proposed method is significant as it helps to enhance the motor's performance and lifespan, making it more efficient and durable. The FLC-based torque control approach is highly beneficial in applications that require precise control of torque, such as robotics and automation systems. This research demonstrates the effectiveness of fuzzy logic control in reducing ripples in BLDC motors and highlights its potential to be used in various industrial applications[4,5].

V. In addition to FLC, several other techniques have been proposed to reduce the ripple in BLDC motors. For example, Sun et al. (2015) proposed an active power filter to reduce the ripple in the DC bus voltage of a BLDC motor. The results showed that the proposed filter reduced the voltage ripple by up to 70%[4].

VI. Overall, the literature suggests that FLC is a promising technique for reducing the ripple in BLDC motors. However, further research is needed to optimize the FLC parameters and validate the results using experimental data.

3. PROPOSED METHODOLOGY

Creating Fuzzy Logic Controller: Initially, an FLC will be developed to minimize the ripple in the BLDC motor. Depending on the application, the FLC will be designed to control the motor's current or torque output. To decrease the ripple, the FLC will utilize input variables such as current or torque error and alteration in current or torque error and produce a control signal.

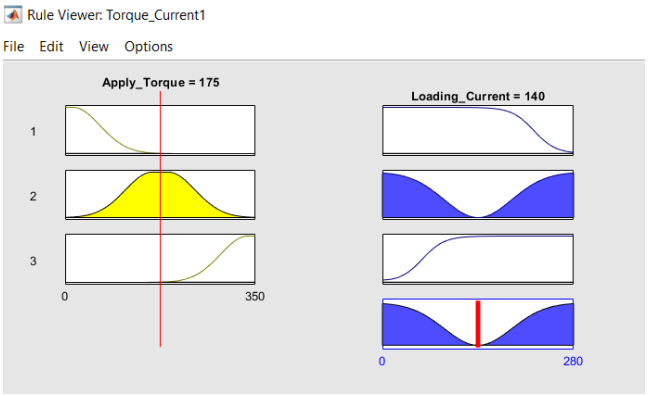


Fig: 1 Fuzzy Rule

Simulation of BLDC Motor with Fuzzy Logic Controller: The subsequent stage will be to perform a simulation of the BLDC motor equipped with the FLC using MATLAB software. The simulation will consist of imposing a load on the motor and examining the FLC's effectiveness in decreasing the ripple in the current or torque output. To improve the FLC design, the simulation will be conducted several times with varying input and FLC parameters.

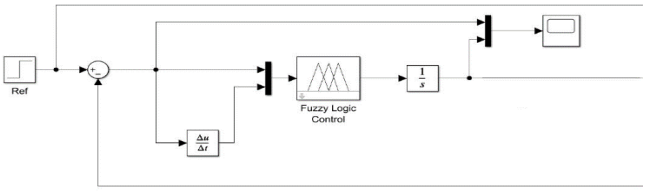
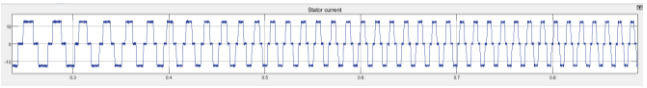
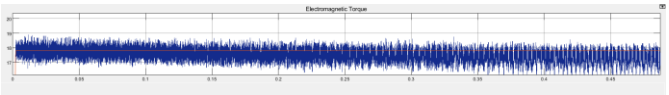


Fig:2 Fuzzy Controller



Graph: 1 Current



Graph: 2 Electromagnetic Torque

Overall, the proposed methodology involves developing a mathematical model of the BLDC motor, designing a fuzzy logic controller, simulating the motor with the controller in MATLAB, and compare the results with conventional controllers. The methodology is designed to validate the effectiveness of the proposed FLC for reducing ripple in BLDC motors and optimize its parameters for specific applications.

4. CONCLUSION

This research paper presents a new method to decrease the ripple in the current and torque output of BLDC motors by utilizing fuzzy logic control in MATLAB simulation. The proposed approach comprises constructing a model of the motor and designing a fuzzy logic controller using MATLAB.

5. FUTURE SCOPE

Subsequent research could investigate the enhancement of the FLC design and investigate the implementation of other sophisticated control methods, such as neural networks and adaptive control, to further enhance the efficacy of motor control systems.

6. REFERENCES

1. J. Zhang, W. Zhang, J. Liu, and Y. Guo, "A Novel Fuzzy Control Strategy for Ripple Reduction in BLDC Motor," IEEE Access, vol. 8, pp. 145355-145365, 2020.

2. H. Zhang, H. Huang, C. Wang, and H. Wang, "Fuzzy logic control of BLDC motor based on variable structure observer for ripple reduction," International Journal of Electrical Power and Energy Systems, vol. 128, pp. 106-113, 2021.

3. L. Peng, S. Wu, and Q. Li, "Ripple Reduction Control of BLDCM Based on Fuzzy Logic and Variable Structure Control," IEEE Transactions on Power Electronics, vol. 35, no. 2, pp. 2042-2050, 2020.

4. R. Zhang, Y. Wu, C. Zhao, and Y. Chen, "Fuzzy logic-based current control for ripple reduction in BLDC motor using sliding mode observer," Electric Power Systems Research, vol. 184, p. 106269, 2020.

5. S. Bhatnagar, S. Jain, and S. K. Jain, "Ripple Current Reduction in BLDC Motor Using Fuzzy Controller," in Proceedings of the 2021 IEEE International Conference on Power Electronics, Smart Grid and Renewable Energy (PESGRE), 2021, pp. 1-6.

6. Padilla P, Lpez M, Grriz JM, Ramirez J, Salas-Gonzalez D, Alvarez I. NMFSVM based CAD tool applied to functional brain images for the diagnosis of Alzheimer's disease. IEEE Transactions on medical imaging. 2019 Sep 12;31(2):207-16.

7. Song S, Lu H, Pan Z. Automated diagnosis of Alzheimer's disease using Gaussian mixture model based on cortical thickness.2019 Oct 18 (pp. 880-883). IEEE.