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SPEED CONTROL AND TORQUE RIPPLE MINIMIZATION OF SWITCHED RELUCTANCE MOTOR USING GREY WOLF OPTIMIZED ANFIS CONTROLLER

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Abstract:

The speed and current management strategy for reducing the SRM torque ripple is proposed in this work. The stringent SRM behaviour has been investigated in relation to torque, speed, and current. The motor's speed has been reduced and the torque ripples have been controlled, depending on certain factors. Eventually, a control signal was created to regulate the speed of the SRM. In order to lessen the torque ripples, we have therefore projected an increased speed and controlled the current using the PWM model. To regulate the SRM speed, the current optimization model that is based on torque and the present control technique has been projected. Moreover, the SRM torque and speed have been examined using a controller that is reliant on the Grey-Wolf Optimization (GWO) algorithm. In the end, the proposed approach has been used in the Simulink/MATLAB area. The performance analysis of the proposed model has been compared and illustrated with existing strategies such as ANFIS & ANN algorithm techniques.

Keywords —: SRM, Torque Ripple, Grey Wolf Optimization, ANFIS, PWM mode

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I. INTRODUCTION

As seen by the ongoing demand for fuel, automobiles are now considered essential components of daily life for both personal transportation and the movement of commodities. In tandem with this desire, concerns have been voiced about escalating fuel costs and environmental issues related to air pollution and climate change. Automakers have been under pressure from multiple governments to provide low-emission and ecologically responsible transportation options as a result.

According to, the true conditions in the SRMDs were the basic architecture, inexpensive gathering and steadfast ability quality, maximum flexibility level among phases, low dormancy as well as short turn end with the ability to work in environments like coal-mining by an extensive speed. Overall, the double post-machine SRMD runs on varied standard hesitance were impressive, as evidenced by the contribution in.

Rotor preference is to reach the region where flux and inductance supplied by empowered winding have been an effort as in contribution, serving as a source indicates for torque generation. Furthermore, a winding capacity rotor and current have been their inductance phase in the SRMD. The control structure requires information about the rotor location across optimal phase excitation.

Additionally, this book addresses the major shortcomings of SRM with their maximum torque ripples. The goal of this book is to control the firing angles of the converter in order to increase the torque ripples (TR) of SRM. SRM has proven extremely non-linear and complex when it comes to applying mathematical equations to directly relate its performance and other characteristics.As a result, autonomous methods have typically been chosen for motor control. In order to obtain an approximation function that links the TR of SRM and their firing angles of converter, turn-off, and turn-on, this manuscript uses the Request Surface Model (RSM). Furthermore, RSM has been a suitable model for SRM since it uses system data to generate a polynomial equation that links the system's reaction and aspects. Moreover, there hasn't been a need for system mathematical approaches to apply this model as successfully as in. Additionally, the equation has been refined through the use of the GWO algorithm to determine the best firing angles for the combination of SRM converters, which helps to obtain the lowest possible number of motor TRs.

II. EXISTING SYSTEM

GWO has drawn interest from the global research community in recent years. This section contains similar reviews that we have previously completed on GWO, arranged chronologically by review year. The details of GWO, their variants, and their applications were documented by Faris et al. in their paper titled "Grey Wolf Optimizer: a review of recent variants and applications". A number of GWO-based research publications were summarized and reviewed. There was a thorough discussion of the theoretical underpinnings, operations, and GWO framework. A study on the trend, guiding principles, and application of GWO was conducted by Hatta et al. between 2014 and 2017. The writers looked at a number of articles that have something to do with GWO. Their investigation looked at the various uses of GWO.

Panda and Das provided a succinct overview of GWO and its uses. The GWO algorithm, its mathematical model, and pseudocode were all given in the paper. In their work, twelve other GWO applications were also covered. The existing variations of GWO, however, were not covered by the writers. Nevertheless, the coverage's duration was not stated. A review of GWO for feature selection techniques for classification problems was conducted by Al-Tashi et al. The general structure of feature selection was covered in the study.

The writers took their time going over the various GWO-based feature selection methods and how they are used in various domains. Nevertheless, the review is restricted to feature selection using GWO. Furthermore, the study did not go into great detail about the GWO varieties. Furthermore, the information that was provided was merely an overview of the application areas. The development of GWO algorithms and their application to problem solving across a range of human endeavors were examined by Negi et al.

III. PROPOSED SYSTEM

GREY WOLF OPTIMISATION (GWO) ALGORITHM

This section describes the GWO algorithm. GWO imitates the social hierarchy and the clever hunting displayed by a swarm of grey wolves. Naturally, grey wolves live in a group of between 5 to 12 individuals. Grey wolves sternly live in a social hierarchy. As depicted in Figure 1, the leaders of a group of grey wolves known as “alpha” are male and female wolves that are in charge of decision making on behalf of other wolves in the group. These choices include where to sleep, when to get up, and when to go hunting. In general, alpha's judgment is binding on the other wolves in the group. However, there are instances where some unethical behavior inside the grey wolf social order is observed. Alpha is able to obey other wolves in the group under certain situations. During meetings, other wolves show their support for Alpha's choice by lowering their tails. It is important to remember that alpha does not always have to be the strongest wolf in the pack. Alpha is mostly in charge of managing the group.

The self-control and organization of a group of grey wolves are their most valuable traits. When it comes to helping alpha make decisions, beta is the next echelon down the grey wolf social structure, following alpha. Any of the wolves, whether male and female, can be the beta, and the best candidate to take Alpha's position at any point in the future when either Alpha passes away or becomes too old to continue running the pack. Alpha expects respect and obedience from beta, but beta also has authority over other wolves in their hierarchy. Alpha looks on beta for guidance, and beta is responsible for disciplining any member of the group who transgresses. The beta highlights Alpha's instructions.

Fig 1: Distribution of Grey Wolves Social Hierarchy and their responsibilities

One of the most interesting communal behaviors of grey wolves is collective hunting, which occurs in addition to their social hierarchy. When hunting, grey wolves follow the procedures shown in Figure 2:

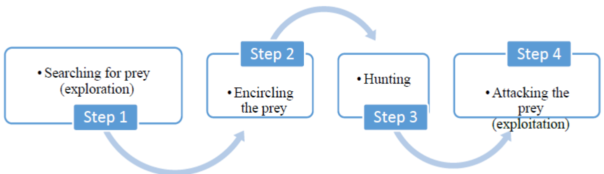

Fig 2 ***Grey Wolf Hunting process***

Mathematical Model of Wolf Pack Hunting

The mathematical model of the GWO algorithm was developed on the basis of the observation of hunting techniques used by wolfs. Wolves can hunt alone, in pairs or in packs. In case of hunting in pack, the group of wolves uses various tactics to confuse their victim.

In the numerical implementation of the wolves pack behavior, the discrete positions of all individuals are determined in successive time step (iterations). The vector of position for the i-th wolf in the k-th time step is determined in the algorithm according to formulae: The algorithm uses the following formulas to determine the vector of position for the i-th wolf in the k-th time step:

$$X_k^i = X_{k-1}^p - A_k\left|C_k X_{k-1}^p - X_{k-1}^i\right| \qquad (1)$$

where X p k–1 is the prey's position (optimal point), and Ak and Ck are the GWO algorithm's coefficients. Here's how the values Ak and Ck are computed:

$$A_k = 2a_k r_1, C_k = 2r_2 \qquad (2)$$

The capacity of wolves to migrate in the area of the optimization problem is determined by the coefficient ak, where r1 and r2 are random values from the range (0, 1). As iterations proceed, coefficient ak decreases. Based on how wolves hunt, it is thought that the best individuals (α, β, and δ) in the pack are where the ideal point is. Consequently, the following formula1 is applied to get the vector of position for every i-th individual in the k-th time step:

$$X_k^i = \frac{X_1+X_2+X_3}{3} \qquad (3)$$

Where,

$$X_1 = X_{k-1}^{\alpha} - A_k^{\alpha}\left|C_1 X_{k-1}^{\alpha} - X_{k-1}^i\right|$$
$$X_2 = X_{k-1}^{\beta} - A_k^{\beta}\left|C_2 X_{k-1}^{\beta} - X_{k-1}^i\right|$$
$$X_3 = X_{k-1}^{\delta} - A_k^{\delta}\left|C_3 X_{k-1}^{\delta} - X_{k-1}^i\right| \qquad (4)$$

where the vectors representing the positions of the individuals α, β, and δ gamma in the preceding time step are: X α k–1, X β k–1, and X δ k–1.

III. RESULT

The overall torque profile of the three-phase SRM for a certain time period is shown in Fig.3. The SRM under consideration featured a 12/8 stator/rotor and ran at 1200 RPM.

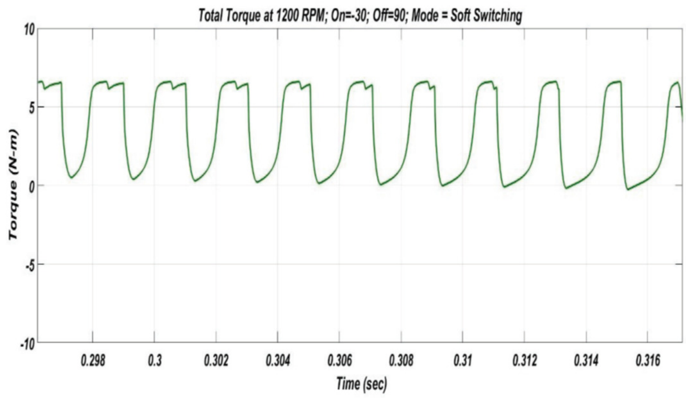

Figure 3: Plot of Total Torque against Time for δON = -30◦ and δOFF = 90◦

Moreover, the maximum applied voltage of 300V and the resistance taken into account were 0.2117Ω. In order to get the necessary excitation signal electrical angle, θON = - 30◦ and θOFF = 90◦ must be used. The soft switching technique was the mode employed, and the hysteresis band taken into consideration was 2%. The overall torque profile of the three-phase SRM over a certain time period is shown in Fig. 4. The SRM under consideration had 12/8 stator/rotor poles and ran at 1200 RPM. Moreover, the maximum applied voltage of 300V and the resistance taken into account were 0.2117Ω. In order to get the necessary excitation signal electrical angle, θON = 10◦ and θOFF = 130◦ must be used. The soft switching technique was the mode employed, and the hysteresis band taken into consideration was 2%.

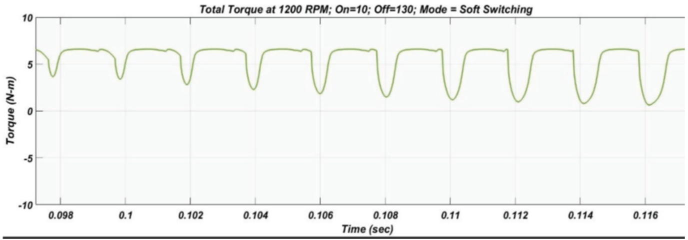

Figure 4: Plot of Total Torque versus Time for δON = 10◦ and δOFF = 130◦

IV. CONCLUSION

There is exciting potential for increasing vehicle economy and sustainability with the construction and evaluation of a wind-solar hybrid power system. Modeling and visualizations suggest that HEVs could be powered by the wind-solar hybrid approach. Under 1000 W of solar irradiation, the vehicle's roof solar panel's maximum power point standard unaligned position and GWO method. When we compared, we saw that the mean torque had greatly improved and that the total torque vs. time plot, which was produced using the θ acquired from the GWO approach, had smoother commutation and less torque ripples. We can also conclude that a larger instantaneous total torque was obtained using the GWO approach. In light of this, we can say that the GWO approach in conjunction with the SRM model produced superior outcomes with less torque ripples, which in turn resulted in fewer vibrations and acoustic noise.

FUTURE ENHANCEMENT

But even though GWO is relatively new, its use has grown over time. Despite the fact that various hybridized versions of GWO have been proposed, we want to hybridize GWO with additional algorithms in the future to create our own variants, like MFO, Harris Hawks Optimization (HHO), LeagueFirefly algorithm (FA), Dragonfly algorithm (DA), and Championship Algorithm (LCA). This will assist in creating GWO variations that yield superior outcomes. Furthermore, while the BGWO approach described in was only tested for a single objective function, it can be applied to different domains to address multi-objective issues. Moreover, extensive real datasets must be used to test the majority of the suggested GWO algorithm variations.In conclusion, knowing the ideal parameter values is essential for applying GWO to issues in any discipline, and integrating any bio-inspired algorithm into GWO can greatly enhance its functionality. Swarm robotics, network traffic management, quantum computing, big data, data mining, image segmentation, cloud computing, email spam filtering, and other fields are among the others in which GWO might be further investigated. Ultimately, the grey wolf optimization algorithm shows promise in resolving optimization issues across various academic disciplines.

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