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MODA-BASED OPTIMIZATION AF A LANDSMAN CONVERTER FOR EFFICIENT BLDC MOTOR DRIVE NN ELECTRIC VEHICLES

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ABSTRACT

The application of a PID controller, optimized with the Multi-Objective Dragonfly Algorithm (MODA), for managing a BLDC motor drive system in an electric vehicle (EV) operating environment has been investigated in this study. In a number of industrial applications and electric mobility systems, BLDC motors are growing more and more popular because of their high efficiency, minimal maintenance requirements, small size, and economy. In dynamic drive systems, precise speed and torque control remains a technical difficulty, as is the requirement for improved energy economy. In order to overcome these difficulties, a modified Landsman converter was added to the system, and the MODA algorithm was used to tune the PID controller in real time. The main goal of the suggested approach was to control motor speed while minimizing torque ripple and declaring quick, steady dynamic reactions. By effectively determining the ideal gain parameters, the MODA-based PID tuning approach improved current regulation, torque ripple decrease, and speed reference tracking. The suggested approach generated better performance metrics than conventional optimization methods like the Crow Search Algorithm (CFA) and Elephant Herding Optimization (EHO). According to the comparison analysis, the MODA-optimized PID controller performs better than current control methods in terms of robustness, dependability, and energy efficiency when used in conjunction with the Landsman converter. For BLDC motor-driven EV systems, the suggested control approach provides an adaptable, intelligent, and scalable solution. It can be further extended to other efficient motion control applications in automation, robotics, or renewable energy. For even more system resilience in dynamic and unpredictable operating situations, future research may focus on integrating this system into real-time hardware and examining adaptive or hybrid control techniques.

Keywords: *BLDC motor, Landsman converter, Elephant Herding Optimization, Cuttlefish Algorithm, Torque ripple*

ntroduction

'he consumption of Electric motors permitted a decrease in human effort in many different fields, specially in the industrial sector. Different rating of motors, including stepper motors, brush DC motors, rushless DC motors, and synchronous DC and AC motors are used for various applications (Sara, 2017; Amirthalingam, 2017; Jiang, 2018). A rotor-wound valve and a stator winding are features of traditional AC motors Jogarao (2016). A series of brush switches were used to finish the switching [5, 6]. More spills and sparks happen as a result of the shifting and brushing units used in typical DC motors resulting in overall increase in the total efficiency of the system. AC switches and breakers are added to improve system performance and reduce additional losses imposed on by the brush switch Gopalakrishnan, 2015; Viswanathan, 2017. The BLDC motor (AC motor) is suitable for usage in electric cars because of its efficiency, accuracy weight, and space requirements. Their characteristics are related to permanent magnet machine with partial twisting of groove fragments Tan, 2017; Liu, 2014. The high-power consumption, improved torque qualities, high dynamic adaptability, high efficiency, high excitation speed, long life, silent operation, and quick operation are all advantages Li (2016). Because of the inductive nature of the motor voltages, the current regulator is unable to produce the necessary di/dt during switching. At high speeds, torque waves can result in motion control mistake noise and vibration Liu (2016). The conventional square wave control method is u eliminate higher acceleration, which enhances adherence noise and lowers torque These issues only arise while BLDCM is used in servo systems and electric cars.

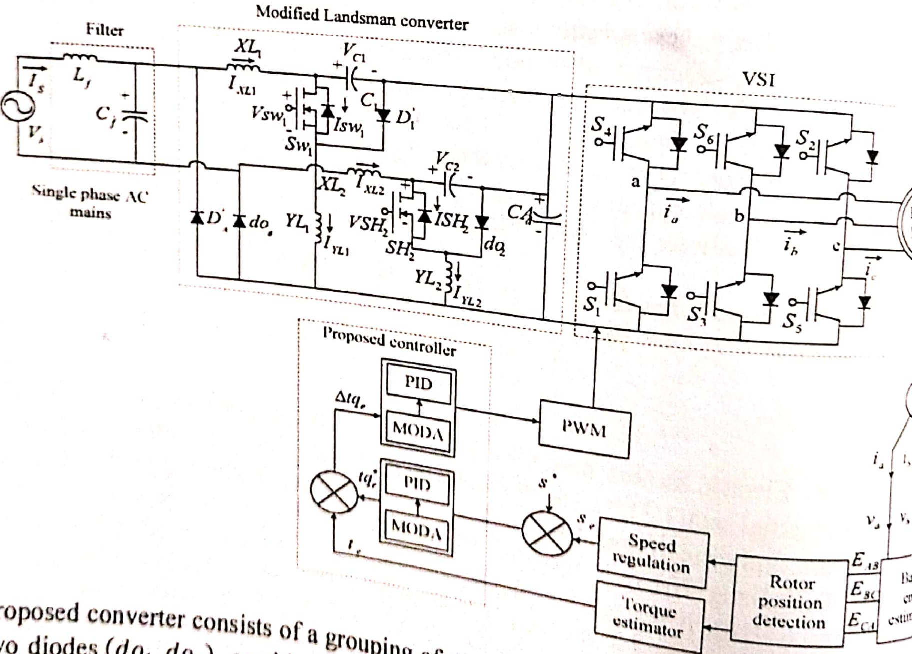
Proposed control scheme for BLDC torque and speed

By adjusting the speed and torque of the BLDC motor, the proposed topology co parameters shown in Table 1. In the control model, two main governing actions are e estimation and speed regulationThe speed regulation system integrates a PID-base controller, which regulates the desired operating speed of the BLDC motor based on the torque controller also PID-based MODA and it is is designed using the torque error appropriate control signals. These control signals are sent to a PWM block, which dr source inverter. The inverter, in turn, adjusts the motor's phase voltages to achieve the and speed. A Landsman converter is used at the front end to adjust the DC link voltage, d ripple, and ensure smooth power delivery to protect sensitive device and enhance system

Working of Modified Landsman Converter

The Landsman converter and the double configuration in DICM method of operation of current channel shown in figure 1. Along these lines, switches $(SH_1)$and(SH_2) is hindered express the tank capacitor(CA_1) is charged by the info source. The stabilizer $(YL_1)$is appe 2 (b). Along these lines, the current (XL_1) abatements and the voltage of the tank capacit The Modified Landsman Converter is an improved buck–boost DC–DC topology continuous input and output currents, making it ideal for EV–BLDC drives. It uses two i L_2), an intermediate capacitor (C_1), an output capacitor (C_o), one switch, and two diodes.

Fig.1: Proposed Modified -Landsman converter-based BLDC motor



The proposed converter consists of a grouping of two switches(SH_1, SH_2),$(CA_1, CA_2)$are the and two diodes (do_1, do_2), combined with input inductors (XL_1, XL_2), (YL_1, YL_2) are repres output inductors and linked with DC bus capacitor (C_d). The DC bus capacitor regulate the vol improved efficiency. Mode I : In the mode of operation, the inductors XL1 and YL2 store ener the DC source, and the MOSFET switches (VSW1, VSW2) are turned on. Through VSI, the capacitors discharge to power the BLDC motor.

mulation Results and Discussions

e proposed PID-controlled BLDC motor drive system, integrated with a Landsman converter and timized using the Multi-Objective Dragonfly Algorithm (MODA), is evaluated through MATLAB mulink-based modelling. The MATLAB Simulink simulation environment enables comprehensive ting of the system's performance under diverse operating conditions.

ODA algorithm for adjusting

ontrol parameters

fter initialization, advantages for both PID controller loops via Landsman converter and VSI BLDC ive switch angles were obtained. Multi-purpose function is used to calculate benefits and angles. nerefore, the BLDC motor drive speed control system is provided with a multi-purpose control. A well-signed control system provides a speed warning, a quick error while reducing the torque currents of e BLDC car. Flow diagram of the proposed plan to implement the BLDC speed control system using e MODA algorithm, as shown in Figure 3. The torque, speed and current are measured and the rformance is reviewed in division 4.

he effectiveness of the proposed BLDC vehicle torque reduction method is analyzed and compared ith existing strategies. Here, the vehicle's BLDC speed and flow control is performed by an improved ID controller. The optimization process is performed using the ASMO algorithm according to the ultipurpose function. The viability of the proposed control approach is evaluated by comparison with aditional methods such as WOA and CFA. The Simulink model of the proposed framework appears in igure 4. The proposed method here reduces torque fluctuations and stabilizes the BLDC vehicle speed. itially, control parameters were measured from the BLDC vehicle, such as torque and current.

o maintain the torque and speed error in the BLDC motor, the suggested controller is explained to ptimize the output gain parameter. The controller guarantees better dynamic response and precise racking of the proposed performance by adjusting these parameters. In order to improve overall system tability and efficiency, the optimization procedure aims to reduce torque ripple and speed deviation.

The BLDC motor is tested at several speed levels while under a continuous load scenario to confirm its fficacy. Two separate modes of operation, each reflecting a different speed scenario, are used to assess he effectiveness of the suggested control approach. These studies show that the controller can precisely egulate torque and speed in dynamic working environments.

The BLDC motor is tested at various speeds and with a steady load. Two modes of operation are tested or the proposed regulator's presentation with respect to speed conditions.

Mode 1: The performance evaluation with speed at 500 RPM
Mode 2: The performance speed test at 750 RPM
The BLDC (Brushless DC) motor functions in this situation under two different reference conditions:
Phase 1: 18 Nm torque and 500 RPM
Phase 2: 18 Nm torque and 750 RPM

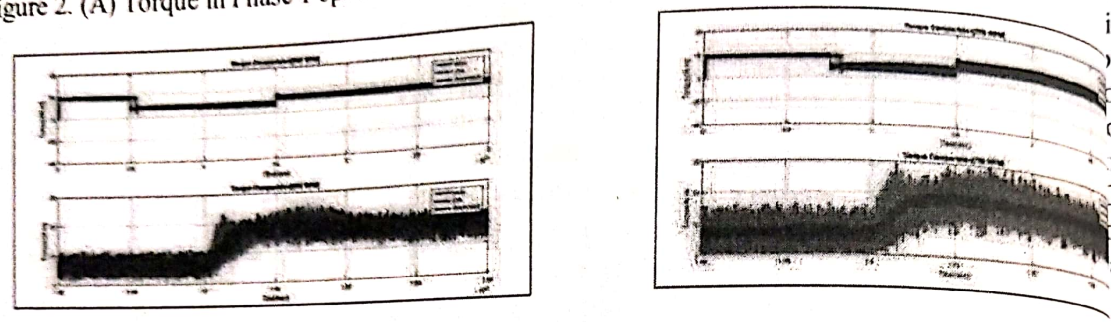
First, important metrics including torque, BLDC motor speed, and vehicle dynamics (integration and flow) are noted. Deliberate control boundaries or preset system constraints are used to determine the input torque.

To assess performance, the BLDC motor speed is constantly observed and compared with the reference speed. Based on this, the difference between the proposed and actual motor performance is estimated to generate a torque reference. The torque error, which is determined by dividing the actual torque by the reference torque, is then used to regulate the PWM (Pulse Width Modulation) control signal. This makes it possible to dynamically modify the motor's functioning, guaranteeing effective tracking of th torque and speed profiles in both phases.

The reference speed and torque of the BLDC vehicle in these circumstances are different, wi and 18 Nm for phase 1 and 750 rpm and 18 Nm for phase 2. First, metrics like BLDC vehicle and motion are measured. The designed boundaries are used to resolve the input torque. reference is calculated from the actual and genuine motor change, and the motor BLDC evaluated. The ratio of the current torque to the BLDC motor reference torque error determines control pulse.

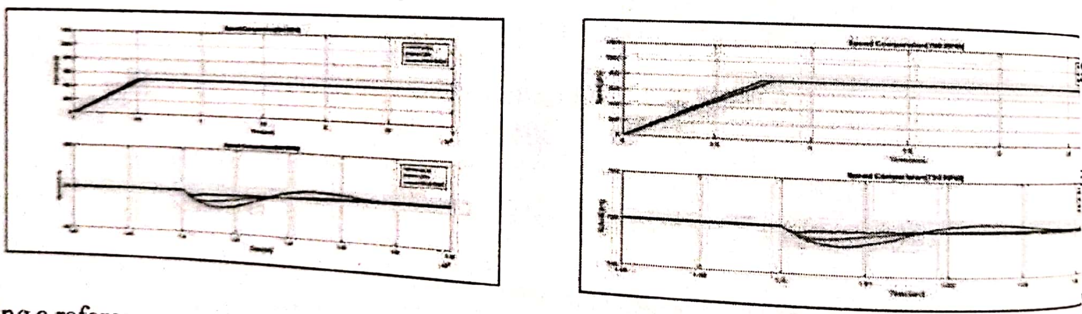
Comparison analysis: The presentation investigation of the proposed technique is compared existing strategies dependent on torque and BLDC motor speed.

Figure 2. (A) Torque in Phase 1 operation Figure 2. (B) Torque in Phase II operation



An analysis of comparing the available methods for the three torque velocity events is shown i 2. In this waveform during the time-frame from 1.48 to 1.54 seconds some disturbances have o furthermore, torque reaches torque, and vibration-based MODA is more desirable than technolo stages.

Figure 3 (A) Speed Measurement **comparison** Phase I Figure 3 (B) Speed Measurement **comparison** Ph



During a reference speed transition to 750 RPM, Figure 8 (D). Compares the speed tracking perf of three control strategies: the Proposed Method, CSA (Crow Search Algorithm), and AOA Optimization Algorithm). The overall speed response is shown in the upper plot, which validate three controllers are able to track the reference speed with little overshoot or settling time. The i transient region, when the reference speed varies, is shown in closer point in the lower plot at seconds. Comparing the Proposed Controller to AOA and CSA, it shows improved performan case with less oscillation, more settling time, and less overshoot. This demonstrates unequiv accuracy and resilience of the suggested control strategy in attaining better dynamic response an state accuracy in the regulation of BLDC motor speed. Figure 3 represents a comparison be suggested speed control mechanism and current approaches. The graph shows that the mo regulation achieved by the suggested PID-based controller closely resembles the reference spe BLDC vehicle. The system's dynamic behavior has been assessed using key performance pa like rising time, settling time, and steady-state error.

clusion

study's findings validate that the N
oller offers effective solution of r
ms. In order to effectively proce
oller works in tandem with a La
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could dynamically adapt to referen
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Conclusion

he study's findings validate that the Multi-Objective Dragonfly Algorithm (MODA)-optimized PID ontroller offers effective solution of regulating speed and minimizing torque ripple in BLDC motor stems. In order to effectively process torque changes and more reliable inverter operation, the ontroller works in tandem with a Landsman converter. The three main performance parameters of eed, torque, and current were examined in a range of operational scenarios. A strong control response at could dynamically adapt to reference changes and disturbances with little overshoot, quicker settling riods, and zero steady-state error was produced by integrating MODA into the PID tuning framework. 500 RPM, the torque ripple of the suggested system was just 6.45%, which is a significant iprovement above traditional algorithms like GA (53.6%), PSO (17.1%), and even sophisticated brids like ANFIS-FFA (8.39%). Improved mechanical strength, less noise and vibration, and smoother otor running are all directly interrelated with this torque ripple decrease. The suggested system also monstrated excellent energy optimization and current handling, which makes it particularly propriate for applications requiring great efficiency and dependability, such industrial automation and ctric vehicle application. For BLDC motors, the Landsman converter topology in conjunction with ODA-based PID control offers an efficient, dependable, and high-performing control architecture. It rforms better than current methods in lowering torque ripple and improving the motor drive system's erall operating stability, responsiveness, and energy economy.

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