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Original Article

Efficient Energy Management in a Hybrid Electric Vehicle Using a Double Cascade Boost Converter With ANN Optimized MPPT Technique

Sudhakar. P[1], I. Kumaraswamy[2]

[1,2]*Department of Electrical and Electronics Engineering, Mohanbabu University, Tirupathi, India.*

[1]*Corresponding Author : sudhakarpoli142@gmail.com*

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Abstract - *The increasing adoption of Electric Vehicles (EVs) underscores the growing need for efficient propulsion with Energy Management Systems (EMS). An advanced EMS that integrates Photovoltaic (PV) systems with advanced converters and optimization approaches for a sustainable solution is required for energy management in EVs. Hence, this paper proposes a double cascade boost converter with an ANN-optimized MPPT technique for enhanced efficient energy management in hybrid electric vehicles. The Double Cascade Boost Converter (DCBC) is designed to enhance efficiency by reducing switching losses and providing a high voltage gain. For efficient energy extraction from the PV system under varying solar conditions, an Artificial Neural Network (ANN) optimized Secretary Bird Optimization (SBO) based Maximum Power Point Tracking (MPPT) approach is used. The motor drive uses a 3-phase Voltage Source Inverter (VSI), which converts DC into AC for driving a Brushless Direct Current (BLDC) motor, with a Recurrent Neural Network (RNN) controller employed for precise speed control of the motor. On the Energy Storage System, a Bidirectional DC-DC Converter is integrated for both supercapacitors and storage batteries, providing better predictions of State of Charge (SoC) and battery lifespan of the RNN controller. Simulation outcomes obtained from MATLAB validation illustrate that the proposed work outperforms conventional methodologies in energy conversion efficiency (98.12%) and tracking accuracy (98%).*

Keywords *- Electric Vehicle, Bidirectional DC-DC Converter, Three Phase VSI, DCBC converter, and ANN Optimized SBO MPPT.*

1. Introduction

Globally, an EMS is a comprehensive solution designed to monitor, control, and optimize the energy usage of electrical systems, ensuring efficient, reliable, and sustainable operation [1]. Through advanced control strategies and real-time optimization, EMS contributes to greater energy efficiency, cost savings, and environmental sustainability. Therefore, charging systems are required to keep EVs' batteries charged and operating effectively [2, 3]. As such, charging EVs using renewable energy is crucial. Utilizing renewable energy to power EV charging infrastructure concurrently with smart EV charging lessens the strain on the grid and the environment. Many variables, such as energy limits, environmental concerns, and low cost, contribute to its increased flexibility in the modern power system [4, 5]. Make absolutely sure that the solar panels in a PV system run at their Maximum Power Point (MPP), which changes based on variables including temperature, sunshine, and panel characteristics. MPPT technology is employed [6]. However, the technology and complexity are needed to continually monitor the MPP of the solar panels or other power sources. Minor inefficiencies or energy losses occur throughout the tracking process; these MPPT controllers are built to maximize power output [7]. Therefore, managing and resolving these issues is essential. So as to enhance energy efficiency and guarantee the lifespan of the power systems in both PV and EV charging applications, this work employed ANN SBO-MPPT approaches. Advanced converter topologies are required because solar power generation under weather conditions produces lower energy [8]. To guarantee that the energy produced by solar panels is useful, efficient, and appropriate for a range of applications, earlier DC-DC converters employed Zeta-Luo converters, SEPICs, and Interleaved Bidirectional Converters (IBCs) [9, 10]. The novelty of this work is the integration of a double cascade boost converter with an ANN-optimized MPPT technique, which introduces intelligent learning capability to track the maximum power point more accurately and rapidly than traditional algorithms, even under partial conditions, fast irradiance changes, and nonlinear PV characteristics.

In the literature review, S. Mehdi Rakhtala Rostami et al (2024) [11] have proposed a Teaching Learning based Optimization (TLO) in Fuzzy Logic Algorithms (FLO) for full-active hybrid energy storage systems. Over time, it also needs to be maintained, repaired, or replaced, raising the overall ownership cost. S. Chakraborty et al (2020) [12] have presented an Optimized Interleaved Bidirectional HVDC/DC Converter for EV drive trains. However, this converter's design is more complicated than other converters because it needs accurate duty cycle management, which makes control systems more challenging. E. Gümrükcü et al (2022) [13] have described a Modular Multilevel Converter (MMC) for megawatt-level electric vehicle charging stations. However, it modifies the solar panels' DC voltage to match the input voltage needed for other parts or storage systems, like batteries. Author have implemented a Fuzzy logic controller for a futuristic energy management solution in EV. However, poorly trained networks mis-track the MPP under unusual or unseen conditions. S. Arandhakar et al (2022) [14] have proposed a Recurrent Neural Network (RNN) implemented for EVs. Nevertheless, these converters produce heat during use, which further lowers their effectiveness if improperly controlled.

1.1. Research Gap

Despite significant progress in HEV technologies, achieving efficient and reliable energy management remains a major challenge due to the drawbacks of conventional boost converters and traditional MPPT algorithms. By combining the DCBC with ANN-SBO MPPT, this work addresses the gaps of low efficiency, poor dynamic response, and limited adaptability in existing systems, leading to better fuel economy, extended battery life, reduced emissions, and enhanced driving range of HEVs.

Thus, the following outlines the goals of the proposed system,

- A DCBC converter is used to maintain a stable output voltage in various load conditions.
- ANN SBO-MPPT is employed to track and manage the PV system at its maximum power point, even under rapidly changing conditions.
- A supercapacitor is employed to handle high current peaks, protecting the battery and extending its life.
- A battery is utilized to store excess energy from PV and distribute it to the motor during insufficient energy from PV.

The paper is divided into four Sections; the first Section I, is an introduction. Section II presents the proposed work and design of the component modeling a. Section III discusses the results of this work. The paper's conclusion is provided in Section IV.

2. Proposed Methodology

An energy management system using a DCBC converter with an optimized SBO-MPPT technique is proposed in this work. Figure 1 displays the proposed block diagram.

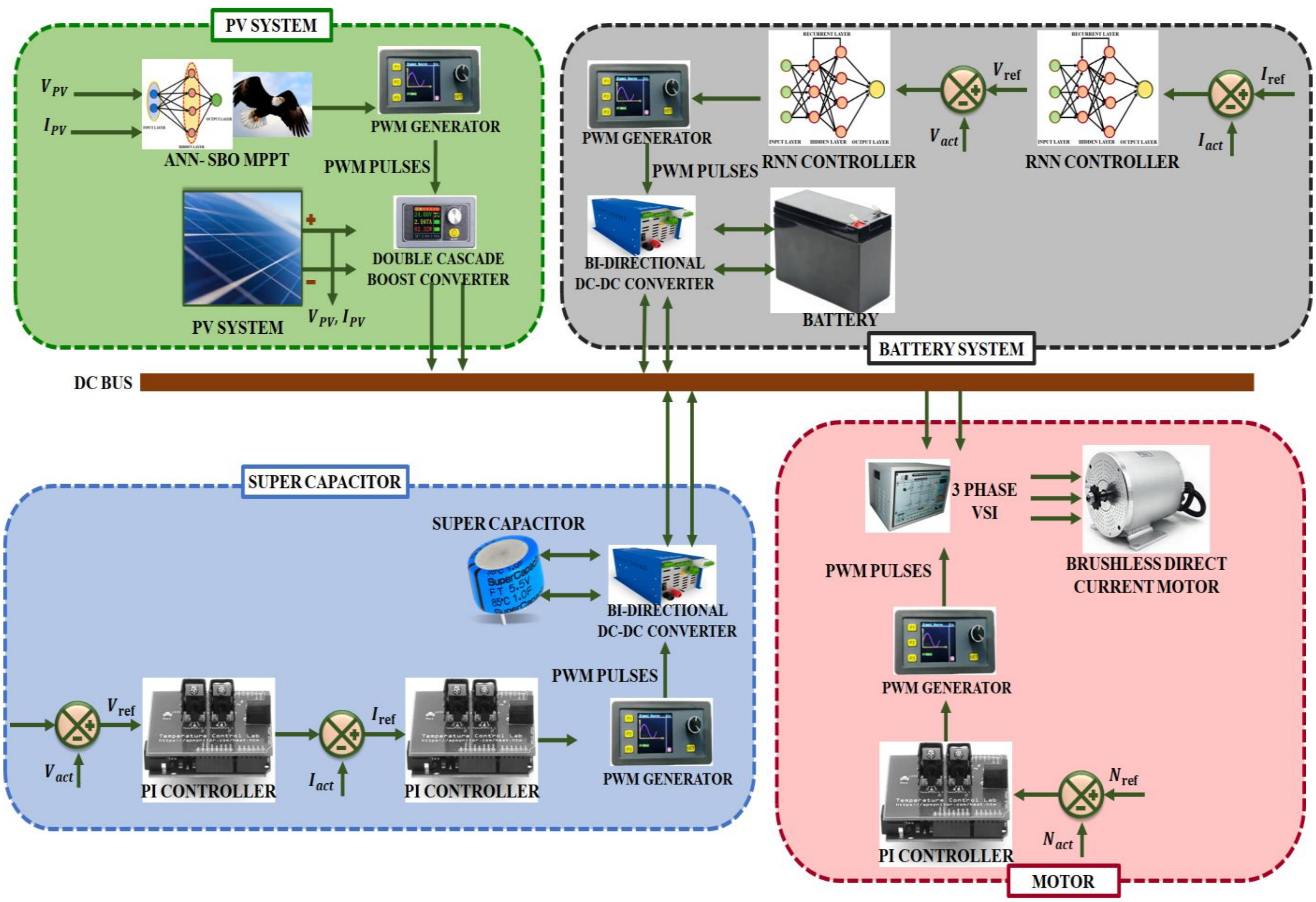

Fig. 1 Block diagram for the proposed work

PV panels usually produce a low voltage, so high voltage is required in this system. Hence, DCBC is used to step up the voltage efficiently in two stages, reducing stress on individual components and improving efficiency. The system also includes an ANN-optimised SBO MPPT controller, which ensures the MPPT output by adjusting the duty cycles of the converters. A battery is used to store chemical energy and convert it into electrical energy, and it allows energy to be used later. Further, a supercapacitor is used to pair with batteries to handle peak power demands, improve efficiency, and extend battery life. The bi-directional nature of the system allows for both energy generation and storage in the battery. It operates the power flow with the EV battery and supercapacitor, while the RNN controller identifies internal short circuits and overcharging, and it estimates the SoC over time based on voltage. Finally, a 3-phase VSI generates three-phase AC output perfect for powering BLDC motors.

2.1. PV System

A PV system is a renewable energy solution that converts sunlight into electrical energy using solar panels based on the photovoltaic effect. These panels typically generate a low DC voltage, which often needs to be increased for practical applications such as grid connection or powering high-voltage DC loads. The PV circuit is shown in Figure 2.

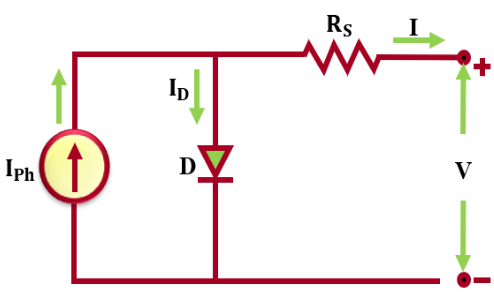

Fig. 2 Equivalent circuit of PV cell

This model reflects the behavior of the PN junction within the solar PV cell. The key equations that define the I-V curve of PV cells are,

$$I_{ph} = [I_{sc} + K_i(T_K - T_{ref})].\frac{G}{1000} \quad (1)$$

Based on the above equations, the temperature coefficient of the cell represents K_i. T_K And T_{ref} Denotes working and reference temperatures in kelvin, and G denotes irradiation (W/m2). Let's, K denotes Boltzmann constant. I_o Represents the saturation current.

$$I_o = I_{rs}\left[\frac{T}{T_r}\right]^3 exp\left[\left(\frac{qE_{go}}{AK}\right)\left(\frac{1}{T_r} - \frac{1}{T}\right)\right] \quad (2)$$

Where A is the ideality factor. E_{go} Denotes the semiconductor band gap energy. To efficiently achieve voltage step-up, a DCBC is used in this work.

2.2. Modelling of Double Cascade Boost Converter

A DCBC is a type of DC-DC converter where two boost converter stages are connected in series (cascaded) to achieve higher voltage gain than a single-stage boost converter. A boost converter increases the input voltage while decreasing current. In a double cascade boost converter, the output of the first stage becomes the input of the second stage. Figure 3 illustrates the circuit diagram of DCBC.

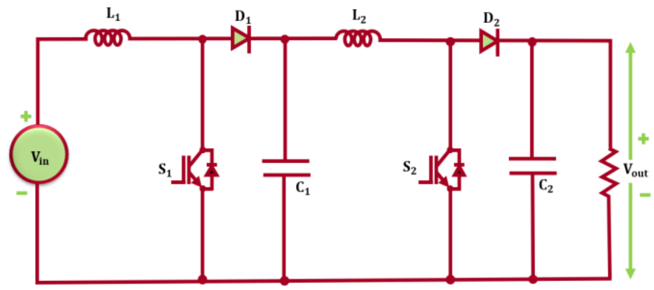

Fig. 3 Circuit diagram of DCBC

In this configuration, the first boost stage steps up the input voltage to an intermediate level, which becomes the input for the second stage that further increases the voltage to the desired output.

2.2.1. Stage 1

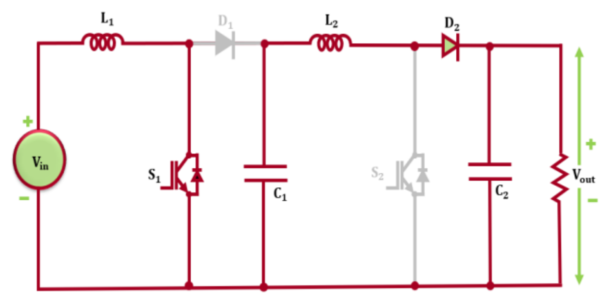

Fig. 4 Stage 1

Figure 4 displays the diagram of stage 1. The power switch provides the inductor current. Here, L receives the energy from the discharge. C_1 and the power supplied to the output V_{out}. It boosts the input voltage. V_{in} To an intermediate voltage.

2.2.2. Stage 2

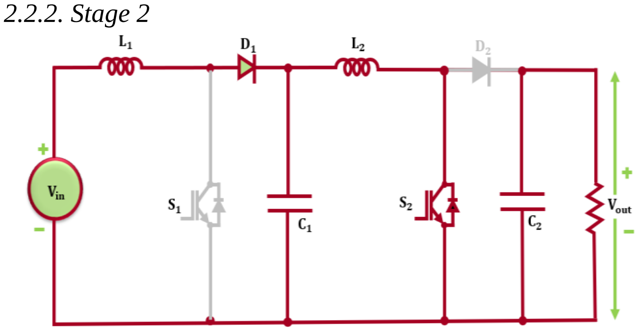

Fig. 5 Circuit diagram of Stage 2

The diagram of stage 2 is shown in Figure 5. Stage 2 then boosts the voltage to the final output V_{out}. In discontinuous continuous conduction mode, the I_L flows via the forward-biased diode D_1 and the diode operation is driven forward while D_1 and the input supply both charge the intermediate capacitor simultaneously.

The output and the I_L are calculated as,

$$I_{out} = \frac{V_{out}}{R} \tag{3}$$

$$I_{L2} = \frac{I_{out}}{(1-D_2)} \tag{4}$$

$$I_{L1} = \frac{I_{L2}}{(1-D_1)} \tag{5}$$

The inductors' values and capacitors' values are designed as,

$$L_1 = \frac{D_1 V_{in}}{f \Delta i_{L1}} \tag{6}$$

$$L_2 = \frac{D_2 V_{in}}{f \Delta i_{L2}} \tag{7}$$

$$C_1 = \frac{D_1 V_1}{\Delta V_{C1} f R} \tag{8}$$

$$C_2 = \frac{D_2 V_{out}}{\Delta V_{C2} f R} \tag{9}$$

Where IL_2 output current for the first boost and V_1 output voltage for the first boost. The overall voltage gain is given by,

$$V_{out} = \frac{V_{in}}{(1-D_1)(1-D_2)} \tag{10}$$

Where D_1 and D_2 are the duty cycles of the first and second converters.

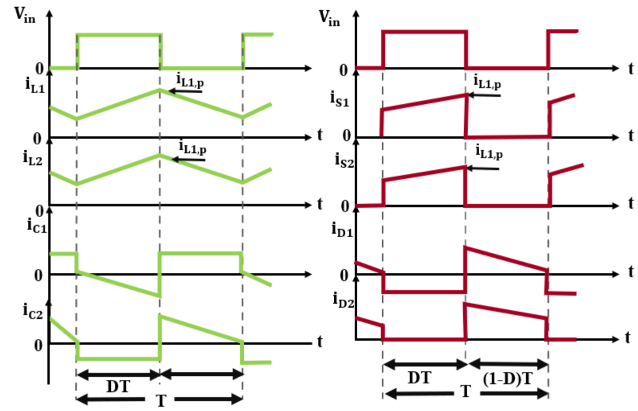

Fig. 6 DCBC's timing diagram

2.3. Modelling of ANN-SBO MPPT

The ANN-SBO MPPT technique is an advanced control strategy used in PV systems to enhance power extraction under varying environmental conditions. An ANN uses the learning and adaptation capabilities of neural networks to manage and regulate the behavior of dynamic systems. The modelling of the ANN is presented in Figure 7.

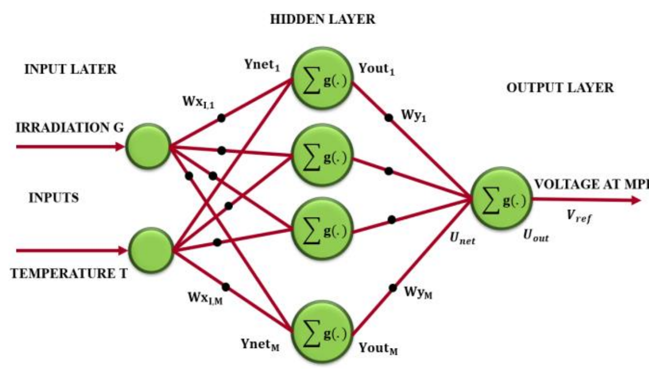

Fig. 7 Modelling of ANN

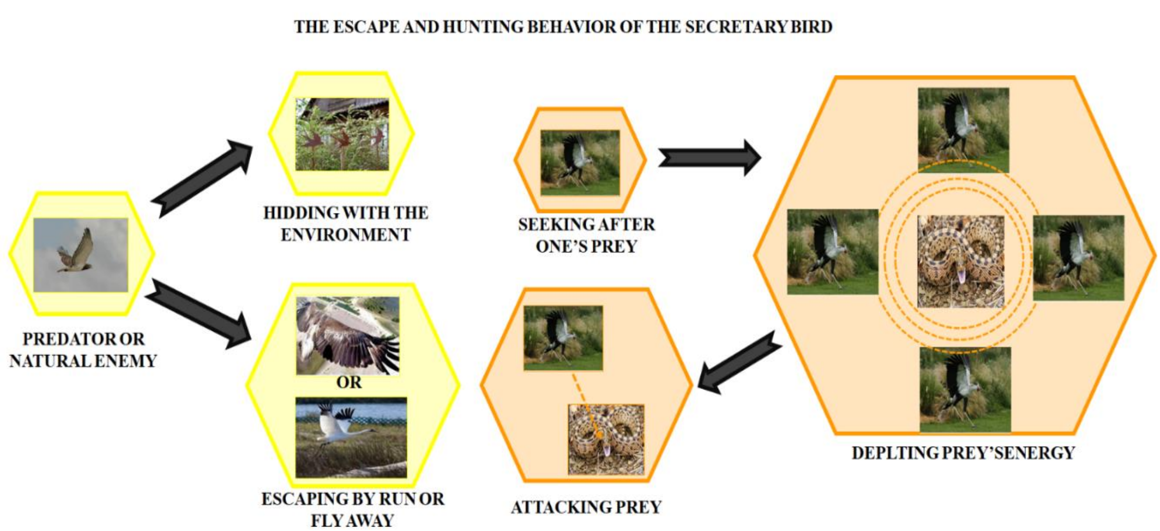

Fig. 8 Behavior of SBO

It develops an internal representation of the system dynamics and uses this understanding to make control decisions. In the context of MPPT for photovoltaic PV systems, SBO is used. The behavior of SBO is presented in Figure 8.

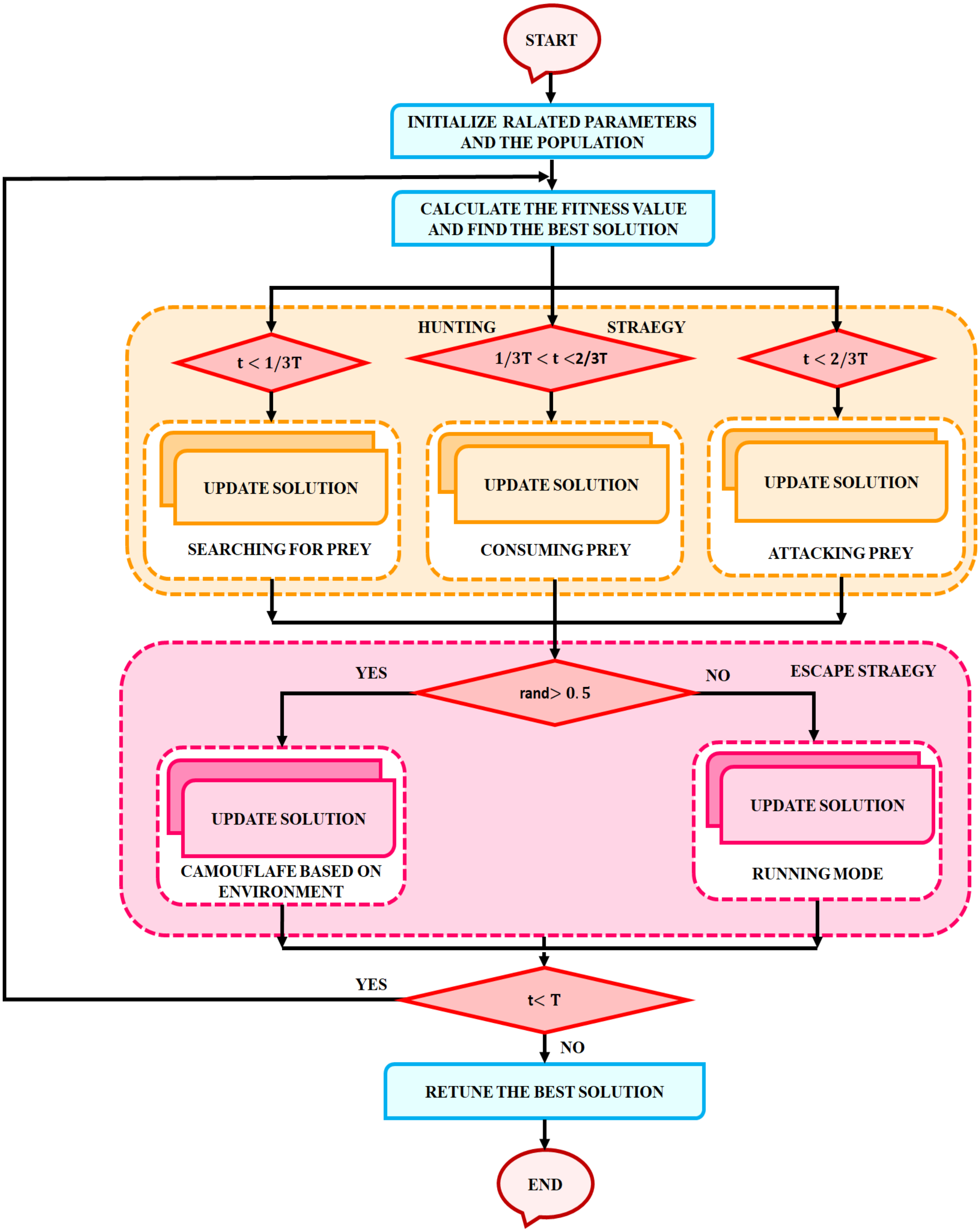

Fig. 9 Flowchart of ANN-SBO MPPT

2.3.1. Exploration and Exploitation Balance

It is designed to strike a balance between exploration and exploitation. This behavior helps in efficiently locating the MPP even in the presence of rapidly changing environmental conditions.

2.3.2. Sequential Selection

The SBO algorithm mimics the sequential selection behavior of the Secretary Bird when hunting. This allows it to avoid unnecessary computations, speeding up the tracking process while still ensuring accuracy.

2.3.3. Dynamic Adaptation

The secretary bird adjusts its hunting strategy based on the presence and movement of prey, which is likened to the algorithm dynamically adjusting its search parameters as it evaluates power output from the PV system.

2.3.4. Convergence Towards Optimal Solution

The secretary bird narrows its search to find prey, and SBO focuses more on the search space regions, showing promising results. A trained ANN estimates the optimal voltage. V_{mppt} for maximum power based on inputs (e.g., irradiance G and temperature T),

$$V_{mppt} = f_{ANN}(G, T) \tag{11}$$

Where f_{ANN} Is the function learned by the neural network during training?

The SBO updates search agent positions using,

$$X_i^{t+1} = X_i^t + A.r.(X_{best}^t - X_i^t) + B.randn() \tag{12}$$

Where, X_i^{t+1} - New position of the solution, X_i^t- Current position of the solution, X_{best}^t - Best position found so far, A - Attack intensity control parameter, B - Exploration coefficient, r - Random number in [0, 1] and $randn()$ - Normally distributed random number. The flowchart of ANN-SBO MPPT is shown in Figure 9.

In contrast, the ANN-SBO MPPT combines the learning ability of an ANN with the intelligent search capability of the SBO. The ANN is trained to predict the optimal operating point of the PV system based on inputs like solar irradiance and temperature, while the SBO fine-tunes the solution by mimicking the natural behavior of seagulls in hunting and migrating, enabling faster convergence and better accuracy. This hybrid approach significantly improves tracking efficiency, reduces response time, and enhances the system's ability, making it a highly effective MPPT method for modern PV systems.

Modeling of BLDC Motor

A BLDC motor operates without brushes, unlike traditional brushed DC motors. It uses electronic commutation instead of mechanical brushes to switch current in the motor windings. This field interacts with the rotor magnets, causing them to spin. BLDC motors are highly efficient and reliable, and require minimal maintenance because there are no brushes to wear out.

BLDC motors generate back Electromotive Force (EMF) as the rotor turns,

$$E = k_e.\omega \tag{13}$$

Where, E is back EMF, k_eIs back EMF constant, and ω is the rotor angular speed. It also offers better speed-torque characteristics, higher dynamic response, and longer lifespan. These motors are widely used in applications such as EVs, drones, computer fans, air conditioners, and industrial automation systems due to their compact size, smooth operation, and energy efficiency.

Modeling of Super Capacitors

Supercapacitors are high-capacity energy storage devices like batteries. It is often paired with batteries to handle peak power demands, improve efficiency, and extend battery life. Their behavior is modeled using equivalent Resistor-Capacitor (RC) circuits, and it is often integrated with DC-DC converters for efficient power management and control.

Modelling of Bi-Directional DC-DC Converter

It is a power electronic device that permits energy flow in two directions between two DC sources or between a DC source and a load. Unlike conventional DC-DC converters that operate in a single direction, this type of converter is designed to either boost or buck the voltage depending on the direction of power flow. Figure 10 illustrates the bi-directional DC-DC converter.

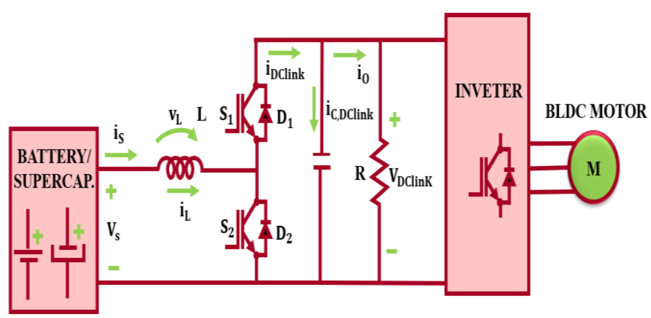

Fig. 10 Bi-Directional DC-DC converter

The converter typically consists of power switches arranged in a symmetrical configuration to facilitate reverse operation. Advanced control techniques are employed to regulate current and voltage, ensure seamless transition between modes, and maintain system efficiency and stability. It permits electricity to flow both ways, from the capacitor to the battery and back again.

RNN Controller

RNN is well-suited for applications such as SoC and state-of-health estimation, where the battery's past behavior significantly influences its current and future states. The architecture of an RNN consists of four theoretical layers: the input, hidden, recurrent connections, and output layer. Figure 11 presents the RNN controller.

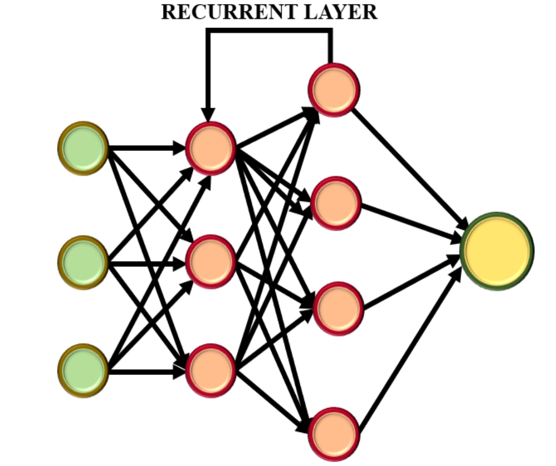

Fig. 11 RNN Controller

The input layer receives a sequence of data points, such as voltage, current, or temperature in battery applications, where each element in the sequence is processed at a separate time step. The core of the RNN lies in the hidden layer, which contains neurons that maintain a state vector. It allows the RNN to capture patterns that evolve over time. The recurrent connections are what enable this memory capability, as they feed the hidden state from one time step back into the next, effectively creating loops within the network structure. Finally, depending on the task, the output layer produces a result at each time step or after the full sequence. It learns complex temporal patterns in voltage, current, and temperature data, leading to more accurate and adaptive predictions. Additionally, RNNs are valuable for fault detection, identifying anomalies and predicting failures before they occur. It also optimizes charge and discharge control, adapting in real time to changing load demands and usage patterns to extend battery life.

3. Results and Discussion

The proposed DCBC converter and ANN SBO-MPPT are implemented for battery energy optimization-based grid-connected EV systems with solar PV. This section presents the findings and illustrates the work that is improving overall system efficiency by minimizing energy loss during charging and discharging procedures. Table 1 presents the system's specifications of parameters.

Table 1. Specifications of parameters

Parameter	Specification
PV System	
Rated Power	$10kW$
No. of panels in Parallel	11
Cell linked in Series	36
No. of Panels in series	4
Short Circuit Current	8.95 A
DCBC converter	
$L_1, L_2,$	4.7 mH
C_1, C_2	$22\mu F$

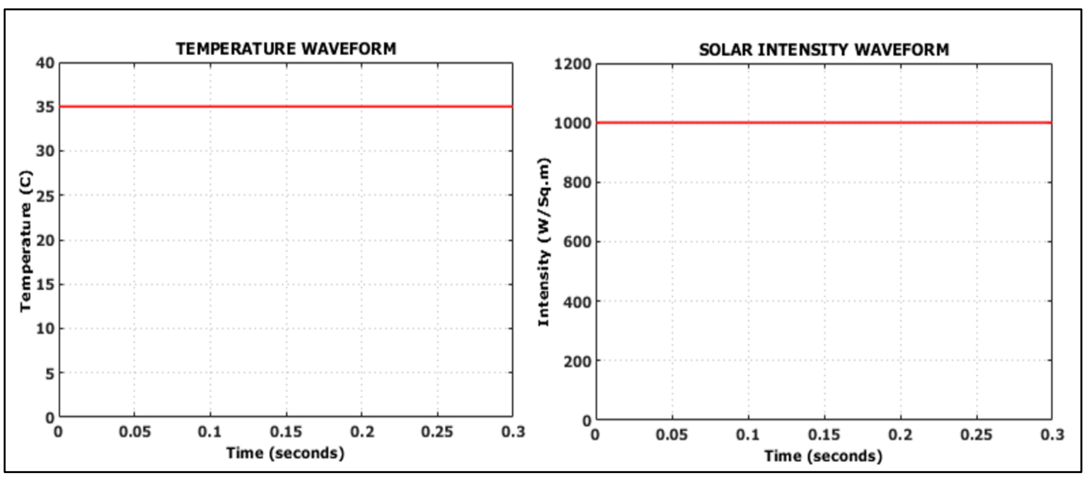

Fig. 12 Solar temperature and Intensity waveform

Figure 12 displays the solar temperature and intensity waveform. The temperature value is 35°C, and the intensity value becomes stable at 1000 W/Sq.m, and it is stable continuously due to different temperature conditions. In Figure 13, the panel voltage is 160V, and DCBC's input current is raised to 32A, and then the current is down to 14A at 0.03 secs. The output of the DCBC with ANN-SBO MPPT's waveform is presented in Figure 14. In the figure, as stated, the output voltage is raised to 270 V at the initial time, and the output current is attained at 7 A.

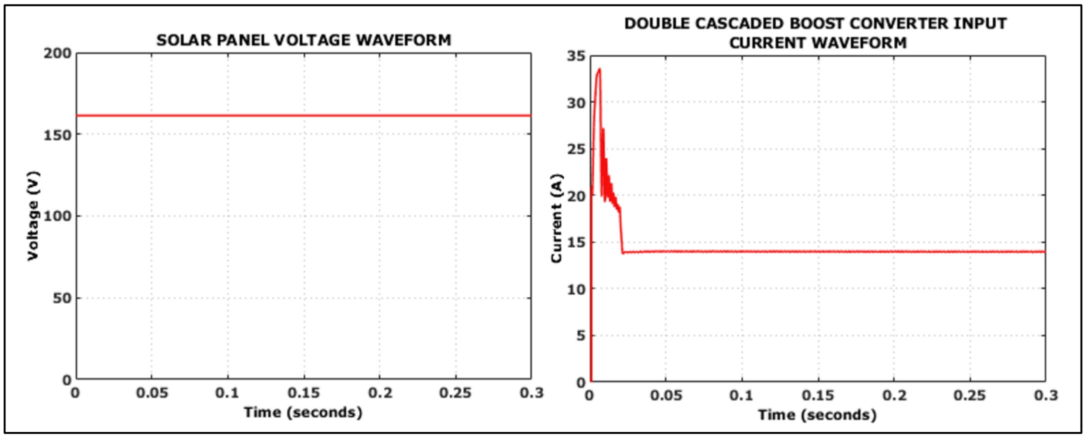

Fig. 13 PV voltage and converter's input current waveforms

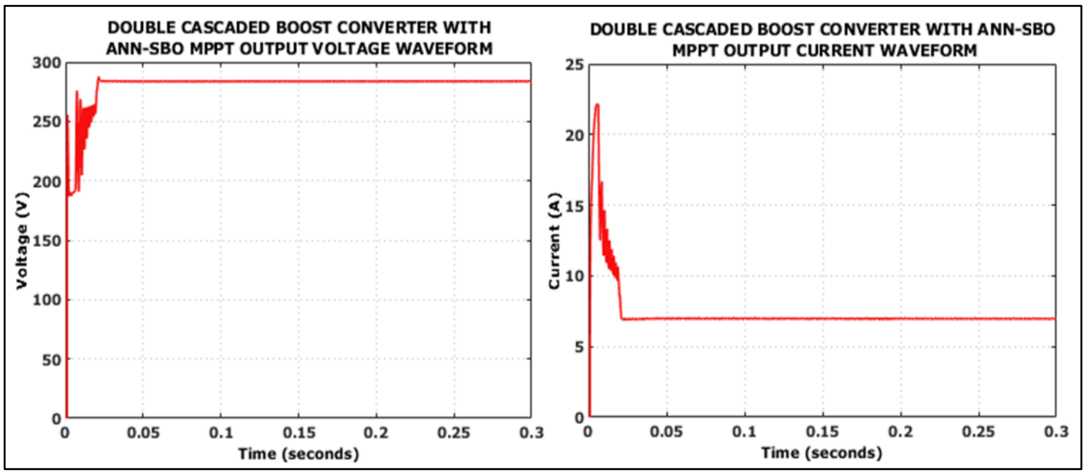

Fig. 14 Output waveforms of the DCBC with ANN-SBO MPPT

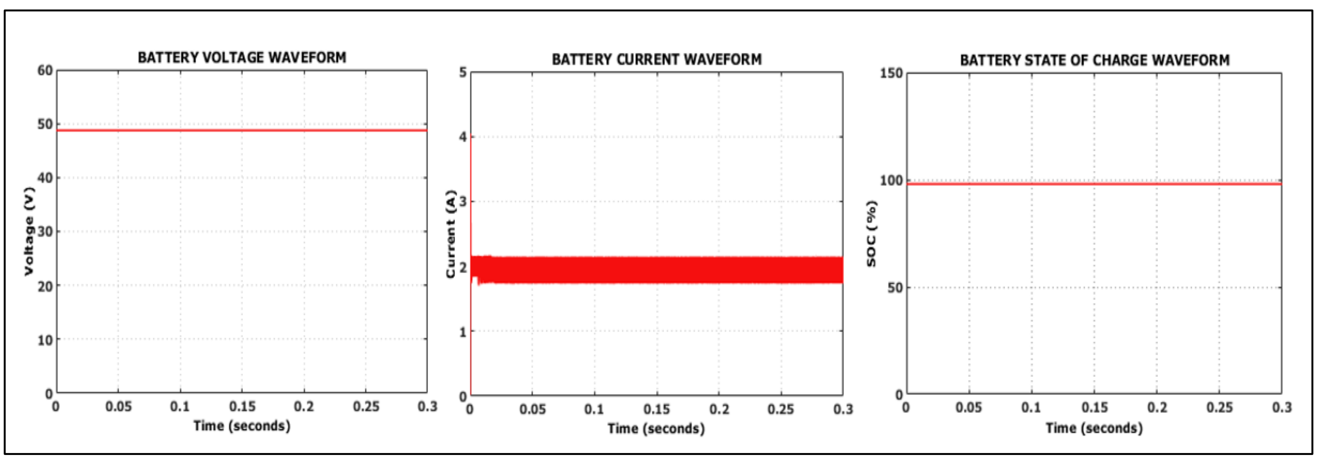

Fig. 15 Voltage, current and SOC waveforms of battery

In Figure 15, the voltage waveform attains 49 V stably and continuously. The current remains in the range between 1.8 and 2.4 A at 0 to 0.3 seconds. The charging state of the battery's SOC value of 98% is achieved in the third plot. The voltage waveform of the supercapacitor is presented in Figure 16. In this case, the supercapacitor's voltage of 120 V is attained. Figure 17 indicates the output waveforms of BLDC. In the first plot, the motor current increases rapidly, and it reaches its maximum of 22A. After going down to a point of 0A, it proceeds to oscillate continuously. In the second plot, the motor's back EMF occupies the range between -75 and 75 V at 0.3 seconds.

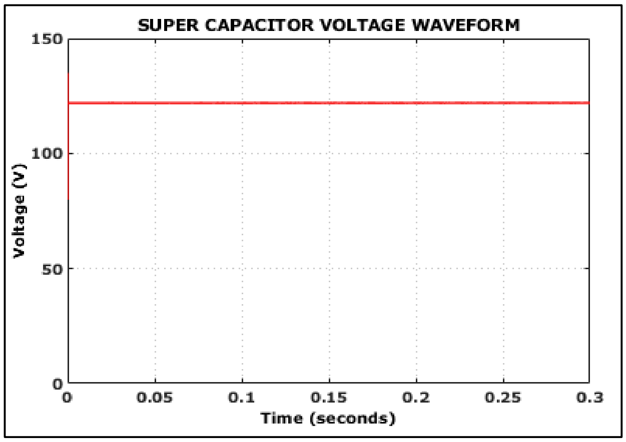

Fig. 16 The voltage waveform of super capacitor

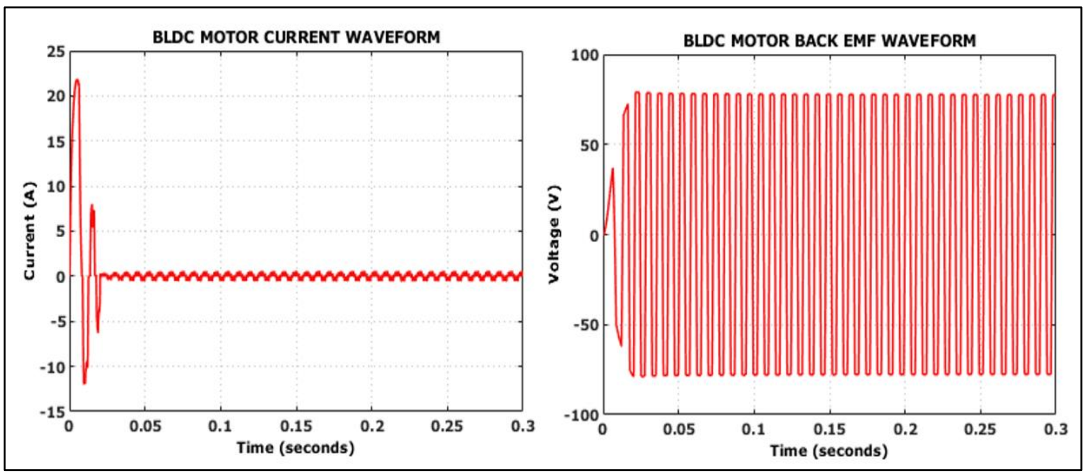

Fig. 17 The current and EMF waveforms of BLDC

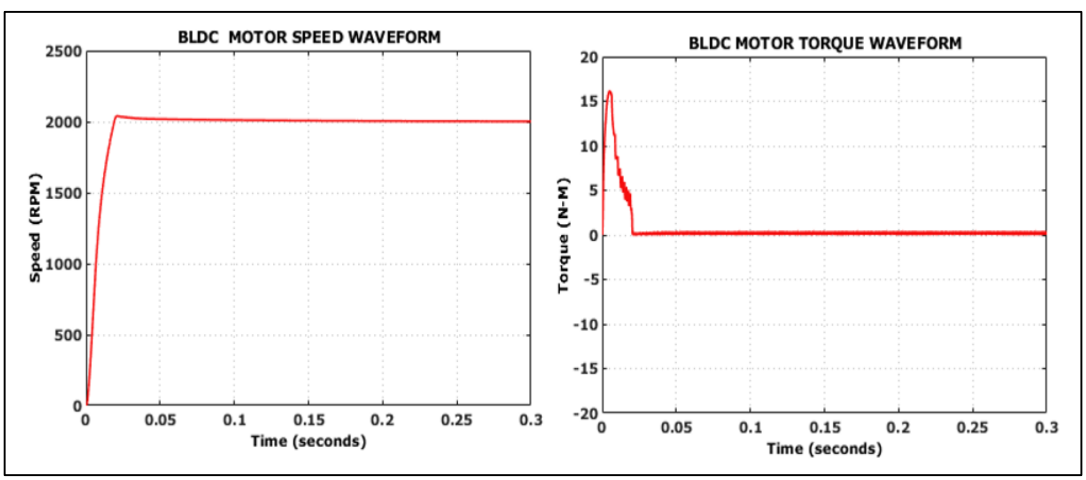

Fig. 18 Speed and torque waveforms of BLDC motor

In Figure 18, the BLDC motor's speed improves quickly; it reaches a maximum power of 2000 RPM and goes to a constant speed. The BLDC motor's torque value is initially increased to 16 N · m and then reduced to 1 N · m at 0.03 seconds.

Figure 19 displays the comparison analysis between the previous Fuzzy Logic Controller (FLC) and the proposed controllers. When compared to the algorithms based on SOC, the proposed RNN controller achieves the highest SOC of 98%.

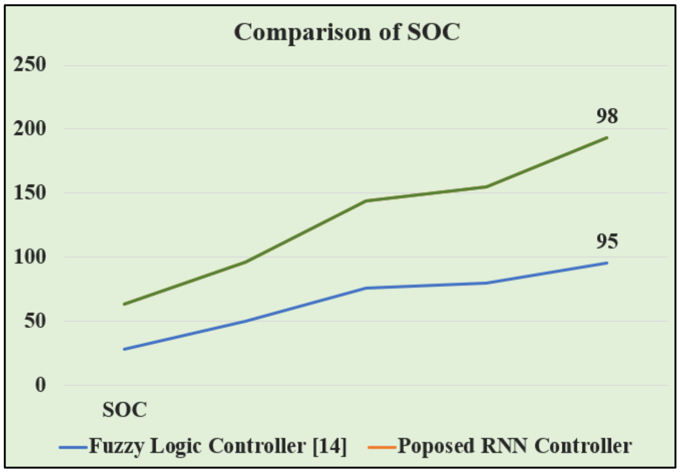

Fig. 19 Comparison of SOC

Table 2. Performance of comparative analysis

Converters	Conversion Efficiency %
MMC [13]	87
DC-DC Boost Converter [11]	95
Multiphase Interleaved Boost Converter [10]	97
IBC [12]	98
Proposed DCBC Converter	98.12

Table 2 displays the findings of the comparative analysis between various and proposed converters. When compared to other algorithms based on efficiency, the proposed DCBC converter achieves the highest efficiency of 98.12%.

Figure 20 shows the comparison of tracking efficiency across multiple controllers, proving that the proposed ANN-SBO MPPT has an efficacy of 98%. As demonstrated by the LSTM-MPPT of 88.32%, the Pb&O-MPPT of 93.45%, and the RNN-MPPT of 95.47%, the proposed controller outperforms the traditional controllers in terms of efficiency. Existing works often fail to provide the high conversion efficiency, fast dynamic response, tracking efficiency, and SOC required under varying load and environmental situations, while classical MPPT techniques like LSTM and Pb&O suffer from slow convergence, oscillations, and poor adaptability during partial shading or rapid irradiance changes. Hence, this work achieves better results than state-of-the-art techniques.

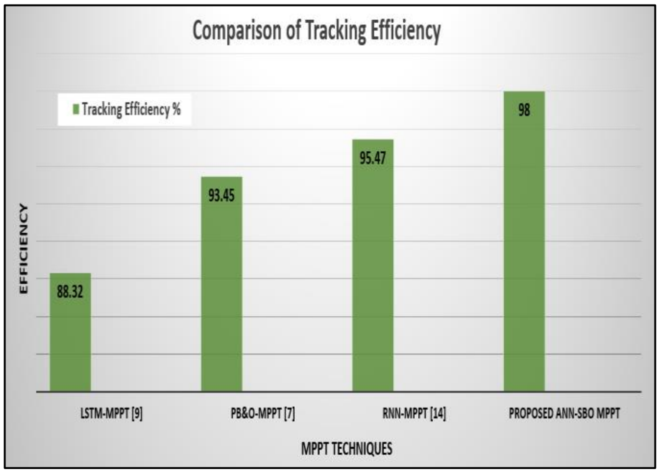

Fig. 20 Comparison of tracking efficiency

4. Conclusion

A DCBC with an ANN-optimised MPPT technique is proposed in this paper to power a BLDC motor and provide continuous energy to the motor. ANNs with a DCBC significantly enhance the energy efficiency and performance of HEVs. Its dual-stage architecture allows for better voltage regulation and improved efficiency, minimizing energy losses during conversion. Further, ANN-SBO with MPPT controllers offers enhanced energy efficiency and system stability. The purpose of this work is to enhance energy efficiency and optimize power management. As a result, comparison analysis demonstrates that the DCBC's high voltage conversion efficiency is 98.12%, and the tracking efficiency of ANN SBO is 98%. Further, the RNN controller predicts the battery's SOC of 98% more accurately and the better battery's lifespan compared to FLC. Additionally, this system improves overall energy efficiency and contributes to the development of more sustainable and environmentally friendly energy management solutions.

References

[1] Liang-Rui Chen et al., "Battery Current-Sharing Power Decoupling Method for Realizing a Single-Stage Hybrid PV System," *IEEE Access*, vol. 10, pp. 86864-86873, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[2] Md. Mizanur Rahman, and Yasser Abdel-Rady I. Mohamed, "Nonlinear Stability Analysis and Active Compensation of a Utility-Scale Single-Stage Grid-Connected PV System," *IEEE Access*, vol. 10, pp. 133333-133347, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[3] Andrei Korneev, Yitong Niu, and Amer Ibrahim, "Electric Vehicles in the 21st Century: Historical Evolution, Environmental Impact, and Safety Challenges for Sustainable Mobility," *Khwarizmia*, vol. 2024, pp. 32-38, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[4] Sairaj Arandhakar, Jayaram Nakka, and V.B. Murali Krishna, "A Comprehensive Analysis and Future Prospects on Battery Energy Storage Systems for Electric Vehicle Applications," *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, vol. 46, no. 1, pp. 13004-13031, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[5] Sahar Mohammed et al., "A Electric Vehicle Blockchain: Problems And Opportunities," *Babylonian Journal of Networking*, vol. 2024, pp. 18-23, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[6] Luise Middelhauve, Cédric Terrier, and François Maréchal, "Decomposition Strategy for Districts as Renewable Energy Hubs," *IEEE Open Access Journal of Power and Energy*, vol. 9, pp. 287-297, 2022. [CrossRef] [Google Scholar] [Publisher Link]
[7] Debabrata Mazumdar et al., "GAO Optimized Sliding Mode Based Reconfigurable Step Size Pb&O MPPT Controller With Grid Integrated EV Charging Station," *IEEE Access*, vol. 12, pp. 10608-10620, 2024. [CrossRef] [Google Scholar] [Publisher Link]
[8] Radha Kushwaha, and Bhim Singh, "Bridgeless Isolated Zeta-Luo Converter-Based EV Charger With PF Preregulation," *IEEE Transactions on Industry Applications*, vol. 57, no. 1, pp. 628-636, 2021. [CrossRef] [Google Scholar] [Publisher Link]
[9] Umair Younas, Ahmet Afsin Kulaksiz, and Zunaib Ali, "Deep Learning Stack LSTM Based MPPT Control of Dual Stage 100 kWp Grid-Tied Solar PV System," *IEEE Access*, vol. 12, pp. 77555-77574, 2024. [CrossRef] [Google Scholar] [Publisher Link]
[10] Nabil A. Ahmed et al., "Soft Switching Multiphase Interleaved Boost Converter with High Voltage Gain for EV Applications," *IEEE Access*, vol. 10, pp. 27698-27716, 2022. [CrossRef] [Google Scholar] [Publisher Link]
[11] Seyed Mehdi Rakhtala Rostami, and Zeyad Al-Shibaany, "Intelligent Energy Management for Full-Active Hybrid Energy Storage Systems in Electric Vehicles Using Teaching-Learning-Based Optimization in Fuzzy Logic Algorithms," *IEEE Access*, vol. 12, pp. 67665-67680, 2024. [CrossRef] [Google Scholar] [Publisher Link]
[12] Sajib Chakraborty et al., "Scalable Modeling Approach and Robust Hardware-in-the-Loop Testing of an Optimized Interleaved Bidirectional HV DC/DC Converter for Electric Vehicle Drivetrains," *IEEE Access*, vol. 8, pp. 115515-115536, 2020. [CrossRef] [Google Scholar] [Publisher Link]
[13] Erdem Gümrükcü et al., "Optimal Management for Megawatt Level Electric Vehicle Charging Stations With a Grid Interface Based on Modular Multilevel Converter," *IEEE Access*, vol. 10, pp. 258-270, 2022. [CrossRef] [Google Scholar] [Publisher Link]
[14] Sairaj Arandhakar et al., "Emerging Intelligent Bidirectional Charging Strategy Based on Recurrent Neural Network Accosting EMI and Temperature Effects for Electric Vehicle," *IEEE Access*, vol. 10, pp. 121741-121761, 2022. [CrossRef] [Google Scholar] [Publisher Link]