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OPTIMIZATION AND INTELLIGENT TECHNIQUES FOR ELECTRICAL VEHICLE

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***Abstract*:**The concept of EVs is actually sustainable, as they are charged with Renewable Energy. The expenditure and great efficiency of solar Photovoltaic (PV) system make it popular in today's society. In contradiction to conventional energy sources includes oil, fossil fuelsandnatural gas.In terms of their purity, quantity and environmental friendliness, renewable energy sources (RES) are considered the most promising. The voltage obtained from PV system requires boosting of voltage, which is attained with the aid of DC-DC converters. However, since the voltage is not steady when it is increased using a converter, a controller approach is employed to stabilise the voltage. In general, utilizing controller leads to issues like high current, voltage ripple, parameter tuning, computational stress etc. In order to overcome the issues designing of an effective controller approach is necessary. In this proposed work, an analysis of various controller approach is carried out to propose an effective and intelligent approach for active working of converter.

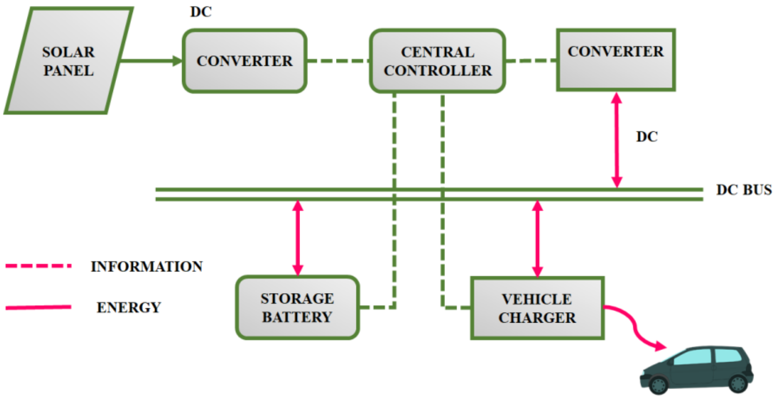
I.INTRODUCTION

The need for energy has increased significantly as a result of growing population. With this increase, the use of transportation is increasing in day to day life. As an environmental awareness, Electric Vehicles (EV) are introduced, which is a replacement for gasoline-powered vehicles in the automotive industry [1]. The main cause of the change is the carbon dioxide emissions that come from vehicle ignition. Therefore, an alternative to fuel-based automobiles is needed, like EV [2]. A traditional energy source utilised to produce electricity is fossil fuels. Because of the emissions of carbon dioxide, this resource is harmful to the environment either directly or indirectly [3]. Compared to internal combustion engines (ICE), EV systems have benefits like zero vehicle emissions, a low maintenance, cost efficiency and greater safety measures [4]. Also, usage of grid tied EV system causes power shortage, voltage stability etc...Therefore, it is important to use alternative energy sources to meet both current and future energy needs. Solutions to supplant traditional energy sources like coal, oil and natural gas are being used more frequently in recent years. The utilisation of RESsupports the country's energy consumption for environmental reasons. In order to boost economic potential in the competitive energy market, RES assist with existing energy needs in some places. The utilisation of RES for the provision of electricity in small cities is rising as a result of higher environmental standards [5]. To combat energy problem and environmental degradation, it is crucial to produce renewable energy (RE), which offers flexibility to lessen the effects of RE access to the grid because RE sources exhibit exceptional features of variable and uncertainty [6].

The most sustainable forms of electricity production include solar photovoltaic systems, wind energy conversion systems and many others. When comparing other sources, solar PV systems are widely selected because of their characteristics, including their permanent structure, low maintenance costs and small size [7]. Solar energy is regarded as a clean, emission-free form of energy. The enhanced solar power generation is made possible by advancements in power electronics and PV systems [8]. The current price decline of solar PV has led to an upsurge in their installation. The efficient operation of EVs depends on their ability to be charged and discharged. The installation of PV systems is crucial to the EV charging system and is also favourable in terms of the locations [9].PV systems have advantages like renewability and cleaning, due to their unpredictable, cyclical and transient character, renewable sources have significant problems with reliability, persistence and power quality [10]. Hence, a converter operation is essential in order to improve the voltage form PV source.

In order to maximize solar power under a variety of meteorological and panel conditions, solar PV systems commonly use DC-DC converters like, Boost, CUK, SEPIC etc., to regulate the PV energy[11].The general representation of Solar PV for EV Charging infrastructure is illustrated in Fig. 1.However, the output voltage generated by converter is not stable. The problem of creating high energy regulation controller for converter operationis getting more challenging in PV system. Therefore, choice of an appropriate controller is essential in stabilizing the output obtain from DC-DC converter.

Figure 1 Structure of EV Charging Using PV System



To improve the converters effectiveness, numerous rule based techniques are established. In [12] Lipschitz Optimization (LIPO) algorithm is utilized which is a powerful global optimization method that relies on Lipschitz constant which accelerate convergence rates for issues with global smoothness. Here, the modified LIPO methodology is implemented to solve the solar system MPPT issue, which helps trackingglobal PV system maximum power under various partial shading conditions (PSCs).However, while it's tracking speed has improved considerably, overall performance hasn't improved much. In [13] Manta Ray Foraging Optimization approach is employed, which is a bio-inspired optimization algorithm whose behaviour mimics three Manta ray foraging properties in order to create an effective optimization norm for solving novel operational problems. This approach results in generating finest solution, but not in all locations. In [14]Improved Team Game Optimization (TGO) is a proposed, which metaheuristic population based method with the benefit of requiring no tuning parameters to reduce complexity, hinged on observed behaviours of PV system during various shading conditions, solar intensity changes and load disturbances. Anyhow, it requires change when there is changes in converter. In [15] Modified Particle-Swarm Optimization (MPSO) method is described, which improves performance and boosts the output power of PV systems in unusual circumstances within short period. However, both environmental conditions and loading states affects the fitness value. Likewise, in this article, a comparison analysis is carried out between several control approaches. From the analyses it is observed that common issues like components damage in case of high current, high part counts, switching noise and ripple etc., are there. Hence, it is necessary to design an intelligent and optimized approach to tackle the issues for better performance of converter.

II.REVIEW ON OPTIMIZATION TECHNIQUES

A lot of optimization and intelligent approaches were established to control the converter operation and some techniques are frequently utilized to enhance the converter performance without any computational stress. Some of the optimized techniques are detailed as follows.

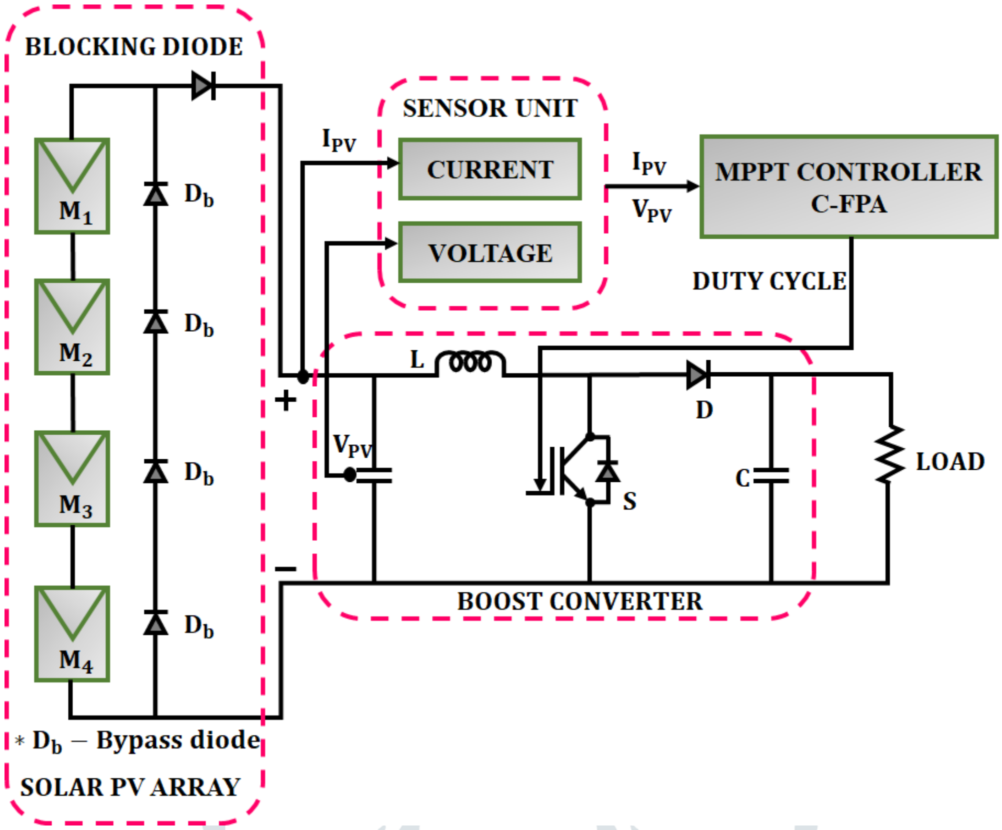
2.1 Chaotic Flower Pollination Algorithm

A unique method for MPPT optimization has been employed in this study. The Chaotic Flower Pollination Algorithm (C-FPA) is a proposed technique that integrates chaos maps to adjust the essential algorithm parameters in an adaptive manner. Utilizing various partial shading techniques, the efficiency of the presented variants is demonstrated. Additionally, these variations are approved for monitoring the GMPP in situations where there is a quick and dynamic change in the irradiance conditions. The schematic diagram of C-FPA is illustrated and Fig. 2. Mathematically, during global pollination the FPA approach is expressed as:

$$U_i^{T+1} = U_i^T + \gamma L(\lambda)\left(G_* - U_i^T\right) \tag{1}$$

At iteration T the solution vector i is specified asU_i^T, global solution asG_*, scaling factor asγ and levy factor as $L(\lambda)$.

Figure 2 Schematic Representation of C-FPA



An effectiveness of the suggested variations in contrast to the FPA in standard version is assessed using a number of statistical analyses. The important finding makes it clear that combining chaos maps with FPA increases it's FPA's reliability and consistency and provides greater tracking efficiency. Nevertheless, because to its non-linearity, poor output power efficiency, short lifespan and dependence on climatic factors such as temperature and irradiance for generating power, solar PV has drawbacks and difficulties [16].

2.2 Population-Based Algorithm

In order to provide a long-lasting solution for partial shading issue, this article suggests brand-new population-based dynamic reconfirmation strategies.Three successful algorithms are proposed fir attaining optimal results. The suggested algorithms efficacy is assessed using certain specifications, such as the proportion of power loss and enhancement. Additionally, a typicalTotal Cross Tied (TCT) connection and recent publication methods like the Genetic Algorithm (GA) and Competence Square (CS) are compared to the findings. The findings of current and voltages in a TCT connected system is expressed as:

$$I_{R_x} = \sum_{y=1}^{9} I_{xy}, x = 1,2, \dots ,8,9 \quad (2)$$

$$V_{array} = \sum_{x=1}^{9} V_{m_x} \quad (3)$$

Here, total PV current at row x is denoted asI_{R_x}, total voltage across terminals as V_{array} and voltage at row x of the PV module asV_{m_x}.Real-time irradiation data from a specific site is consider as an input to the suggested algorithms for efficient shade distribution to show a possibility of the proposed methodologies for real time implementation. Additionally, the system's many peaks are less frequent according to the PV parameters reported. This technique involves connecting PV strings to individual converters that have the same irradiation level. Nonetheless, because it uses a lot of converter circuits, this technique is costly [17].

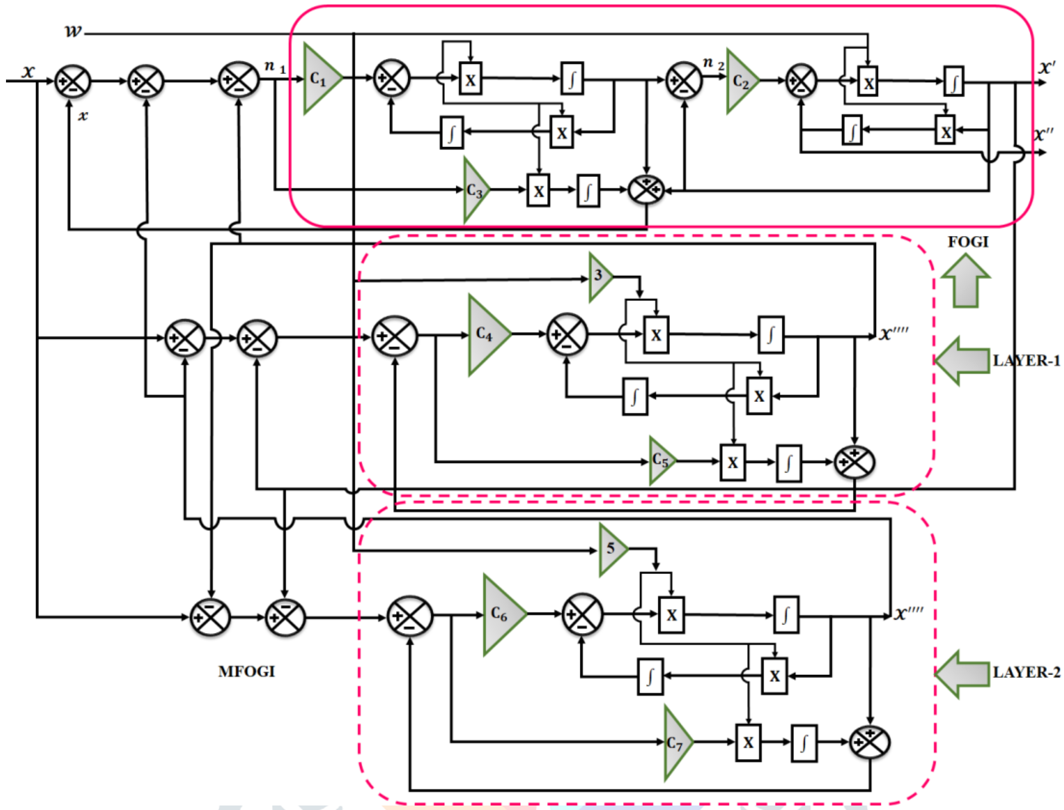
2.3 Managing Energy Storage in Real-Time Stochastic Optimization

In this exploration, a real-time domestic BES power managing strategy is suggested for a householder with a Photovoltaic hybrid system to minimise daily electricity expenses, with an emergence of advanced real-time energy management algorithm with optimizing parameters. Revised load and photovoltaic profiles obtained from rolling horizon forecasts aid in boosting the energy management algorithm's ability to make the best choices. The optimization is more effective when unknown parameters and their correlation are taken into account. Reduced solar energy loss and proper use of energy storage are made possible by the incorporation of rule-based control in practical systems. Remaining offline power management techniques for the day ahead schedule of BES persist power losses in real time due to a stochastic behaviour of solar generation and its load. To lower a daily power purchase costs, optimization has been carried out in rolling horizon utilising deep learning based on memory technique with load and solar energy forecast profile. The optimum set point for BES is updated at a set interval using stochastic dual dynamic programming approach in a multistage stochastic programme a receding horizon. Online optimization techniques, on the other hand, necessitate update intervals that may cause solar energy to be postponed and discharged without necessity in actual systems [18].

2.4 Implementation of Multilayer Fifth Order Generalized Integrator

A unique Human Psychology Optimization (HPO) techniqueis implemented as adaptive control approach to monitor Global Maximum Power Point (GMPP) employing a single phase (1φ) two stage grid coupled partial shading system. The Structure of MFOGI is depicted in Fig. 3. This technique makes use of a brand-new single input fuzzy adjusted proportional integral (PI) controller and multilayer fifth order generalised integrator (MFOGI).

Figure 3 Architecture of MFOGI



The HPO is established for fast GMPP tracking and a photovoltaic feed forward component is integrated to a control algorithm to establish a rapid dynamic response. A benefits of MFOGI are established by analysing it with current approaches and through testing on a created laboratory prototype. These methods call for a vast amount of data, a sizable population and an intricate iterative procedure. Therefore, it is not feasible to apply this method on a cheap microcontroller due to the high computing burden [19].

2.5 Multi-Objective Optimization Using RESCA

A novel approach Reformed Electric System Cascaded Analysis (RESCA) or reforming power systems cascades evaluation, is being developed for an optimization of hybrid renewable energy systems (HRES), which include the grid, wind energy conversion systems, photovoltaic systems, energy storage systems and non-intermittent sources.Ho's approach has a number of drawbacks, including isolating operation mode single constraints optimisation, primitive system component model and single source handling and simplistic power control strategy. This method addresses the aforementioned drawbacks and a case analysis on its implementation demonstrates how straightforward and reliable the optimization technique is in addressing significant shortcomings of the currently used traditional optimization strategies. The primary tenet of LPSP optimization is that the system is designed to operate with no power loss at first. Nevertheless, to resistant the shortcomings of other optimization methods, such as low conversion rates, uncertainty surrounding a conclusive answer, localised optimal solutions that rely on the input range chosen [20].

2.6 Hybrid Approach for Interval Prediction of Solar Output

A hybrid ensembles technique based on a probability ship model generated for the best interval prediction of on-board solar energy. A hybrid prediction procedure is generated by conjoining a number of machine learning methods. These methods include Radial Basis Function Neural Network (RBFNN), back propagation neural network (BPNN), an Elman neural network and extreme learning machine (ELM). The ELM model is written as:

$$\sum_{i=1}^{K} \beta_i \lambda\left(a_i x_j + b_i\right) = y_j, j = 1 \ldots, N \quad (4)$$

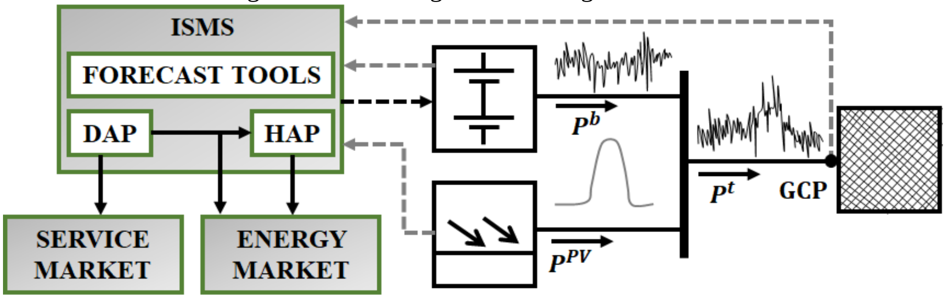
Here, $a_i$specifies the weight vectors of input to ith hidden layer, β_i indicates the joining of ith hidden layer with output and b_i denotes the hidden nodes bias.

Additionally, because of the ship's rolling, a power requirements of on-board PV modules exhibit considerable variability and stochastic uncertainty. It indicates that estimating maritime solar irradiance with terrestrial solar power forecasting techniques leads to major forecasting errors. Therefore, compared to a challenge of land based prediction with defined sites, the forecasting challenge for solar energy on board a ship is more challenging. This work develops a hybrid ensemble forecasting model to anticipate on-board PV power outputs while taking into account the effects of ship motions in order to resolve this challenging problem. To further increase an effectiveness of forecasting, the bootstrap method is required [21].

2.7 Optimal Planning Utilizing BESS-PV Systems

An optimal system management is a systematic approach for a photovoltaic power plant and storage battery .The main grid will receive photovoltaic power from this integrated system while also receiving droop based primary regulated output. An algorithm for day ahead planning schedules an energy profile for trading on the day-ahead market, which also determines a primary control reserve that an integrated solution can supply on the day under consideration. Fig. 4 illustrated the configuration scheme of the integrated system. A conjoint formulation integration of two services is the primary contribution of this work.

Figure 4 Block Diagram of Configuration Scheme



Additionally, the problem is specified in accordance with present grid codes and market demands. In order to account for the frequencies signal dynamics and PV generations uncertainty. It is important to note that the issue formulation is universal; there are no assumptions about the kind of battery and it performs, or highly the resources are rated. Future efforts, however, it will need to take into account of numerous functions by using a comparable methodology, as well as non-Gaussian depictions of uncertainty and stochastic models of an electricity price [22].

2.8 RECKF Technique for Rooftop-PV System

For a dual stage, grid connected, multifunctional Solar PV Array (SPVA) system, a Reliable Extended Complex Kalman Filter (RECKF) oriented control has been developed. It has the ability to function in conditions involving a polluted grid, such as uneven grid voltages and under overvoltage. When compared to single stage architecture, the double stage topology has more functioning zones. The load current sensed is given by,

$$i_L = \sum_{n=1}^{M} I_{pn} sin(\omega_n t_k + \varphi_n) + v_k \qquad (5)$$

Here, magnitude is indicated as I_{pn}, angular frequency as ω_n andφ_n specifies the nth harmonic component of load. Also, observation noise is represented asv_k.The PI controller gains are tuned using an enhanced Real Code Particle Swarm Optimization(RCPSO) based Meta heuristic optimization technique, which successfully controls the voltage of VSC's DC link under disturbance in network. A utility of the revised RCPSO approach in maximising system performance under changing terminal voltage. Nevertheless, in accordance with advised practise and the harmonic control standard, grid current harmonics are maintained within a permitted range. Therefore, by modifying the innovation vector and consequently, the Kalman gain, the normal algorithms are still capable of functioning to anticipate the values of the states, which reduces the filter outcome [23].

2.9 Pareto Optimization on Solar PV

A complex urban environment of the organisation, where atypical PV shape and installations topologies are studied, to discover partial and complete shading of PV systems. Nominal Operating Cell Temperature (NOCT) for a glass section has been taken into consideration as an essential parameter of the Pareto optimization that reduces losses in a specific region with increased output energy and without flustering the effectiveness of entire system. A solar PV energy production systems can include as many solar panels as possible by maximising install variables including tilt angle, pitching, efficiency factor, elevation angle and shading to increase energy yield. The Paretooptimization (PO) method was used to design and optimise a solar system with a nominal power generation objective for a complicated structure in adensely populated in environment. This algorithm that takes into account both full and partial shadowing of photovoltaic array in an urban situation to enhance an effective energy generated by the solar panels. However the PV module's input data needs to be given extra consideration in the suggested method because it significantly affects an outputs [24].

2.10 Integration of Rooftop PV Based on ATC

Considering the optimum sequencing of power factor from rooftop PV generators, a unique hierarchical multilevel decentralised Optimal Power Flow (OPF) is employed to minimise the electricity loss in 3φunbalanced large scale distribution networks. To reduce energy loss while taking into consideration operating parameters, an Analytical Target Cascading (ATC) scheme based distributed sequential coordinating technique is developed. An acceptability and correctness of a parallelized coordination approach was also created and it was compared to a sequentially coordinating model in terms of solution accuracy and computing load. The described techniques, which involve OLTC collaboration and capacitor operation in distribution lines with substantial rooftop Solar PV installation, is used to a system over a prolonged period of time. But coordinating the injection of power flow by a large number of inverters for the best system functioning is a challenging problem that necessitates an appropriate strategy. [25].

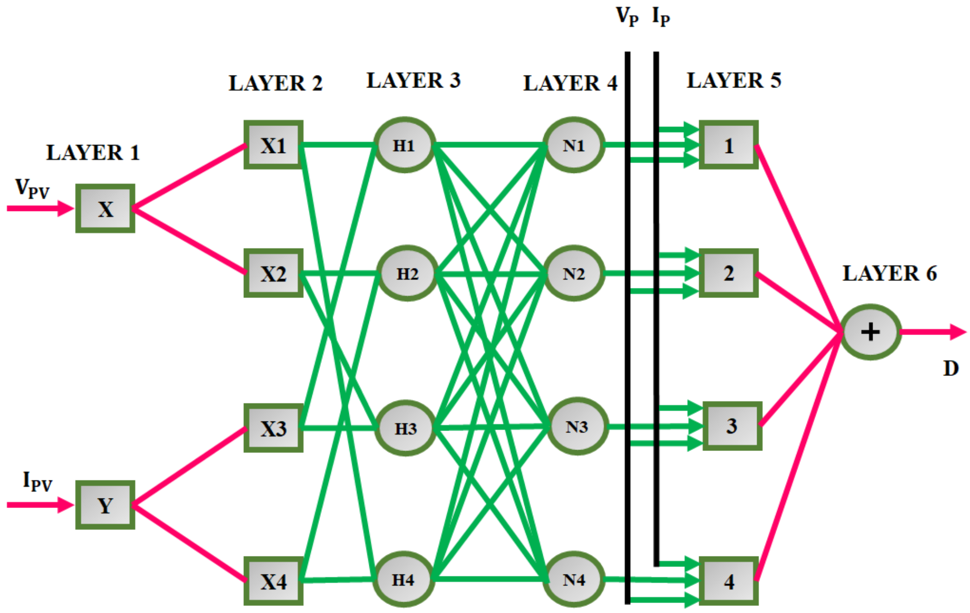
2.11 Hybrid ANFIS-ABC Algorithm Based MPPT

For grid tied photovoltaic systems, a unique MPPT approachhas been developed. Fig. 5 illustrates a hybrid Adaptive Neuro Fuzzy Inference System (ANFIS) and artificial bee colony (ABC) approach, which are employed to maximize a degree of membership. Thus, this regulates SEPIC premised MPPT algorithm to provide quick PV power monitoring by minimizing the

RMSE using Equation 6. By generating switching signals for the inverter power switches, fuzzy logic control (FLC) improves the system performance.

$$RMSE = \sqrt{\sum_{i=1}^{N} \frac{(\bar{Y}i - Yi)^2}{N}} \tag{6}$$

Figure 5 Architecture of ANFIS-ABC Based MPPT



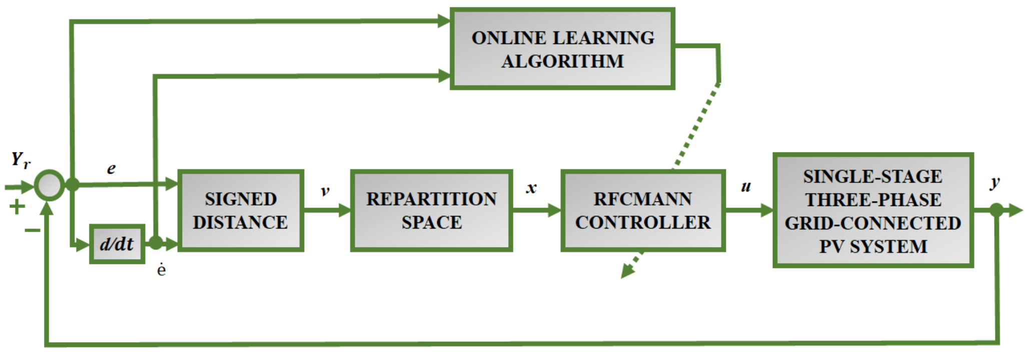
The suggested hybrid MPPT controller is unusual and it uses ABC algorithm to optimize tuning of ANFIS membership function, which has not previously been described for Photovoltaic power operations. The proposed hybrid ANFIS-ABC offer improved photovoltaic tracking efficiency, quick dynamic reactions, faster convergence and robust flexibility under various weather circumstances. Future research will focus on the extension of multilevel inverter architecture with Internet of Things (IoT) and improved MPPT advancements based on machine learning [26].

2.12 RFCMANN Oriented MPPT Approach

This work suggests the novel Recurrent Fuzzy Cerebellar Model Articulation Neural Network (RFCMANN) illustrated in Fig. 6, is a controller used in a single stage 3φ, photovoltaic system to locate grid problems. Likewise, to ensure acceptable learning precision while of covering a large input space, the input space for RFCMANN controller is additionally divided into appropriate resolutions using a decision boundary.The variable learning rate coefficients are additionally established by using discrete type Lyapunov functions in order to change learning rate values while maintaining convergence of the suggested RFCMANN controller.

$$\eta_1 = \frac{\left(\frac{1}{2}\right)}{\sum_{j=1}^{12}\left(\frac{\partial y(k)}{\partial w_j}\right)^2 + \varepsilon}, \eta_2 \frac{\left(\frac{1}{2}\right)}{\sum_{j=1}^{12}\left(\frac{\partial y(k)}{\partial m_j}\right)^2 + \varepsilon}, \eta_3 = \frac{\left(\frac{1}{2}\right)}{\sum_{j=1}^{12}\left(\frac{\partial y(k)}{\partial \sigma_j}\right)^2 + \varepsilon}, \eta_4 = \frac{\left(\frac{1}{2}\right)}{\sum_{j=1}^{12}\left(\frac{\partial y(k)}{\partial r_j}\right)^2 + \varepsilon} \tag{7}$$

Figure 6 Structure of RFCMANN Controller



Here ε specifies the smallest positive numbers. It is also possible to retrieve the online learning system parameters' method. Finally, a number of instances are evaluated to determine how well the suggested RFCMANN controller performs. In addition to ensuring safe operations, for a grid tied photovoltaic (PV) system during grid faults, the presented method is capable to support reactive current. An occurrence of oscillation over maximum power point and simple to lose tracking of MPP during quick irradiance level changes are drawbacks of the proposed approach [27].\

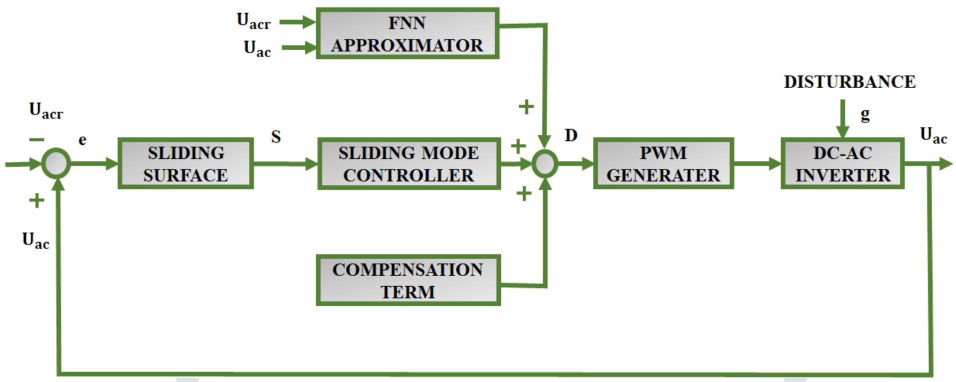
2.13 Grid Tied PV System Using FNNGFTSMC

In this study, a transformerless single phase (1φ) PV grid connected technique for adaptive Global Fast Terminal Sliding Mode Control (GFTSMC)utilizing Fuzzy Neural Networks (FNN) has been developed. The system primarily consists of a boost chopper and a dc-ac inverter. Utilizing PV array to its full potential, the boost section tracks the maximum power point. This work uses the INC approach with adjustable step size to build an MPPT of a photovoltaic system. The DC-AC converter is controlled using an optimized Fuzzy Neural Network Global Fast Terminal Sliding Mode Control (FNNGFTSMC) approach as shown in Fig. 7. FNN is adopted for approximating system uncertainties as:

$$\hat{g} = w^T \xi(x) \tag{8}$$

Here connection weights of FNN is denoted as w, input layer transfer function to rule layer is represented as ξ and estimation at FNN output is specified as $\hat{g}$ with uncertainties g.

Figure 7 Schematic Representation of FNNGFTSMC



With the aid of a GFTSMC method, the tracking error between an H-bridge inverter's output voltage and the grid reference voltage compresses to zero in a short period of time. The system uncertainties are approximated using FNN, which improves inverter robustness. Likewise, switching strength in control law is relatively low, since system instabilities are corrected iteratively, thereby reducing chattering of the system. FNNGFTSMC achieve dependable grid-connection and are flexible to changes in the external environment, however the dynamic tracking procedure is slower [28].

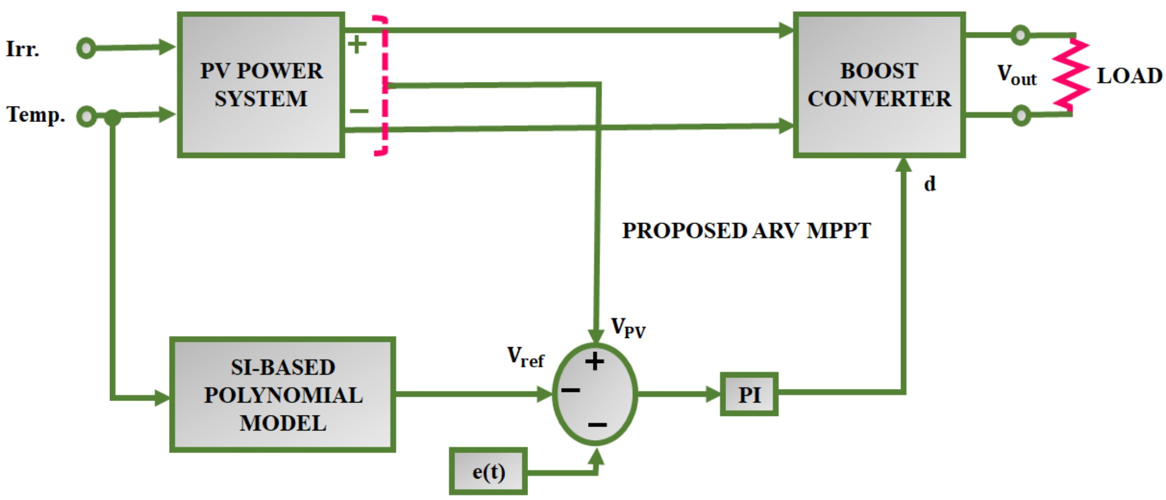
2.14 MPPT Approach with System Identification Utilizing ARV

In this research, a novel MPPT approach for a PV system with homogeneous irradiance is presented. It is created utilizing System Identification (SI) and is termed as SI-dependent polynomial Adaptive Reference Voltage (ARV) as depicted in Fig. 8. This technique utilizes a model with a simplistic polynomial structure to calculate the reference voltage. The black box modelling technique of photovoltaic power system wherein maximum power is monitored and is used to determine the reference voltage using a SI-based polynomial modeling. In general, polynomial design is formulated as:

$$A(q)y(t) = \sum_{i=1}^{n_u} \frac{B_i(q)}{F_i(q)} u_i(t - nk_i) + \frac{C(q)}{D(q)} e(t) \tag{9}$$

The variables from A to F is specified as q^{-1} (time shift operator). Here, $e(t)$ specifies the noise with variance λ. Also, u_i indicates the ith input, the total input as n_u and ith input delay as nk_i.

Figure 8 Block View of SI-Based ARV MPPT Approach



The generated nonlinear model is unaffected by the PV system's physical parameters. Additionally, the issue of Maximum power capture that occurs due to temperature change has been resolved. The resulting have therefore demonstrated that the suggested reference voltage-based MPPT approach outperforms existing methods in monitoring MPP under fluctuating atmospheric conditions. Maximum power point is obtained with minimal changes in voltage, current and power. Low-level microprocessors readily perform it because of its straightforward and affordable structure.Optimizing the polynomial model's coefficients and degree leads to the creation of a system model that is more functional [29].

2.15 Eliminating Harmonics Using ANN-NR Approach

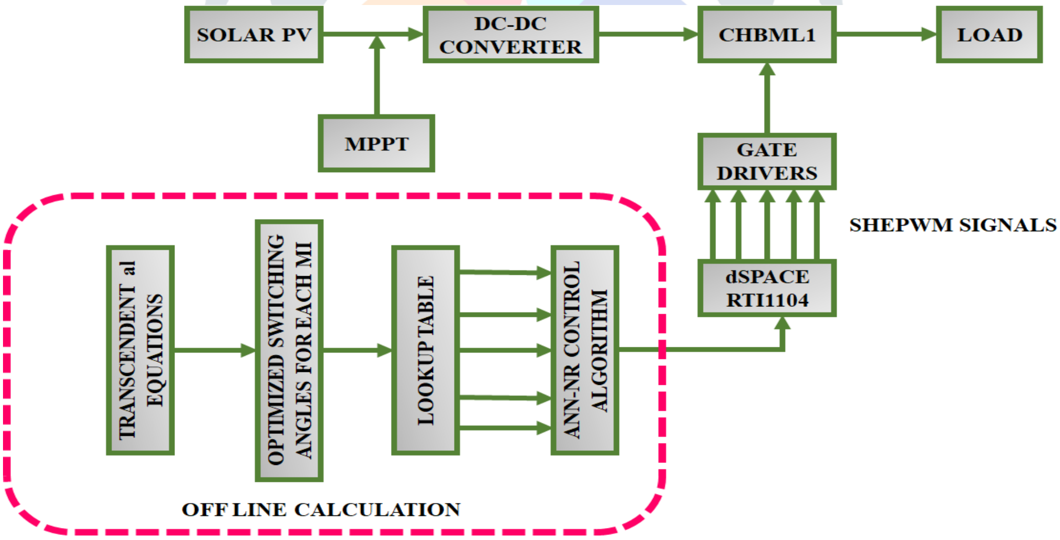
The PWM methodology, which uses both Newton Raphson (NR) technique and ANN, is highlighted in this research along with an integrated algorithm. In order to lessen the undesirable decreased harmonic distortion in cascaded H Bridge multi-level inverter for solar PV systems, a hybrid ANN-NR is developed in this research. The block representation of SHE-PWM is illustrated in Fig. 9. To improve and lower the Total Harmonic Distortion (THD), harmonics are extracted by making wise decisions about switching angles and utilizing the Selective Harmonic Elimination (SHE) PWM in conjunction with the same approach. The output voltage of this approach is written by,

$$f_n(t) = A_0 + \sum_{n=1}^{s} \left(A_n \cos(n\omega t) + V_n \sin(n\omega t) \right) \tag{10}$$

Here, the DC component is given byA_0, harmonics asA_n and odd harmonics asV_n.

The ANN is trained using offline computations of optimal switching angles, and the estimations it produces serve as Newton Raphson method's first guess. A 3-stage boost converter is utilized to enhance the input of inverter, which is obtained from photovoltaic system. For more efficient solar PV operations and stable output, P&O-based MPPT approach is applied. The proposed method is effective and provides extremely accurate firing angles after a few cycles, thereby increasing the ability to handle local optima values. The established SHE-PWM technique is a good fit for FACTS device and grid-connected scenarios. The discussed algorithm has shortcomings, such selection strategy for new population, complexity of finding local optima with a rough search space and low convergence [30].

Figure 9 Structure of SHE-PWM Based on ANN-NR



2.16 STPV Based on Custom Neural Network

Semitransparent Photovoltaic (STPV) technology is used in a broad range of submissions to enable sunlight absorptivity for generating solar electricity with some shade, which is advantageous in warm climates.The suggested methodology analyses a Thin Film Solar Cadmium Telluride Type Module to simulate the generated power that is represented by its mathematical formula and describes the efficacy of this type of PV system. A suggested model incorporates three components such as a number of hidden layer neurons, using all information available and a linear output activation function. The developed algorithm's mathematical modelling concept is represented as,

$$h_j = {}^{1}/[1 + \exp(-\sum_{j}^{m} = 0\, W_{ij}^{h} * X_j)] \tag{11}$$

This reduces the difficulty of resolving the network problems.Convolutional Neural Network (CNN) model PV systems is implemented in real-world applications and the output power of the recommended model validated both the feasibility and power quality that PV power systems demonstrate. Only a certain amount of irradiation causes each individual thin film module to generate electricity.There has been a notable increase in the number of electrical entries employing ANN-built methodologies during the last few years. However, there have not been many applications for PV systems [31].

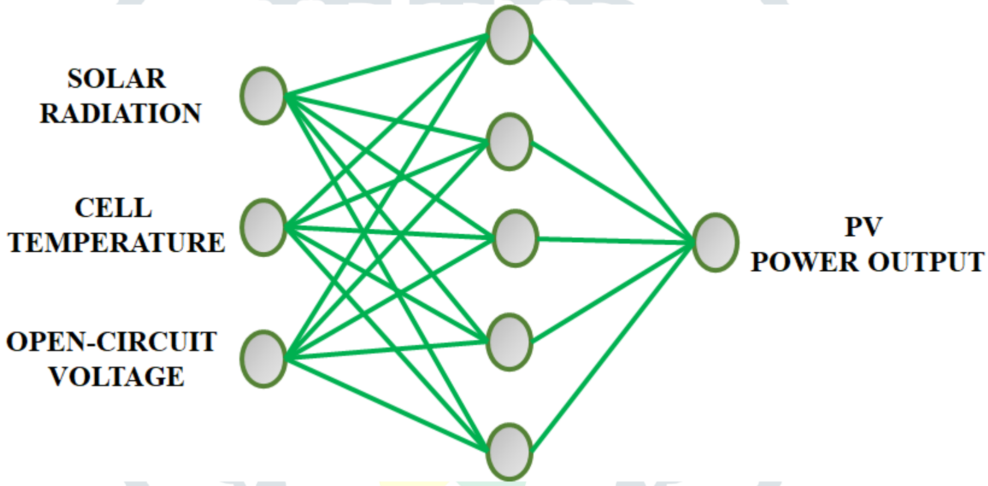
2.17 Modified PUC-5 Inverter Based on ANN Approach

The reliable performance of a 1φ Modified Packed U Cell five level inverter (MPUC-5) for solar application to operate consistently under a variety of irradiance conditions is achieved by the development of an artificial neural network (ANN) based controller. A converter having an equal amplitude main and auxiliary dc links is characterized as an MPUC-5.The MPUC-5's output's fundamental value also has a tendency to fluctuate.It has to be capable of generating angles, which commit to an AC voltage output with a stable core value are limited to minimal THD and exclude third order harmonics caused by variations in the voltages on dc link.The test dataset has been used after training to assess the performance of network, while training and validation datasets are engaged during training.Once the best result in the validation is obtained, the training is terminated.The training dataset's over fitting is prevented. The ability to remove harmonics is achieved by increasing switching pulses. Furthermore, the difficulty of the SHE equation enhances with the number of switching pulses [32].

2.18 Monitoring of PV Panel Using ANN

A unique real time tracking method that employs a modest but efficient ANN, small enough to function on a cheap device has been implemented. The solar panel degradation caused by fault situations has been detected by the described PV monitoring system.The model has been developed to forecast the power output of a solar panel which is typically functioning under a variety of shifting environmental factors.Depending on the type of information required to pass across the network, a particular network topology is chosen. The Feed Forward Neural Network (FFNN) as shown in Fig. 10, approach is highlighted as an efficient technique among the many ANN topologies.

Figure 10 FFNN Architecture



Heterogamous PV panels with multiple production features are regulated by the newly introduced surveillance system.The suggested tracking system has capacity to record information online over the internet to support other crucial topographies like notification, additional training, configuration management modification and, data analysis.The expense per additional PV panel decreases as more Solar panel are added to the monitoring system.Therefore, an intelligent monitoring system is essential in the event of an alteration in weather dependent energy efficiency [33].

2.19 Analysis of Step-Size Using RBFC Technique

An integrated fuzzy radial basis functional regulator with different step dependence is proposed.When establishing the hybrid power point finding controller, the benefits of fuzzy and ANN are taken into consideration.The RBF is comprised of five input neurons, one output side node and nine hidden layer nodes. A variable step RBFC has been used in the hybrid MPPT controller's first stages to place the PV array's operating point close to the desired power point location. Engineering based uncertainty difficulties are solved using fuzzy logic and it provides precise solutions to challenging nonlinear issues. The PV converter is operated with good efficacy in a variety of partially shadowed conditions owing to the RBFC optimized Fuzzy controller. Furthermore, disadvantages of IC include significant complexity when coupled with traditional P&O controller and moderate power fluctuations near to the MPP [34].

2.20 Estimation of Hybrid ANFIS-PSO Approach

A hybrid MPPT methoddeveloped on ANFIS-PSO to obtain quick and maximum PV power even without oscillation tracking is suggested. There is no additional sensor needed to monitor irradiance and temperature variables when employing the ANFIS-PSO based MPPT approach.The technology employed provides significant driving control to improve PV energy extraction.Fast, precise and reliable PV monitoring is attained by the suggested MPPT's performance under a variety of seasonal changes.During very erratic solar irradiance, the PV energy system operates with zero stable error and a quick PV tracking convergence speed.The following mathematical formula is related to multilayer feed forward network,

$$W_j = \mu P_j(x) * \mu Q_j(y), \overline{W_j} = \frac{W_j}{W_1+W_2}, j=1,2. \qquad (12)$$

The hybrid ANFIS-PSO is more effective at tracking power generation. It has the shortest execution time for RMSE and allows free extraction of antecedent variables for appropriate training under uniform, partial shading and non-uniform situations. Nevertheless, the system's temperature changes along with fluctuations in solar radiation [35].

III.COMPARATIVE ANALYSIS

A complete observation is carried out between distinctive optimization approaches and intelligent techniques for analysing the performance of converter in a system. Tab.1 and 2 specifies manifold approaches along with its merits and limitations.

Table 1 Comparative Analysis of Optimization Approaches

SI. No.	Author/Year of Publication	Methodology	Advantages	Limitations
1	Zeyuan Yan *et al* [2019]	Improved Brain Storming Optimization (IBSO) is utilized to establish local and global search for the entire process [36]	Increasing the accuracy in identifying the parameters of different PV modeling techniques.	Restricted and multi-objective optimization and difficult renewable energy challenges demand further IBSO enhancement.
2	Hong Liu *et al* [2019]	A fast optimization technique for BSS day-ahead monitoring is created by fusing genetic algorithm with feasible solution space [37].	Enhances the algorithm's overall uniqueness and succeeds in efficiently exploring optimum solution.	Expense of risk penalty is larger, which suggests that the solutions has lower customer satisfaction and poorer viability.
3	Abdullah M. Shaheen*et al* [2021]	Forensic Based Investigation Algorithm (FBIA) is proposed to precisely extract electrical properties of various photovoltaic configurations [38].	Comparing with other methods, FBIA model's optimal parameters are consistent.	Depends highly on case tools.
4	M. Premkumar*et al* [2021]	Chaotic map-based Gradient Based Optimizer (GBO), is utilised to analyze the PV parameter and to increase the precision and convergence rate of GBO [39].	Achieves lower RMSE, Minimizes STD value and faster convergence.	The suggested CGBO technique is anticipated to be used for industrial optimization applications and discrete optimization in future works.
5	Sad Motahhir*et al* [2021]	ABC optimization is established to draw optimum global power from each substring [40].	Provides effectiveness and precision for determining maximum available power from the complete PV system.	The slight deviation from a typical response is deemed as a problem.
6	ChanakaKeerthisinghe*et al* [2019]	Policy Function Approximation (PFA) approach is proposed for controlling PV-storage system efficiently [41].	Computationally quick for both online and offline phases, used for a longer period without updating and yet able to provide solutions of high quality.	In real-world applications, users are not able to alter the essential parameters.
7	Pengfei Zhao *et al* [2021]	Atwo-tage Distributionally robust- Volt-VAR pressure optimization (DR-VVPO) model is proposed, to control voltage variation, maintain gas quality and reduce IES system operation costs along with Photovoltaic uncertainty [42].	Offers system operators a workable operation plan for assuring gas quality and voltage profile stability at lower operational cost in the period of multiple energy sources and significant renewable absorption.	Volt-VAR Optimization (VVO) is slightly impacted by gas quality management.
8	Bin Huang *et al* [2021]	A Deep Reinforcement Learning (DRL) based Proximal Policy Optimization (PPO) technique is utilized to carry out the capacity	In order to increase PV-net BSS's profit, PPO agent creates safe scheduling plans.	The primary drawbacks include their poor sampling efficiency and hypersensitivity towards modification

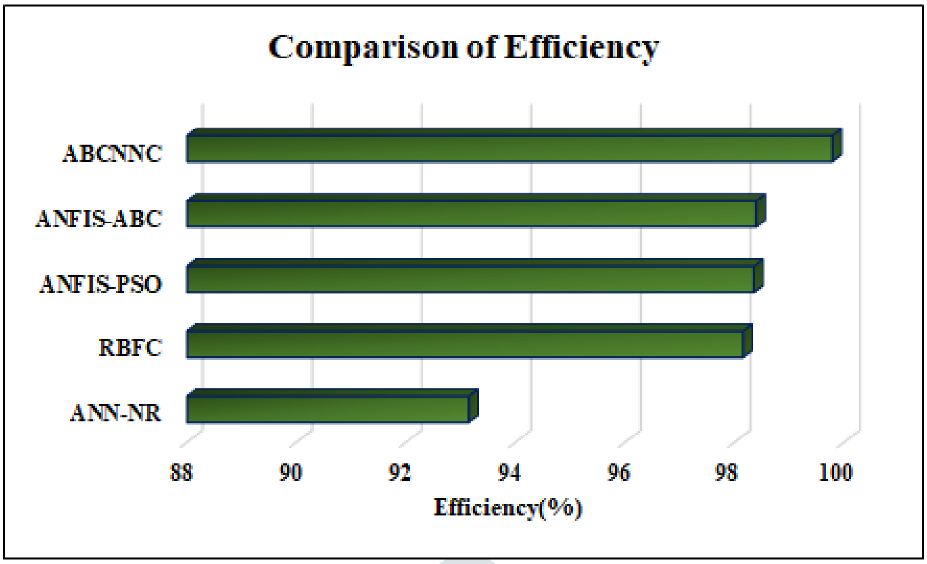
		scheduling of PV-BSS [43].		of hyperparameters including step size and learning rate.

Table 2 Comparative Analysis of Intelligent Approaches

References	Year	Author's	Description of the Work
[44]	2019	Nishant Kumar *et al*.	Power Normalized Kernel Least Mean Fourth (PNKLMF-NN) based approach and Learning based Hill Climbing (L-HC) MPPT approach for grid tied PV system is proposed, in which PNKLMF-NN provides enhanced results on non-linear loads and helps in reducing complexity.
[45]	2022	Sara Allahabadi*et al*.	This research introduces a new two-stage GMPPT approach that combines traditional Hill Climbing (HC) technique and ANN and intends to be precise and fast.
[46]	2020	Farkhanda Aziz *et al.*	In order to efficiently identify and categorise photovoltaic system defects, this research introduces a unique method that makes use of deep (Two-Dimension) 2-D CNN to extract feature from 2-D scalogram produced from PV system data.
[47]	2021	ArunprasadGovindharaj*et al.*	To essence maximum power from solar panel, an adaptive Chebyshev back stepping neural controller is presented.
[48]	2015	Faa-Jeng Lin *et al.*	In this study, a smart controller built on a 3φgrid-tied photovoltaic system's reactive and active power control during grid disturbances is developed utilizing Takagi Sugeno Kang Probabilistic Fuzzy Neural Network with Asymmetric Membership Function (TSKPFBB-AMF).
[49]	2021	VeerapandiyanVeerasamy*et al.*	In this article, a Recurrent Neural Network (RNN) based Long Short-Term Memory (LSTM) method is employed to determine High Impedance Fault (HIF) in a solar PV integrated system.
[50]	2017	Yang Sun *et al.*	The 1φ, residential photovoltaic system is proposed in this research that uses ANN and adaptive dynamic programming to regulate MPPT and integrate a solar photovoltaic array with the grid utilizing an LCL-filter-based inverter.

The following comparison graph exhibits the analysis made between different optimization and intelligent approaches in terms of efficiency, THD and tracking speed.

Figure 11Comparison of Efficiency (%)



The efficiency obtained by intelligent approaches like ABCNNC, ANFIS-ABC, ANFIS-PSO, RBFC and ANN-NR is displayed in Fig. 11. It is noticed that, the ABCNNC approach attains the maximum efficiency in comparison with other approaches. Similarly, the ANN-NR approach attains the minimum efficiency with 93.14%.

Figure 12 THD Comparison

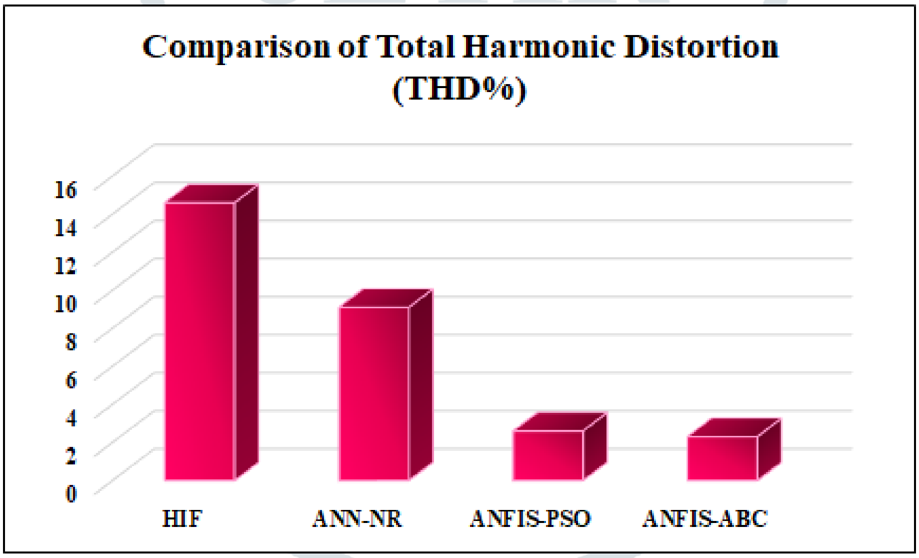
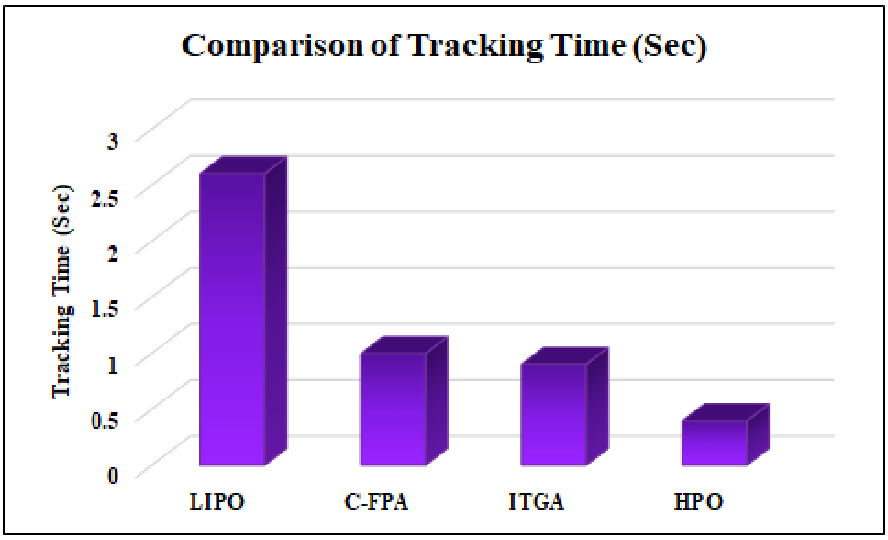


Fig. 12 demonstrates the THD comparison of intelligent approaches like HIF, ANN-NR, ANFIS-PSO and ANFIS-ABC. It if noticed that, the ANFIS-ABC approach has the minimum THD value of 2.3%, which meets the standard requirements of IEEE 519-2022. Similarly, the HIF technique attains a THD value of 14.6%, which is above the IEEE standards.

Figure 13 Comparison of Tracking Time (Sec)



The Tracking time comparison, performed between different optimization approaches like LIPO, C-FPA, ITGA and HPO is illustrated in Fig. 13, which aids in making decisions based on the system performance. From the comparison it is concluded that, the tracking time of HPO is faster when compared with other approaches. Similarly, establishment of new hybrid optimized techniques results in better tracking time than the recent approaches.

IV. Conclusion

EV charging systems have been incorporating solar PV modules for several years due to factors, including continuing price reductions for Photovoltaic modules, rapid EV growth and concerns over greenhouse gas emissions. However, converter operation is essential in order to boost the PV voltage. It is necessary for a converter to maintain stabilized voltage and hence controller approach is utilized. Several Intelligent and Optimized approaches are introduced in recent years for attaining stabilized voltage, but all those approaches face common issues like slow convergence, hardware dependence, computational stress and large training data. Therefore, it is essential to develop and hybrid optimized technique to overcome such issues. In this article, a comparison analysis is accomplished between various approaches for enhancing the performance of the system, to grab the optimal approach. The comparison graph is analyzed for efficiency, THD and tracking time for various approaches and optimal solutions are obtained. Thus, the evolution of electric power is expected to move inexorably toward renewable sources of energy. Hence, by developing hybrid approaches more efficient and improved outputs for control of converter operation can be attained.

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