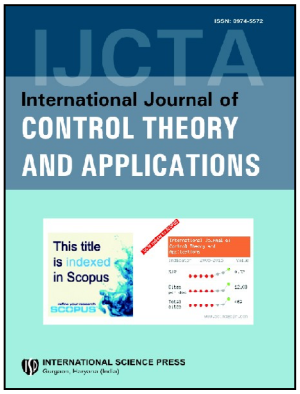

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An Battery Performance Aware Opitmal Solar Tracking System to Fulfill Home Appliance Need

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Abstract: An enhanced insists of energy needs made additional attractiveness of renewable energy resources where solar energy is very substantial one. Harvesting needed power from the solar energy resource turns out to be the most composite activity that is concentrated in diverse researches with the aim of attaining high power point. In our earlier work, HBAT-DEF algorithm is presented for identifying the best possible values of angle and position of solar devices to attain the high power point range. On the other hand, the photo voltaic panels will not produce steady voltage and current that may result in battery performance deprivation and as well battery life time will be decreased significantly. This issue is solved in the presented research by presenting the new structure called Battery Performance aware Optimal Solar Tracking System (BPOSTS). In the presented structure, to increase the power production Dynamic programming based on Policy Iteration (DPPI) Algorithm is presented to discover the best possible values of angle and position of solar devices. Then Single-Stage Balanced Forward Fly back Converter (SSBFFC) is utilized for compensating the voltage power that are unevenness while it is noticed from the solar openly. Lastly battery lifetime performance is enhanced by utilizing three phase charging method which that enhance the storage performance, therefore the life span of battery cells can be enhanced. The simulation outcomes have been performed and the final performance outcomes have been verified that the presented research technique results in giving superior result to the previous research technique.

Keywords: battery lifetime, voltage imbalance, solar tracking, angle, location, fly back converter.

1. INTRODUCTION

Renewable energy resources have turn out to be the most widespread energy resources in current years, and researchers have made significant attempt to improve the effectiveness of these systems and to enhance the functionality. The conservative energy crisis and rising rate of environmental chaos for example air pollution and global warming; result in quickly rising rate of usage of non-conventional or renewable energy resources since they are spotless and free from a lot of dangerous effects. One among the most hopeful renewable energy resources is solar energy.

Photo voltaics (PV) include the transfer of light energy into electrical energy by semiconducting materials which reveal the photovoltaic effect, a fact considered in electrochemistry, photochemistry and physics. A classic photovoltaic structure applies solar panels, every consisting of an amount of solar cells that produce electrical power. The first step is the photoelectric effect subsequent to an electrochemical process where crystallized atoms, ionized in a sequence, produce an electric current [1]. PV installations possibly will be rooftop mounted, ground-mounted or wall mounted. They might be mounted in a stable direction to increase production and value or they might be mounted on trackers which track the sun crossways the sky.

A solar tracker is equipment on which solar panels are fixed that follows the movement of the sun crossways the sky making sure that the highest number of sunlight hits the panels all the way through the day [2]. While it is matched up with the cost of the PV solar panels, the rate of a solar tracker is comparatively less. The majority of photovoltaic (PV) solar panels are fixed in a permanent location platform, for instance it is fixed on the slanting roof of a house or on structure set to the ground. As the sun goes crosswise the sky although the day, this is distant from a perfect resolution.

The photo voltaic panels will not produce steady voltage and current that may result in the battery performance deprivation and as well battery life span will be decreased significantly. This issue is solved in the research by presenting the new structure called Battery Performance aware Optimal Solar Tracking System (BPOSTS). In the research work, to increase the power production Dynamic programming dependent upon Policy Iteration (DPPI) Algorithm is presented to discover the best possible values of angle and position of solar devices. Then Single-Stage Balanced Forward Fly back Converter (SSBFFC) is utilized for compensating the voltage power that are unevenness while it is monitored from the solar openly. At last battery life span performance is enhanced by utilizing three stage charging method that will enhance the storage performance, therefore the life span of battery cells could be enhanced.

The on the whole structure of the proposed work is specified in this manner: In this part, thorough discussion regarding the solar power system and the functionality of photo voltaic system is specified. In part 2, diverse associated research works has been conversed that concentrates on following the solar power systems are specified. In part 3, thorough overview of the presented research method is specified with appropriate diagram and examples. In part 4, simulation outcomes are matched up in opposition to diverse performance measures. At last in part 5, on the whole conclusion of the proposed work is specified.

2. RELATED WORKS

One among the first explanations of a MPPT system had been made public while Cheikh, M. A et al [3] explained a self adaptive DC converter for spacecraft power supply. It was the starting of the enormous growth of the domain [4]. Bread board confirmation has been accomplished with energy transfer in the 50W range utilizing hill climbing algorithm associated with bidirectional current mode power cell. Esram, T., et al [5] has presented a switching system which alters the cell array topology and connections or the configurations of the cells to acquire the needed voltage for the duration of diverse times of a day.

Kadri, R et al [6] mentioned that in case there is no battery exists in the system, so as to tie the bus voltage at close to constant level, an uncomplicated control could be applied. Masoum, M. A et al [7] thought that the boost converter is exposed to contain a minor benefit over the buck converter mainly at minor light levels. Giraud, F et al [8] utilized PV system with storage batteries, as a MPPT equipment to improve battery charging. The improvement must be superior to the interior loss of the device itself.

MPPT device underneath dissimilar climatic conditions of Beijing and Gaungzhan in china was regarded. Kolhe, M et al [9] identified that a PV array alone had comparatively less output power density and had significantly drooping I-V features. Consequently MPPT was utilized. This control idea was accomplished by simulation study by PSM and Labview software. Eakburanawat, J et al [10] studied a TE battery which utilizes waste heat and illustrated a battery charger that was powered by TE power modules.

V. Salas et al [11] evaluated the MPPT techniques in relation to Quasi seeking techniques that comprise wave filtering technique, backup table technique and so on and true searching techniques together with sampling techniques, differentiation technique and so on. Weidong Xiao [12] presented a modified hill climbing MPPT method for PV system installed as a test bench utilizing TMS320LF2407 controller for automatic testing mechanism.

Byunggyu Yu et al [13] proposed the design and experimentation outcomes of enhanced dynamic MPPT performance utilizing P&O MPPT technique that was assessed by European Standard EN 50530. Performance of P&O technique was assessed by 250 KW PV inverter. It was exposed that P&O technique proves maximum dynamic MPPT effectiveness underneath EN 50530. G.M.S. Esram, T et al [14] proposed a study of two high power point tracking techniques for grid connected photovoltaic systems. The most excellent operating forms of the perturbation and examination and the incremental conductance were inspected to recognize the functioning of photovoltaic structures.

N. Femia et al [15] proposed the customization of duty cycle perturbations to the dynamic behavior of the boost converter to understand P&O MPPT. They had exposed that the P&O parameters have to be modified to the dynamic behavior of the particular converter adopted. A hypothetical analysis letting the best possible option of such parameter was performed and was experimentally confirmed.

3. OPTIMAL SOLAR TRACKING SYSTEM WITH BATTERY PERFORMANCE IMPROVEMENT

Renewable energies are the very significant energy resources that are contaminant free and could produce more power of energy resources. Solar energy is the very significant energy resource in the India, mainly in Tamilnadu. Here the 90% of days are engaged by sun. Photovoltaic cells are utilized to produce power from the solar energy. In the research work, the best possible dealing of photo voltaic machines is focused to get better the power production capability and shield the battery life span.

In the research, the new framework called Battery Performance aware Optimal Solar Tracking System (BPOSTS) is presented. In the proposed work, to increase the power generation Dynamic programming based on Policy Iteration (DPPI) Algorithm is presented to discover the best possible values of angle and position of solar devices. After that Single-Stage Balanced Forward Fly back Converter (SSBFFC) is utilized for compensating the voltage power that are imbalanced while it is monitored from the solar openly. Lastly battery life span performance is enhanced by three phase charging method that will enhance the storage performance, therefore the life span of battery cells could be enhanced. The modules which are in the proposed methodology are listed in this way:

1) The best possible tracking of angle and position of solar devices by DPPI algorithm.
2) Voltage balance control by SSBFFC.
3) Battery life span protection by Three stage converter.

The thorough elucidation of the proposed method is listed in the subsequent subsections.

Optimal Tracking of Angle and Location of Solar Devices Using Dppi Algorithm

The plan of our research is to compute the best possible ST trajectories for the day ahead, dependent upon existing weather forecasts that could really come from online providers for at no cost. To this last part, it utilizes dynamic programming and, especially an instinctive policy iteration method (and variants). The method intertwines two separate PI procedures that are utilized in some other fashion. The first PI procedure, SlopePI, thinks a random input policy for the above MDP, e.g., a myopic one. It after that tries to get better that policy, in a common PI fashion, but presuming a permanent azimuthal policy, π_k. Specified this permanent π_k policy, it calculates the appropriate best possible slope-positioning policy, π_y. The output policy is afterward provided in a second PI algorithm that guesstimates the best possible (given π_y) azimuth-positioning policy, π_y.

The procedure redoes till convergence, or till some computational or time limit is attained. By merging the derived policies calculated for every axis, we could draw from a ST policy. The similar PI algorithm could be willingly applied for single axis tracking, with the action choice process for the static axis (the slope one, regarding VSAT) thinking just a set of permanent probable orientations for the complete motion (in order to guesstimate the optimal fixed slope angle for VSAT tracking throughout the next day). The on the whole PI method is exposed in Alg. 1, while Alg. 2 defines the PI process to draw from a slope policy (the PI for originating an azimuthal policy is completely alike). Notice that STPI efficiently changes amid resolving MDPs with state-action spaces that are orders of magnitude lesser than that needed by the real problem formulation. Although there are no proper assurances for junction to the best possible policy,4 the method is instinctive, and shows superior behavior in fact.

ALGORITHM 1

1. Procedure STPI (π)
2. Initialize π_y and π_k based on π
3. While π_y and π_k are not stable do
4. $\pi_y \leftarrow$ SLOPEPT (π_y, π_k)
5. $\pi_k \leftarrow$ AZIMUTHPI (π_k, π_y)
6. Derive π' by combining π_k and π_y
7. Return π'

ALGORITHM 2: Slope policy iteration

1. Procedure SLOPEPI (π_y, π_k)
2. while π_y is not stable do
3. for all $t \in I$ in descending order do
4. for all $s \in S$ that can emerge based on π_k and t do
5. a $\leftarrow$ <$K_a = \pi_k(s, t)$, $Y_a = \pi_y(s, t)$>
6. V_t (s) $\leftarrow$ $\Sigma_{s'} P(s,a,s')\ (R_a(s,s') + V_{t+1}(s'))$
7. For all $t \in I$ (in any order) do
8. For all $s \in S$ that can emerge based on π_k at t do
9. $\pi_y(s,t) \leftarrow \arg\max_y \Sigma_{s'} P(s,a,s')\ (R_a(s,s') + V_{t+1}(s'))$
10. Return π_y

Voltage Balance Control Using SSBFFC

To resolve voltage imbalance issue, a high competence and high power factor single-stage balanced forward fly back converter is presented as depicted in Figure 1. As the presented converter combines the forward and fly back topologies, it could function as the forward and fly back converters all through switch turn on as well as off periods, correspondingly. Consequently, it could not only carry out the power transmission for the duration of a complete switching time however as well attains the high power factor. Particularly, as the charge balanced capacitor Cb could create the presented converter carry out the forward process despite the input voltage, the magnetizing inductor offset current, core loss and transformer size could be reduced.

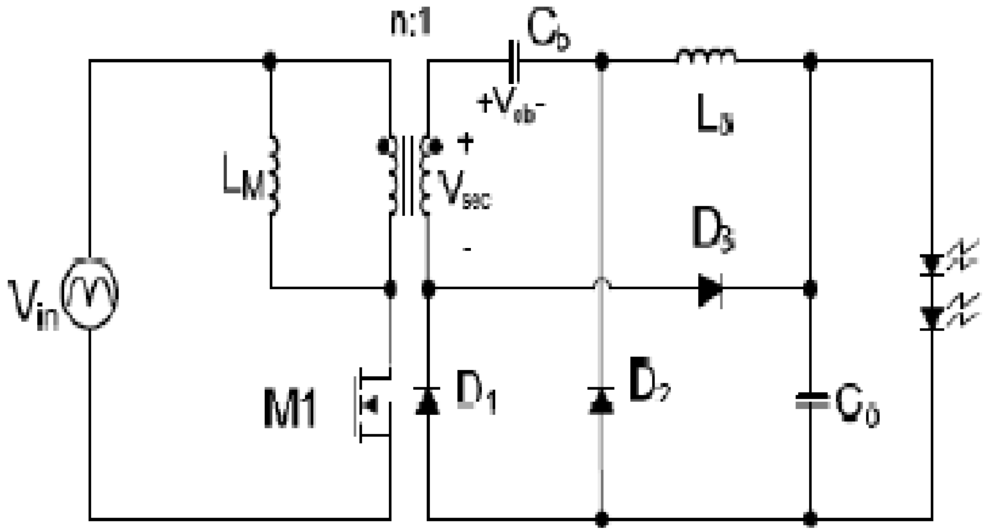

Figure 1: Proposed Single Stage PFC Forward fly Back Converter Circuit

Fig.1 depicts the circuit diagram of the presented forward fly back converter.[1] As exposed in this figure, its principal side is accurately similar as that of the traditional fly back converter comprising one power switch (M1) and one transformer. Conversely, its another side comprises one output inductor (Lo) for forward operation, one DC blocking capacitor (Cb) for balancing operation and three output Diodes (D1, D2, D3). While M1 is conducting, the presented converter works like a forward converter. Alternatively, if M1 is blocked, the presented converter works like a fly back converter. However, in case it is presumed that the presented converter contains no balancing capacitor Cb, aforementioned forward process is probable simply while the reflected primary voltage Vin/n to the transformer secondary side is greater than the output voltage Vo.

This is for the reason that the forward converter is rooted from the buck converter. Consequently, the forward-fly back converter works simply as a fly back converter over the range of Vin/n < Vo. Particularly, at the least input voltage near Vin=90Vrms, Vin/n is lesser than Vo all through lot of periods and therefore, the transformer contains a huge magnetizing offset current alike to the conventional fly back converter. In this situation, the transformer core loss and volume are furthermore as huge as those of the traditional fly back converter. Alternatively if the balancing capacitor Cb is successively included with the transformer secondary side, it could create the average current via Cb for the period of forward operation turn out to be accurately identical as that for the period of fly back process by the charge balance principle of Cb. In other terms, as the voltage across Cb charged by fly back operation is appended to the Vsec=Vin/n for the duration of forward operation, Vin/n+Vcb turns out to be greater than Vo and therefore, the forward operation is probable even at Vin/n<Vo. Consequently, the research forward-fly back converter with the balancing capacitor Cb could as well as work as forward and fly back converters apart from the input voltage.

Battery Lifetime Protection Using Three Stage Converter

The three stage battery charging methodology is a customized two stage constant current constant voltage (CC-CV) charging technique. In preference to two charging phases it contains three charging stages. The topology of the circuit utilized to develop this charging algorithm is alike to the two stage CCCV charging method as depicted beneath in the figure 2,

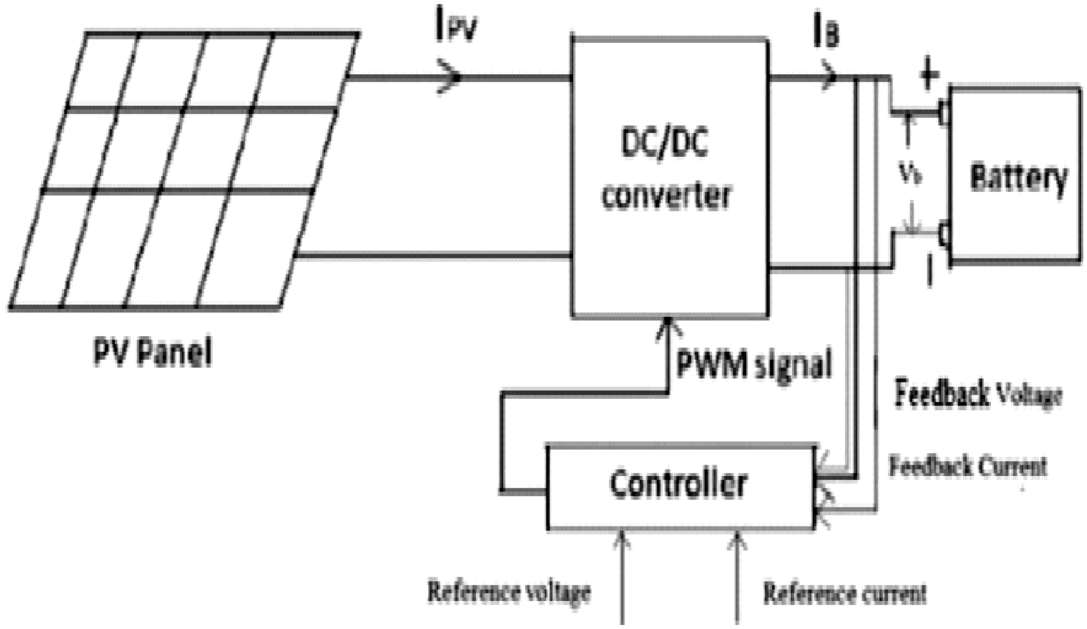

Figure 2: The Three Stage Charging Topology

The needed charging profile of the presented three stage charging technique is exposed in the figure 3,

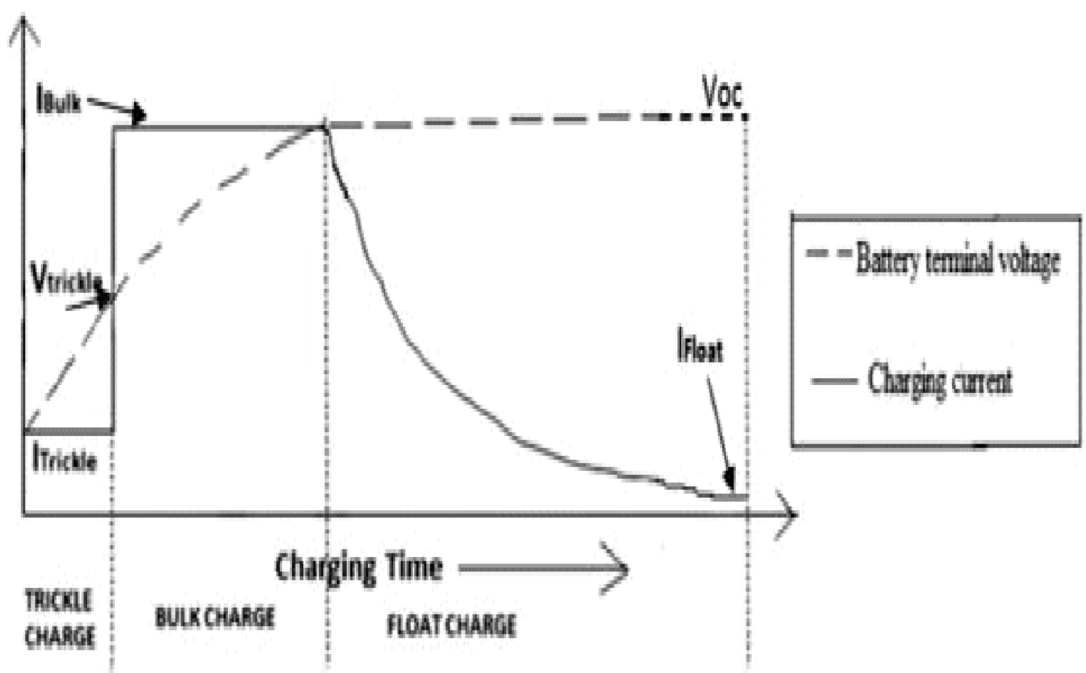

Figure 3: Charging Profile of the Three Stage Constant Current Constant Voltage Charging Technique

The three stage charge control logic is shown in figure 4.

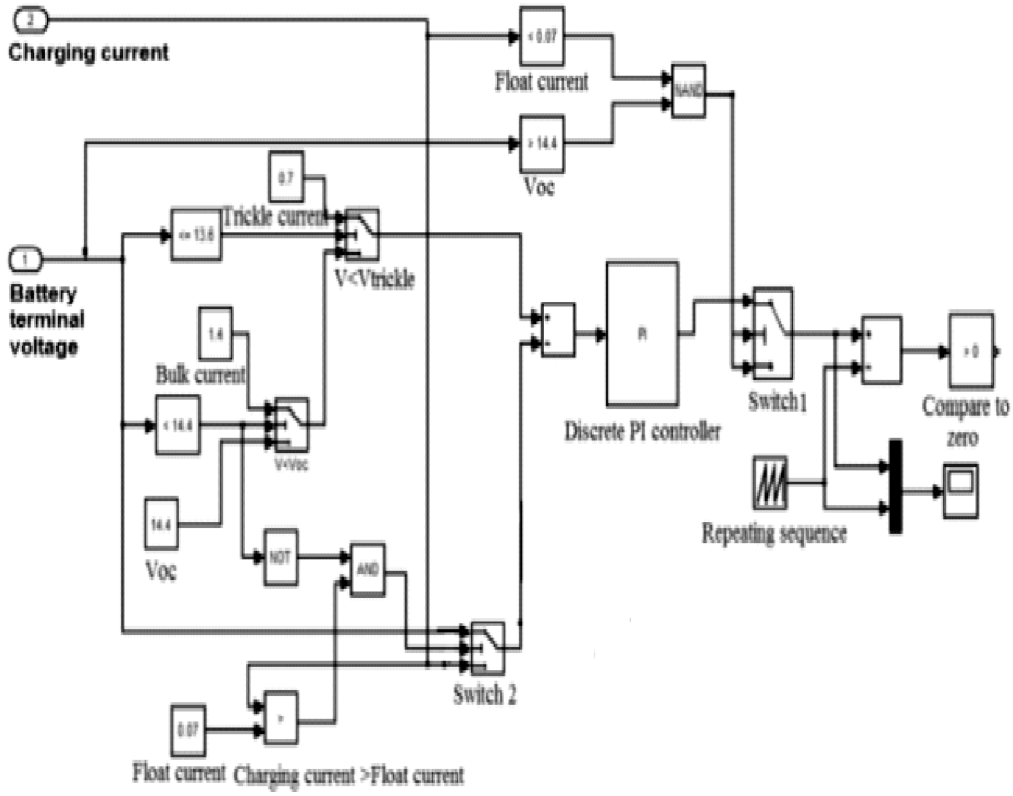

Figure 4: Control Logic with PI Controller for the Three Stage Charge Control Algorithm

Primarily the discharged battery terminal voltage is matched up to the trickle charge voltage threshold at the start of the charging process. In case the battery voltage is below the trickle charge voltage threshold (given by battery manufacturer) afterward the trickle charging phase is facilitated. Here in the above figure 4, the switch state called V <VTrickle is chosen if the charging current to be provided in trickle mode or not. When this state is right afterward the upper case (0.7 ampere) is enabled and in case this is false afterward the subsequently switch condition comes into action. The PI controller is intended in such a way that it reduces the error amid the real and the needed/reference value of charging current and in relation to that PWM (Pulse Width Modulation) signal is provided to the dc-dc buck converter.

The buck converter after that provides the preset trickle current to the battery. The trickle charge current reference is set to C/10 amperes here C is the battery capability in Ampere-hour (Ah). The lead acid battery utilized here for experiment contains capacity of 7Ah. For this reason the trickle charging current set for it is 0.7 Ampere. The battery voltage begins rising and the trickle charge current is provided to the battery till the battery voltage attains the Trickle voltage threshold VTrickle.

4. EXPERIMENTAL RESULTS

The experimentation assessment of the presented research method is performed in the matlab simulation environment. The presented research scenario called Battery Performance aware Optimal Solar Tracking System (BPOSTS) is matched up with our existing work Hybridized BAT with Differential Evolution function (HBAT-DEF) and the previous work called Particle Swarm Optimization (PSO) and Genetic Algorithm (GA) to verify the performance enhancement. This assessment is carried out in opposition to diverse performance metrics, for instance

1) Prediction accuracy.
2) Convergence rate.
3) Voltage level.

These measures are assessed underneath changing load conditions and timing for both presented and previous research methods. The comparison assessment is shown in the graph format that is demonstrated in the subsequent figures from 5 to 7.

Prediction Accuracy Comparison

Accuracy is described as, "The capability of a measure to match the real value of the quantity being deliberate". In the presented work accurateness is described as the capability of the research method to discover the location and place of sun properly with the intention that the greatest power point could be attained. In the subsequent figure 5 prediction accurateness comparison is demonstrated

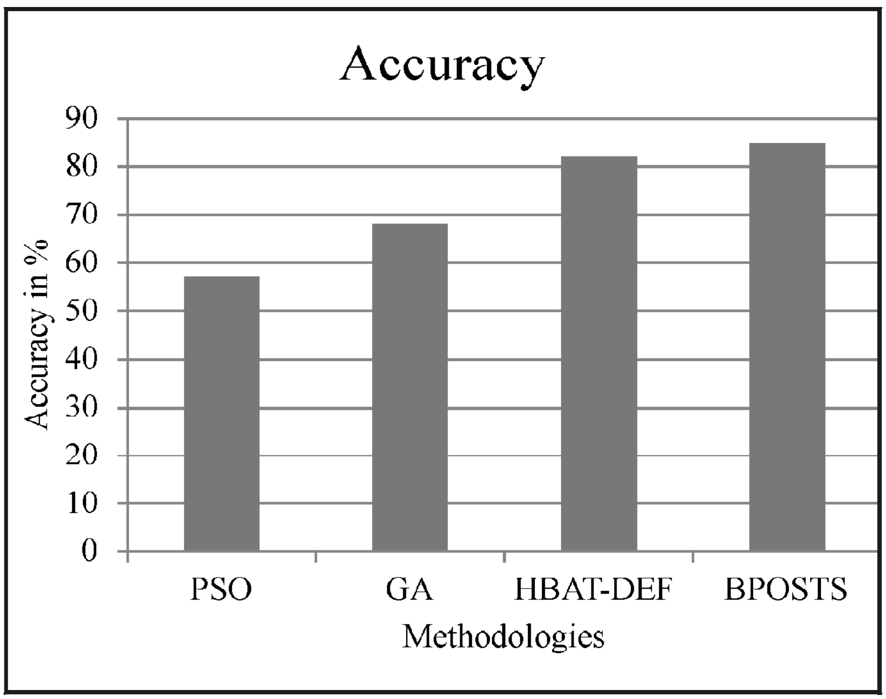

Figure 5: Accuracy Comparison

In the above figure 5, performance assessment of the research and previous techniques is specified. From this specified figure it could be verified that the research scenario results in giving superior result to the previous researches. The accurateness of the current methodology is enhanced 24% higher than the previous research techniques.

Convergence Rate

In arithmetical analysis, the speed at which point a convergent series approaches its boundary is known as the rate of convergence. Even though firmly speaking, a boundary does not provide details regarding any finite first part of the series; this idea is of realistic significance if we handle a series of consecutive rough calculations for an iterative technique, because afterward classically less iteration are required to produce a helpful rough calculation if the rate of convergence is superior. This might even create the distinction amid needing ten or a million iterations unimportant. The comparison of the convergence rate value of current and previous research methods is demonstrated in the figure 6.

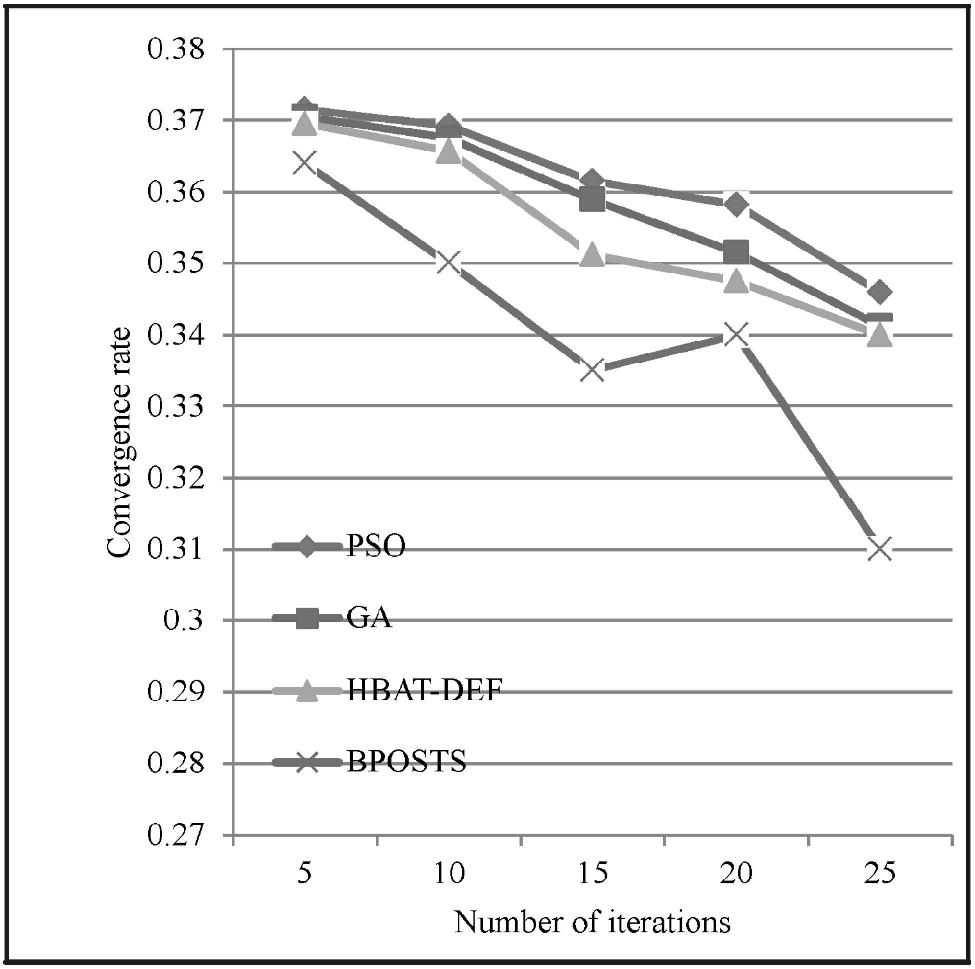

Figure 6: Convergence Rate Comparison

In the above figure 6, performance assessment of the current and previous methodologies is specified for the convergence rate. From this specified figure it could be confirmed that the current research scenario results in giving improved result compared to the previous researches. The convergence rate of the current research BPOSTS is superior to the previous works by discovering the worldwide solution in words of poor utilization of populations.

Voltage Level Comparison

Voltage level denotes the capability of Photovoltaic power system to produce the power with the active moving of sun. The system could not produce highest power point in case not tracking the sun location and position best possibly. In the subsequent figure 7, voltage level deliberated in the diverse sun locations is matched up for the presented and previous scenario.

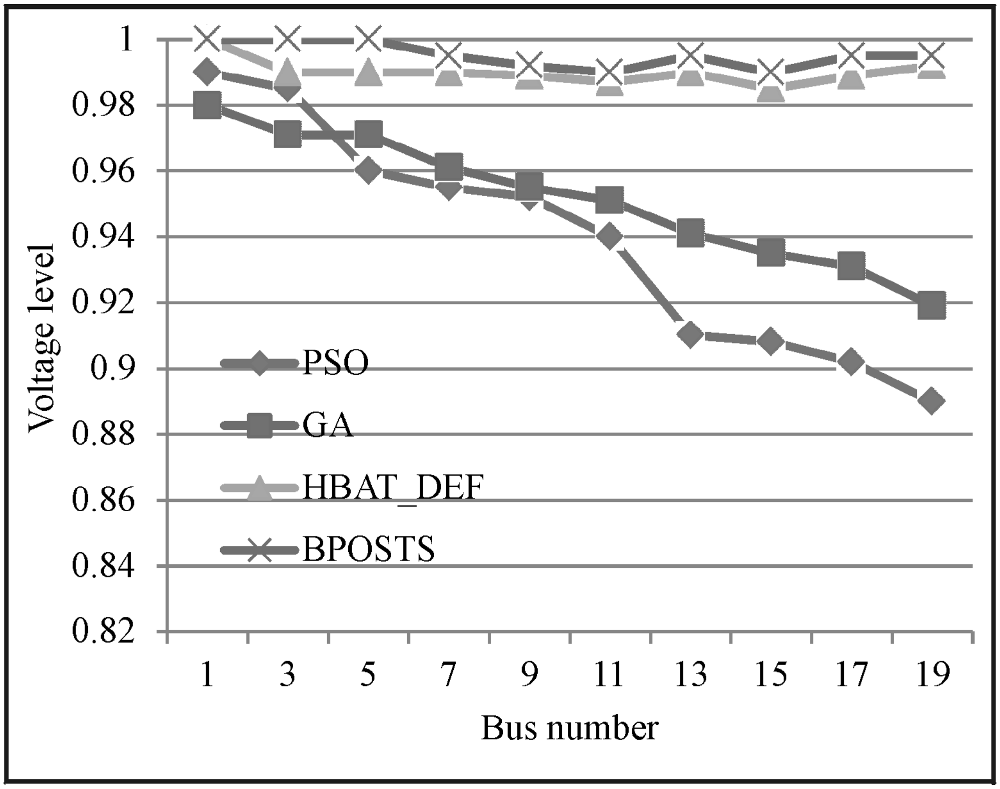

Figure 7: Voltage Level Comparison

In the above figure 7, performance assessment of the presented research method and previous techniques is specified for the voltage level. From this specified figure it could be shown that the research scenario results in giving improved outcome than the previous researches. The voltage stability of the current research BPOSTS is superior to the previous works by sustaining voltage flow rate for diverse sun locations and positions.

5. CONCLUSION

The best possible solar tracking is the most concentrated in the research problem to satisfy the needs of home based and industrial based applications. This is attained in the current research by bringing in the new framework called Battery Performance aware Optimal Solar Tracking System (BPOSTS). In the proposed work, to increase the power generation Dynamic programming dependent upon Policy Iteration (DPPI) Algorithm is presented to discover the best possible values of angle and location of solar devices. Afterward Single-Stage Balanced Forward Fly back Converter (SSBFFC) is utilized for balancing the voltage power those are imbalanced while it is monitored from the solar openly. Lastly battery life span performance is enhanced by three stage charging method that would enhance the storage performance, therefore the life span of battery cells could be enhanced. The simulation outcomes have been performed and the final performance outcomes have been verified that the current research methodology results in giving superior outcome compared to the previous research methodology.

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