MPPT for Solar PV Panel using WSPS Technique

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Abstract: *For evenly shaded solar PV (photovoltaic) panel conditions, a new "Weight of Set Point Similarity (WSPS)" method is devised. One of the major problems with traditional MPPT algorithms like Perturb and Observe is oscillation in a steady-state situation, and greater tracking time during dynamic change. This method's most significant contribution is the minimization of these problems. Comparative research of four sets of duty cycle sets the steady-state condition, and severe reduction of the amount of step-change mitigates the oscillation problems in a steady-state condition. Furthermore, a dynamic situation may be detected using an envelope of power that encompasses both minimum oscillating power and maximum oscillating power. The WSPS method is tested on various irradiance change conditions, including modeling and testing. Moreover, WSPS method outperforms the Perturb and Observe the MPPT algorithm by comprehensive comparison.*

Keywords: PV System, Weight of Set Point Similarity, Maximum Power Point Tracking,

1. Introduction

Every day technology and contemporary electronic devices make life easier, but at the same time, energy use has risen dramatically. Because of this, the price of fossil fuel is rising steadily each day. When the renewable is used, it can satisfy the load requirement and the price is fair. Many renewable resources are popular, such as solar and wind [1]. Also, because of its simple operation and customizability, rooftop solar PV (photovoltaic) power production systems are widely used. It is used in the industrial zone for large-scale power generating purposes. On vehicles such as rickshaws, aeroplanes, and trains, solar PV is now being installed as well. One of the major problems with commercial solar PV array is that it is around 20–25% efficient. In this scenario, every user is vying for as much PV panel power as possible. However, the PV array's power-voltage characteristic is extremely non-linear, and operational voltages correlate to various power levels. Out of many voltage -power pairs, only one voltage equals the maximum power [3]. MPP voltage is also known as MPP voltage, and comparable power is MPP power. However, MPP voltage and MPP power are not equal. Solar irradiation and environmental temperature are important factors. At varying irradiance and temperature, the MPP voltage and MPP power will likewise vary. Thus, to monitor the MPP voltage and MPP power at various time instants, MPPT (maximum power peak tracking) algorithm is used. A literature study on MPPT reveals that 'fractional open circuit voltage [4]', 'fractional short circuit current', lookup table-based MPPT [5] methods were used. The fluctuating nature of open-circuit voltage and short circuit current of PV array are major disadvantages for fractional open circuit voltage and fractional short circuit current based MPPT methods. Lookup tables are dependent on trial and error, as well as being an application-specific solution. Researchers have devised a generalised method that does not rely on open circuit voltage and short circuit current. Also popular are perturb and observe (P&O) [6], hill climbing, incremental connection (InC) [7] The methods are effective in all types of dynamic conditions. Regardless, the fixed step change is utilised in all of these methods. It also oscillates over a set reference level when in a stable state. As a result, constant oscillations are seen in all of these methods. Many publications propose a very tiny step change size, which stabilises steady-state condition. However, it takes longer time to follow the new reference level during a step-change in irradiance. As a result, few publications propose a significant step shift in which the new reference level is rapidly tracked. In steady-state, the oscillations in the waveforms are high. The literature shows algorithms with adjustable step size, such as improved P&O [8, 9] and enhanced InC [10] These, however, are dependent on the scaling factor [11, 12]. The constant that dictates the scaling factor is dependent on the PV array's power rating. Nonetheless, to far, no generalised equation for scaling factor exists. The aforementioned writers (i.e. the authors of [13–19]) assert that MPPT based on fuzzy logic and neural networks should be used. However, because metaheuristic optimization method uses population-based searching, finding the global peak will take longer. Neural networks need training data to fine-tune their internal weight. Likewise, data sets are needed for fuzzy logic as well. Thus, the load on the processor using soft computing-based MPPT methods is very significant. PV systems in a partly shadowed situation use soft computing-based MPPT methods. Newly, MPPT algorithms and models predictive control algorithms have been developed which are extremely sensitive. reliant on all ratting information for solar PV arrays and DC–DC converters Here, a new 'Weight of Set Point Similarity (WSPS) method' is established for MPPT for evenly shaded solar PV panel situation. The four-set duty cycle comparison research determines the steady-state situation where severe reduction of the step change value alleviates the oscillation problems. Furthermore, a dynamic situation may be detected using an envelope of power that encompasses both minimum oscillating power and maximum oscillating power. In a dynamic irradiance change scenario, the envelope of power identifies the circumstance and changes step size to capture the MPP zone. Both these methods minimise steady-state oscillation and decrease MPPT time. The WSPS method is tested on various irradiance change conditions, including modelling and testing. Furthermore, the WSPS method outperforms the P&O MPPT algorithm via comparison analysis.

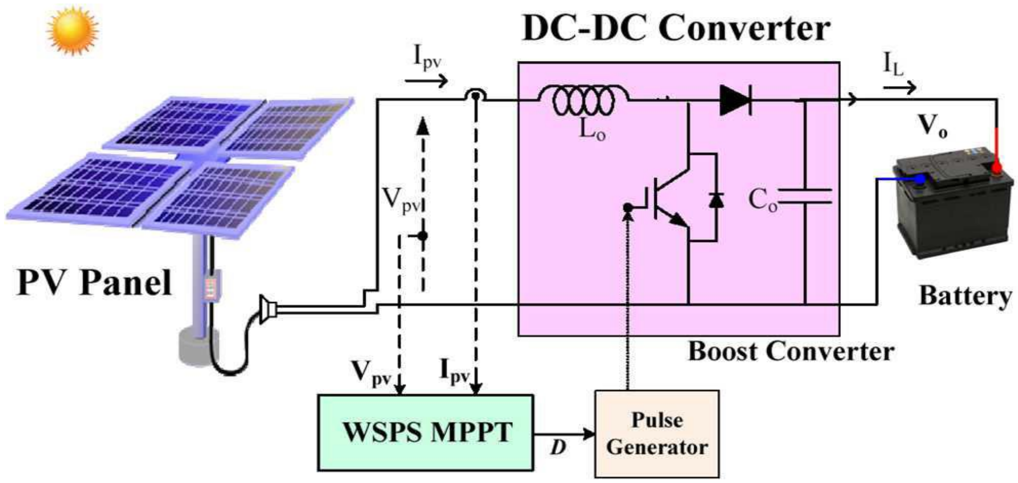

Fig. 1 *System layout of solar PV power fed battery charging*

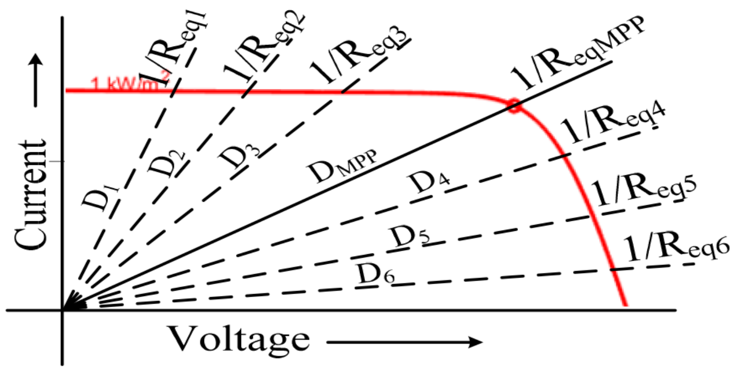

Fig. 2 Duty cycle and equivalent resistance variation

2. Configuration of solar PV system

When MPPT is in operation, a DC-DC converter is utilised to set the voltage of the solar PV array to match MPP power. Dump the produced electricity into the battery, load, or grid. DC–DC converter selection relies on the input–output voltage level. In this situation, ‘Boost converter [20-27] is used. Solar MPP voltage exceeding output voltage dictates usage of a Buck converter. In this article, DC-DC converter is utilised, where on the input side a PV array is connected. For PV electricity, a battery is needed. For further information, see Fig. 1, where WSPS MPPT algorithm is utilised in the arrangement. The WSPS MPPT algorithm provides the duty cycle, which passes to the pulse generator. Generated pulses run the boost convertor switch, which applies MPP to the solar PV array.

3. Weight of set point similarity MPPT algorithm

Duty cycle or weight of reference voltage is kept and analysed in the WSPS algorithm. The previous three data are conjugative; the first data is present. Fig. 3 illustrates a continuous moving performance.

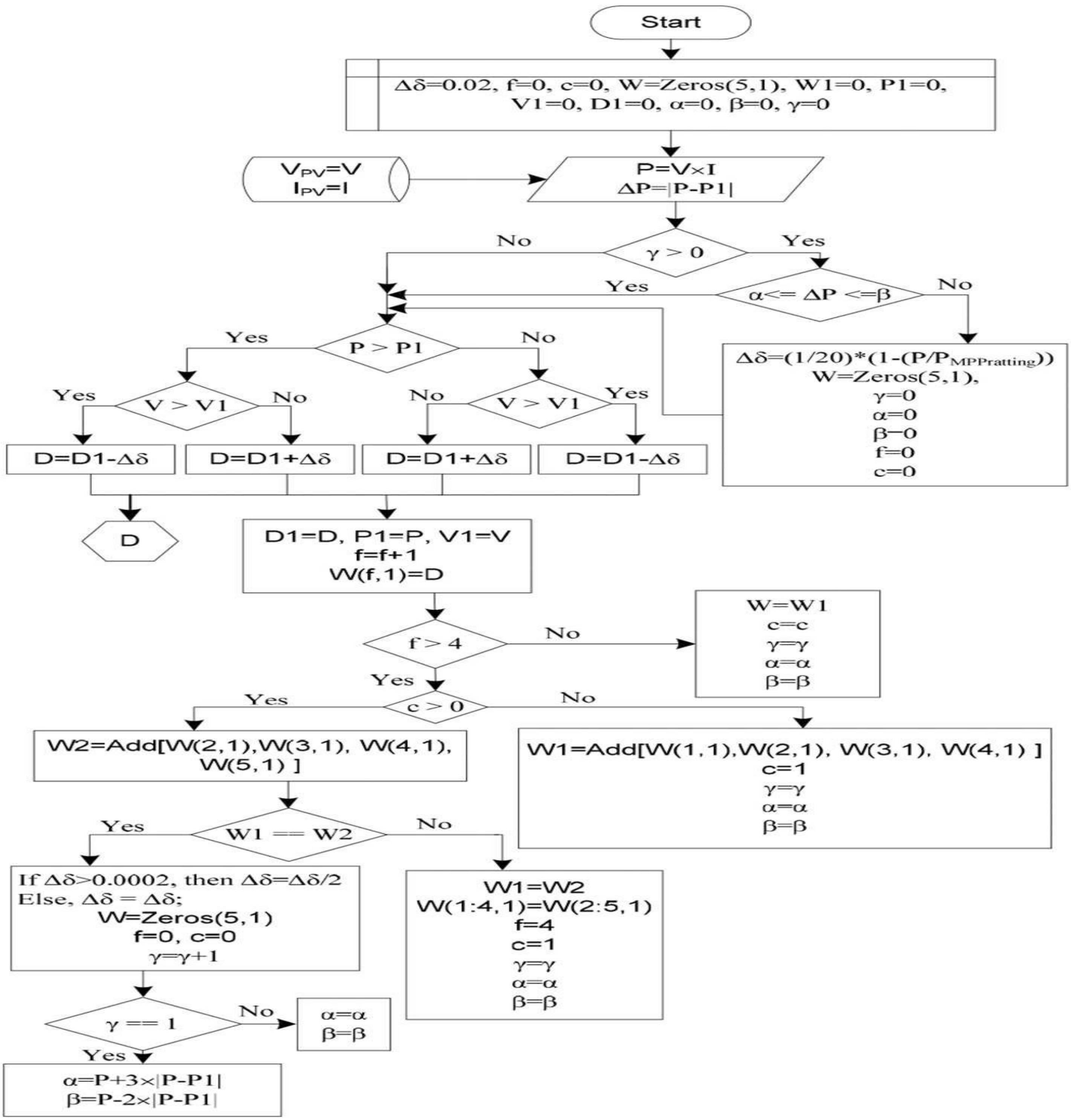

Fig. 3 Flow chart of WSPS algorithm

4. RESULTS AND DISCUSSION

The performance of the WSPS algorithm is simulated and proven in the laboratory. On the window operation system with 4 GB RAM, the programme is MATLAB 2015a. Throughout simulation, the battery is given. Simulations are run using Simulink library blocks of MATLAB 2015a. Table 1 lists the values of system parameters and circuit components. While the simulation is running, the change in solar irradiance from 1000 to 900 W/m2 and subsequently 400 W/m2 is taken into account, with the ambient temperature being constant at 25°C throughout. The suggested WSPS MPPT algorithm is implemented in this climatic scenario. Furthermore, in order to conduct a comparison research, the most current adaptive P&O MPPT algorithm [8, 9] is also implemented in the same environment and circuit condition as the previous algorithms. The waveforms produced by the adaptive P&O MPPT algorithm and the WSPS MPPT method are shown in Fig. 4, respectively, as a result of the algorithms. Figure 8a depicts the waveform of solar PV power, which demonstrates that the adaptive P&O MPPT algorithm [8, 9] has effectively archived the MPP. In contrast, the waveforms of solar PV voltage and solar PV current exhibit a continuous oscillation during the whole operation, which is due to the fixed step size of the duty cycle shift, as seen in Figure 1. The duty cycle waveform produced by the adaptive P&O MPPT algorithm is also oscillating as a result of this. The duty cycle waveform produced by the WSPS MPPT algorithm, on the other hand, exhibits a steady decrease in oscillation, as shown in Figs. 4 As a result; there are no oscillations in the waveforms of the solar PV voltage and solar PV current. In a dynamic change situation, the performances of both methods are quite comparable, and both techniques reach the new MPP zone in a relatively short period of time. However, under a steady-state situation, WSPS exhibits excellent performance, which may be attributed to the evenly distributed fluctuation of the duty cycle. Figure 4 depicts how MPP searching began with a step change of 0.02 at the outset. Following the identification of the initial oscillation zone, the value of is changed to 0.01. The identical process is done over and over again, and as a result, 0.005 becomes 0.0025, and 0.00125 becomes 0.00125. Further reduction in is not feasible due to the fact that it has decreased to 0.001. However, when the power changes by a little amount, begins searching with a value of 0.005, which increases to 0.0025 and 0.00125 in subsequent rounds. However, around 1.2 s, during a period of significant power fluctuation, begins searching with a value of 0.03, which increases to 0.015, 0.0075, 0.00375, and 0.001875 in subsequent rounds. Following the identification of oscillations, the value of is changing in this case. If you use the new, it travels a minimum of 4–5 steps, after which only oscillation detection is done. Furthermore, once the oscillation zone has been confirmed, the value of is reduced by one. This well-balanced variation is suitable for all types of irradiance fluctuation. The superiority of the WSPS algorithm over current state-of-the-art methods is shown in this way.

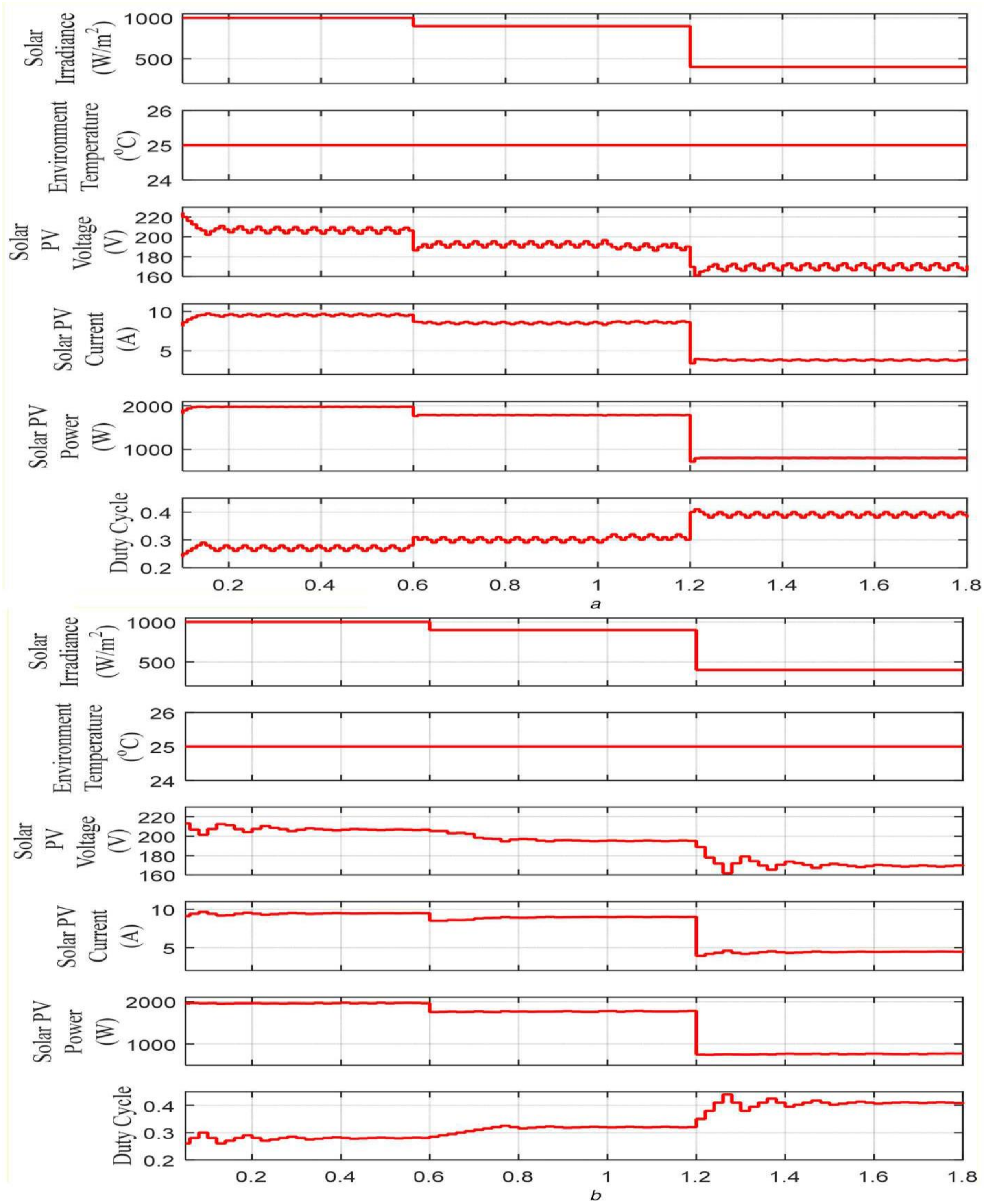

Fig. 4 *Simulation results obtained by*

(a) Adaptive P&O MPPT algorithm [8, 9], ***(b)*** WSPS MPPT algorithm

5. CONCLUSION

In this work, a new 'Weight of Set Point Similarity (WSPS)' method for MPPT for a uniformly shaded solar PV panel situation has been devised and tested for the first time. Using the WSPS method, which involves a comparative analysis of the weight of four different duty cycle sets, it is possible to determine the steady-state condition, in which a dramatic reduction in the value of step-change helps to minimize oscillation problems in a steady state condition. Furthermore, in the presence of dynamic solar irradiance change, the envelope of power recognizes the situation and, in response, provides an adaptive change in step size for the purpose of rapid identification of the MPP (maximum power point) zone. MATLAB simulation and testing were used to verify this method, and the results demonstrated that the suggested technique achieved the goal it was designed to achieve.

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