IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

IJARSCT
Impact Factor: 6.252

Volume 2, Issue 6, June 2022

An Adaptive Voltage Sensor Based MPPT for Photovoltaic System with Sepic Converter Including Steady State and Drift Analysis

Vikrant P. Moon[1] and Vishal M. Pimpalkar[2]
Post Graduate Student[1] and Assistant Professor[2]
Ballarpur Institute of Technology, Bamani, Chandrapur, Maharashtra, India
vikrantmoon123@gmail.com and vishalpimpalkar7@gmail.com

Abstract: *Solar energy is the most important and freely available energy source which generate DC power. High DC/ DC conversion and Maximum Power Point Tracking (MPPT) control are essential component in Photovoltaic (PV) system. An adaptive voltage sensor based MPPT algorithm employing a variable scaling factor for a Single Ended Primary Inductance converter (SEPIC) is presented. In these method, only a voltage divider circuit is used to sense the PV panel voltage. It can effectively improve both transient and steady state performance [2] varying the scaling factor as compared to the fixed step size and adaptive step size with fixed scaling factor for sudden change in solar insolation or in start-up, these method leads to faster tracking while in steady state it leads to lower oscillation around Maximum Power Point (MPP). To determine the tracking efficiency steady state behaviour and drift phenomenon also given in these paper. To simplify the control circuits duty cycle is generated without using any proportionate integral control loops for simplicity. MATLAB/Simulink is used as a digital platform to implement the proposed algorithm for experimental validation.*

Keywords: Photovoltaic (PV), voltage sensor, maximum power point tracking (MPPT), adaptive, drift phenomena, scaling factor, duty cycle and single ended primary inductance converter (SEPIC).

I. INTRODUCTION

The increased energy demand and shortage of fossil reserves motivated researchers to focus on renewable energy sources PV power generation is evolving as one of the most prominent renewable energy sources because of its merits such as eco-friendly in nature, less maintenance, and no noise. The fundamental component of PV system is a PV cell. Series connection of PV cells forms modules, and series and parallel connection of modules forms arrays. The characteristics of a PV module will vary with solar insolation and atmospheric temperature [1]. The efficiency of the PV system mainly depends on the operating point on the characteristic curve of the PV module. The point at which available maximum power can be extracted from the PV module is called MPP. So far, a large number of MPPT techniques have been developed [4] to increase the efficiency of the PV system.

MPPT algorithms such as fractional open-circuit voltage, Fractional short-circuit current, hill climbing, perturb and Observe (P&O), incremental conductance (IncCond), incremental resistance, ripple correlation control, fuzzy logic, neural network, particle swarm optimizations, and sliding mode control techniques Have been developed to extract the maximum power [4],[9] from the PV arrays. Among the various MPPT techniques, fractional open-circuit voltage and short-circuit current techniques provide a simple and effective way to extract maximum power, But they require periodical measurement of open-circuit voltage or short-circuit current [5] for reference, causing more power Loss. Both P&O and hill climbing methods are extensively practiced methods because of their increased efficiency and ease of implementation [9]. However, the sudden changes in atmospheric conditions cause these P&O-like algorithms to drift away from MMP. According to the literature, the problem of drift is addressed and solved by using IncCond technique. However, the present studies observed that IncCond Method also suffers from drift. Other existing techniques show improved performance using fuzzy logic, neural network, optimization algorithm, and sliding mode control, but they are not commonly used due to their complexity and need of expensive digital processor [9]. Overview of all the MPPT techniques recently published is thoroughly discussed in [4].

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor: 6.252
Volume 2, Issue 6, June 2022

The conventional MPPT methods are usually implemented with a fixed perturbation step size determined by the trade off Between efficiency and tracking speed requirements . Variable-step-size MPPT methods are presented in and To reduce the tracking time and to improve the steady-state performance. The step size is defined as a function of either the derivative of power to voltage $\frac{dP}{dD}$ or the derivative of power to duty cycle $\frac{dP}{dD}$ [5]. The adaptive MPPT Algorithms immensely increase the efficiency of the system by reducing the tracking time and power loss in steady state .

Among the various MPPT techniques, P&O and IncCond Are the most widely used techniques. To implement the P&O and IncCond methods, both voltage and current sensors are required. In general, current sensing is done by using a shunt resistor in differential amplifier configurations, but power losses will occur in current conducting path, and the bandwidth is limited by the amplifier. Hall-effect current sensors can provide an alternative option with low loss and good accuracy, but at a higher price; moreover, they are inherently noisy in nature thus, an MPPT method with only voltage sensing is more efficient [5] in terms of reduced power loss and low cost. Voltage-sensor-based MPPT technique with fixed step size has been developed and is validated for an interleaved dual boost converter in . Later, an adaptive voltage-sensor-based MPPT With a constant start-up scaling factor has been developed by considering $\frac{dP}{dD}$ as an objective function, where P is the power of the PV module, and D is the duty cycle of the converter [6]. A variable scaling factor is applied in the proposed voltage-based adaptive MPPT technique to obtain fast tracking response and reduced steady-state oscillations.

Steady-state behaviour and drift phenomena are the main concern of any MPPT algorithm to determine the tracking efficiency. These analyses for most popular MPPT methods such as P&O and IncCond methods well exist in the literature [4], but there is no existence of literature analysing Steady-state behaviour and drift phenomena for voltage-sensor-based MPPT method. Thus, in this paper, along with the proposed adaptive technique, steady-state behaviour and drift analysis for the voltage-sensor-based MPPT method have been addressed. Single-sensor-based MPPT algorithms have been proposed by sensing only current or voltage of the PV module or the load, which eliminates the need for calculating the power value in the conventional power-based MPPT methods. Those algorithms are basically based on hill-climbing algorithms. Therefore, they still have the issues as same as P&O and IncCon . Recently, some strategies have been developed to overcome the mentioned issues of single-sensor-based MPPT algorithms. Adaptive step size is adopted to adaptively generate large perturbations during transients and generate small perturbations during steady-state operation to optimize steady-state and dynamics performance of the algorithm simultaneously Voltage reference control technique is adopted to improve the tracking performance.

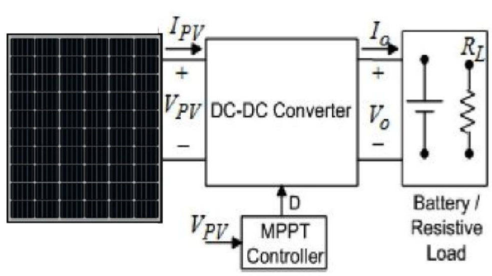


Fig. 1 Block diagram of a PV system with MPPT control.

However, The possible drift remain unsolved in above modified MPPT algorithms, which decrease the tracking speed and result in power losses during transient state. Some MPPT algorithms have been presented to overcome the drift for traditional hill-climbing algorithms. Literature realizes drift avoidance with correct irradiance change identification, which needs current or voltage sensor only. But the computational burden and cost of this algorithm are still much more than single-sensor-based MPPT. In general, current sensing is difficult and it has some demerits like presence of undesired signals (i.e., noise) in response, power loss, and high cost. Hence, voltage-sensor-based MPPT algorithm is a better choice for minimizing the power loss and price reduction.[8] So in this paper, a modified voltage sensor based MPPT algorithm to realize drift avoidance is developed. Compared with existed voltage-sensor-based MPPT algorithm, the modified algorithm removes drift caused by sudden change in solar irradiance. As a result, the tracking speed and efficiency of the voltage-sensor-based MPPT are increased at the same time.[9]

In this paper, single-ended primary-inductance converter (SEPIC) is considered because it works as step-up/step-down converter [3], thereby, it will increase the range of operation of PV voltage. This topology has merits of non inverting output polarity, easy to drive switch, and low input current ripple.

This paper is organized as follows: The study of various MPPT algorithms are discussed in the introduction which cover the section l of the paper. Voltage sensor based MPPT with fixed step size and adaptive step size are first addressed and then steady state 2-level operation and drift analysis for a change in insolation are presented in Section II. and in Section III and Section IV respectively. Finally conclusions are presented in Section V.

II. VOLTAGE SENSOR BASED MPPT FOR SEPIC.

MPPT controller is essential to extract the maximum power from the PV module or array. If the load is directly connected to the PV module, then it is not possible to operate at peak power point due to impedance mismatch. Converter acts as an interface to operate at MPP by changing the duty cycle generated from the MPPT controller. A general block diagram of a PV system with MPPT controller is shown in Fig. 1.

From the plotted P−D characteristics shown in Fig. 2, It can be observed that the slope of the curve $\frac{dP}{dD} = 0$ at MPP, $\frac{dP}{dD} > 0$ to the left of MPP and $\frac{dP}{dD} < 0$ to the right of MPP. Thus, the voltage sensor based MPPT algorithm for SEPIC converter is developed by using the P−D characteristics obtained with the PV module. The objective function to implement this algorithm for SEPIC converter has been derived for both resistive and battery load.

A. Case 1: For resistive load

Using input and output voltage relation for SEPIC (i.e., $V_0 = \frac{D}{1-D} V_{PV}$) efficiency of the converter can be expressed by using output power ($P_0 = V_0 \, I_0$) of the converter and PV power as a input power ($P_{PV} = V_{PV} I_{VP}$) as a input power to the converter.

$$n = \left(\frac{D}{1-D}\right)^2 \frac{Req}{Rl} \qquad (1)$$

Where V_{PV} and I_{VP} are PV voltage and current respectively. The equivalent input resistance (R_{eq}) of the converter can be obtained from (1)

$$R_{eq} = n\left(\frac{1-D}{D}\right)^2 R_l \qquad (2)$$

By using (2) the output power from the PV module, which is input power to the converter by taking the square root of power (P*) is given by (3)

$$P^* = \sqrt{P} = \frac{Vpv}{\sqrt{nRl}}\left(\frac{D}{1-D}\right) \qquad (3)$$

For MPP $\frac{dP*}{dD} = 0$ R_{eq} and it can given as after differentiation of equation (3)

$$\frac{dP*}{dD} = \left(\frac{Vpv\, dD + D(1-D)dVpv}{(1-D)^2 dD}\right) \frac{1}{\sqrt{nRl}} = 0 \qquad (4)$$

By evaluating $\frac{dP*}{dD}$ using (4) at MPP, the objective function (Q) can be obtained as follows :

$$Q = (1-D)dVpv + VpvdD \begin{Bmatrix} = 0,\ at\ MPP \\ > 0, on\ left\ of\ MPP \\ < 0, on\ right\ of\ MPP \end{Bmatrix} \qquad (5)$$

Hence depending on the sign of Q the MPPT algorithm decides whether to increase or decrease the duty cycle and the corresponding Q − D characteristics are shown in fig.3

B. Case 2: For battery as a load

As $P = Vpv\, Ipv$ and hence $\frac{dP}{dD}$ can be expressed as

$$\frac{dP}{dD} = Ipv\frac{dVpv}{dD} + Vpv\frac{dIpv}{dD} \qquad (6)$$

For SEPIC converter I_{pv} and battery current I_{bat} can be expressed by

$$I_{pv} = \frac{D}{1-D} I_{bat} \qquad (7)$$

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Volume 2, Issue 6, June 2022

Impact Factor: 6.252

$$\frac{dIpv}{dD} = \frac{1}{(1-D)^2} I_{bat} \qquad (8)$$

$$\frac{dP}{dD} = \left(\frac{Vpv\ dD + D(1-D)dVpv}{(1-D)^2 dD}\right) I_{bat} \qquad (9)$$

At MPP $\frac{dP}{dD} = 0$ as shown in Fig. 2 and hence by evaluating at MPP, the objective function (Q) for tracking the peak power with the battery load can be obtained as same as (5). Thus, the voltage sensor based MPPT method is valid for both resistive as well as battery load.

The objective function (Q) for tracking the peak power in case of a PV system with boost converter can be obtained by evaluating the corresponding R_{eq} and $\frac{dP*}{dD}$ as follows:

$$Q = (1-D)dVpv + VpvdD \begin{Bmatrix} = 0,\ at\ MPP \\ > 0, on\ left\ of\ MPP \\ < 0, on\ right\ of\ MPP \end{Bmatrix} \qquad (10)$$

From (5) and (10) it can be concluded that the objective function (Q) will vary depending on the DC-DC converter used with the PV system. Thus, the objective function (Q) for tracking the MPP depends on the converter topology for voltage sensor based MPPT method, whereas the widely accepted methods like P&O and IncCond are independent of the converter.

The two key parameters in any MPPT algorithm are perturbation time and perturbation step size and the selection criteria for these two parameters is described as follows:

Selecting proper perturbation time (T_a)

For a step change in duty cycle, the perturbation time should be greater than the settling time of the system. Different values of ΔD will result in different values of settling time. The perturbation time is chosen such that it should be greater than the settling time for a maximum step (ΔD_{max}) change in duty cycle.

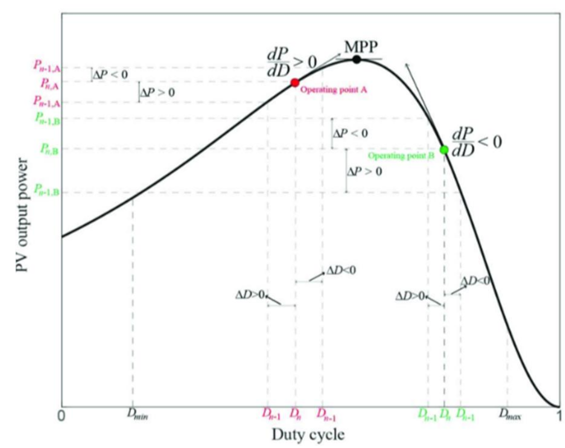


Fig. 2. Variation of PV output power with duty cycle for SEPIC.

Selecting proper perturbation step size (ΔD)

The perturbation step size should be chosen by considering dynamic and steady state performance. The maximum value of step size (ΔD_{max}) improves the dynamic performance, whereas the minimum value of step size (ΔD_{min}) results in lower oscillations around the MPP, which in turn improves the steady state performance. The step size ΔD_{min} should be chosen based on the tracking accuracy in steady state, and ADC resolution of the microcontroller used in the system. The standard procedure for choosing ΔD_{min} value is that, the minimum voltage change due to perturbation of D by ΔD_{min} should be more than the ADC resolution. For an N-bit ADC with a maximum value of the ADC channel as VADC should satisfy the following condition.

$$[V(D + \Delta Dmin) - V(D) * S \geq \frac{Vadc}{2ñ} \qquad (11)$$

Where S is the scaling factor which is equal to $\frac{R2}{R1+R2}$ in this case. Thus, ΔD_{min} will vary with different PV panel characteristics and different ADC's. In this case, ΔD_{min} is chosen as 0.5% for a 10-bit ADC with $Vadc$ of 5 V which satisfies above equation.

C. Adaptive voltage sensor based MPPT with variable scaling Factor

In this paper, an adaptive voltage sensor based MPPT with variable scaling factor is proposed to reduce the tracking time as well as power loss in steady state. The present and previous iteration values of PV voltage and duty cycle of the converter are denoted by

V_{PV} (k), V_{PV} (k – 1), D(k), and D(k – 1) respectively. The change in the voltage and duty cycle from the present iteration to the next iteration are defined as follows:

$$dV_{PV} = V_{PV}(k) - V_{PV}(k-1). \qquad (12)$$

$$dD = D(k) - D(k-1) \qquad (13)$$

The location of the operating point is decided by evaluating Q and depending on the sign of Q, the duty cycle is incremented or decremented by ΔD . If Q is positive, then the duty cycle is incremented by ΔD and if Q is negative, then the duty cycle is decremented by ΔD. As ΔD is directly used in adjusting the duty cycle, the controller is simple and easy to implement with a microcontroller.

$$D(k+1) = D(k) \pm \Delta D \qquad (14)$$

Variation of Q using the experimental data in start-up case for a change in insolation from 0 to 270 W/m^2 and for a change in insolation from 270 W/m^2 to 480 W/m^2. These shows that the value of Q is large in start-up and during insolation change, whereas it is small in the steady state. So a fixed scaling factor cannot satisfy the requirement of MPPT controller in different conditions. Hence in this proposed algorithm two different scaling factors M_1 and M_2 are considered to optimally vary the perturbation step size (ΔD) that has been defined as a linear function of Q . The scaling factor, Mi (I = 1, 2) plays a significant role in an adaptive MPPT method, therefore it should be chosen judiciously to increase the peak power tracking efficiency. The scaling factor M_1 is chosen to reduce the tracking time in start-up and for a large change in insolation. The scaling factor M_2 is chosen to reduce the power loss in the steady state. Thus, the proposed adaptive MPPT method improves both the transient and steady state performance.

$$\Delta D = M_i Q \qquad (16)$$

The scaling factor either M_1 or M_2 is chosen to generate ΔD depending on the value of Q with respect to a predefined threshold value of the objective function (Q_{th}) as shown in the pseudo code of the algorithm. By considering an upper limit (ΔD_{max}) of 10% and Lower limit (ΔD_{min}) of 0.5% to perturbation step size (ΔD), the scaling factors M1 and M2 should obey (17) and (18) respectively in order to guarantee the convergence of the MPPT algorithm. The value of ΔD will vary between ΔD_{min} and ΔD_{max} as given

$$M_1 Q \le \Delta D_{max} \qquad (17)$$

$$M_2 Q \le \Delta D_{min}. \qquad (18)$$

$$\Delta D = \begin{Bmatrix} \Delta Dmax, & if\ \Delta D > \Delta Dmax \\ \Delta D, & if\ \Delta Dmax \le \Delta D \le \Delta Dmin \\ \Delta Dmin, & if \Delta D < \Delta Dmin \end{Bmatrix} \qquad (20)$$

The MPPT algorithm is generated using these conditions so that the required maximum power point of the operating V-D curve is used for the reference.

D. Steady state analysis

The movement of the operating point on the corresponding point on P – V characteristics is shown Assume that the operating point during (k – 3)Ta time interval is at point A . As Q > 0 at point A, the algorithm increases the duty cycle and hence the operating point moves to point B during (k−2)Ta time interval. At point B the algorithm again increases the duty cycle as Q > 0 and the operating point moves to point C . Similarly at point C the algorithm increases the duty cycle because Q > 0 and hence the operating point moves to point D during kTa time interval. At point D as Q < 0, the algorithm decreases the duty cycle and hence the operating point moves back to point C. Again at point C as Q > 0 the algorithm makes the operating point to move to point D by increasing the duty cycle. Thus in steady state the operating point moves in two levels, resulting in power loss reduction compared to P&O and IncCond because in case of P&O and IncCond the operating point moves in three levels as shown.

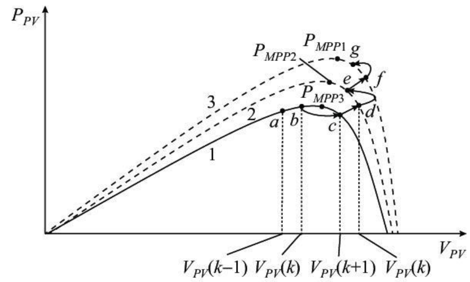


Fig .3. Movement of operating point on the corresponding P-V characteristic.

E. Steady state power loss evaluation

The two level operation of the voltage sensor based MPPT algorithm reduces the voltage oscillations around the MPP resulting in power loss reduction compared to three level MPPT algorithms like P&O and IncCond. The steady state power loss calculation in case of P&O has been addressed in The power losses (P_r) due to oscillations in comparison with the available maximum power (P_{mp}) is expressed with this method.

F. Drift analysis

The movement of the operating point in a wrong direction for a change in insolation is called drift and this effect is severe in case of rapid change in insolation [8] –[9]. The drift problem occurs in case of change in insolation with P&O and Inccond methods and it is well addressed in literature but the drift analysis for voltage sensor based MPPT does not exist in the literature. The drift analysis with this method can be examined by evaluating the change in operating voltage (V_{pv}) and the objective function (Q) for a change in insolation.

The relation between the I_{pv} and V_{pv} corresponding to the present operating point on the I – V characteristics of the PV module with SEPIC converter can be expressed in terms of slope of the load line. assume that there is an increase in insolation while operating at point d, then the operating point will be settled to a new point e on the Q−D or P −V curve corresponding to the increased insolation. Now the algorithm takes a decision to increase the duty cycle as $Q > 0$ at pointe and thereby the operating point moves closer to MPP (point f). Thus, the voltage sensor based MPPT method is free from drift in case of increase in insolation. Similarly for a decrease in insolation while operating at point d as shown in Fig. 6(b), the operating point will be settled to a new point e on the Q − D or P − V curve corresponding to the decreased insolation. As $Q < 0$ at point e the algorithm decrease the duty cycle and hence the operating point moves closer to MPP (point f). So the voltage sensor based MPPT algorithm is free from drift for both increase as well as decrease in insolation.

III. SIMULATION RESULT

Increasing in prices and the limited amount of non-renewable energy sources has lead to the use of renewable energy sources is also increasing. One type renewable energy power source that can be used are photovoltaic. At present, renewable energy-based photovoltaic has attracted attention as a future energy because of capable to solve the problems of global warming and the energy crisis caused by the increasing in energy consumption. Photovoltaic-based renewable energy has many advantages because it does not require fuel, pollution-free, and no noises. In addition, photovoltaic modules also have a lifespan of up to 20 years so can reduce the cost of maintenance.

Single-sensor-based MPPT algorithms have been proposed by sensing only current or voltage of the PV module or the load, which eliminates the need for calculating the power value in the conventional power-based MPPT methods. Those algorithms are basically based on hill-climbing algorithms. Therefore, they still have the issues as same as P&O and InCon. Therefore the main moto is to improve the quality of the signal.

Hence, some strategies have been developed to overcome the mentioned issues of single-sensor-based MPPT algorithms. Adaptive step size is adopted to adaptively generate large perturbations during transients and generate small perturbations during steady-state operation to optimize steady-state and dynamics performance of the algorithm simultaneously . Voltage reference control technique is adopted to improve the tracking performance . However, the possible drift remain unsolved in above MPPT algorithms, which decrease the tracking speed and result in power losses during transient state and improves the quality of the signal.

The data taken in these is from the ieee literature's from online resources and by referring there analysis I added some my own work to it and analysis is done on the Matlab Simulink .

To observe and study the functionality and performance of the required circuit model, a prototype of SEPIC converter and control circuit has been developed. The design parameters presented in simulation result section. The matlab function is developed to implement the MPPT algorithm and to provide the PWM control signal to the SEPIC converter. The circuit model of the proposed system is as shown in fig.7

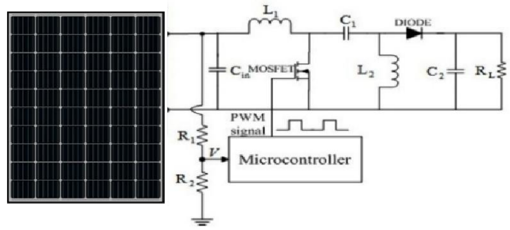


Fig. 7. Circuit model of developed PV system

Here we are going to discuss the different MPPT techniques like IncCond, P&O and Adaptive voltage sensor based MPPT there Matlab Simulink model, controller design and control logic.

The simple system without MPPT with Simulink Model is shown in fig.8 and there performance of the Output Voltage (V_{dc}), Output Current (I_{dc}) Output Power (P_{dc}) is as shown in fig. 9.

The analysis of the solar PV system with IncCond method its Matlab Simulink model, Controller design and Control logic used in the system is shown in fig. 10 (a), (b) and (c). Its Performance of the Output Voltage (V_{dc}), Output Current (I_{dc}) Output Power (P_{dc}) is as shown in fig. 11.

The analysis of the solar PV system with P&O method its Matlab Simulink model, Controller design and Control logic used in the system is shown in fig. 12 (a), (b) and (c). Its Performance of the Output Voltage (V_{dc}), Output Current (I_{dc}) Output Power (P_{dc}) is as shown in fig. 13.

The analysis of the solar PV system with Adaptive Voltage Sensor Based method its Matlab Simulink model, Controller design and Control logic used in the system is shown in fig. 14 (a), (b) and (c). Its Performance of the Output Voltage (V_{dc}), Output Current (I_{dc}) Output Power (P_{dc}) is as shown in fig. 15.

Analysis of PV system without MPPT

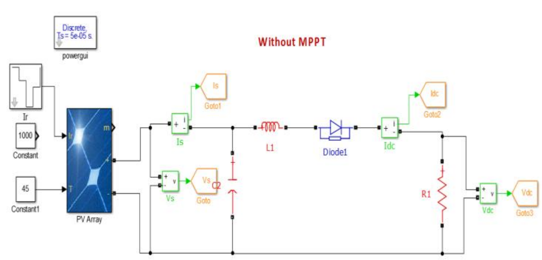


Fig. 8. Simulink model for PV system without MPPT.

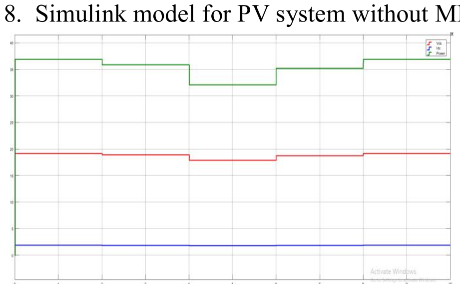


Fig. 9. Performance of PV system without MPPT

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 6, June 2022
IJARSCT
Impact Factor: 6.252

Analysis of PV system with IncCond MPPT.

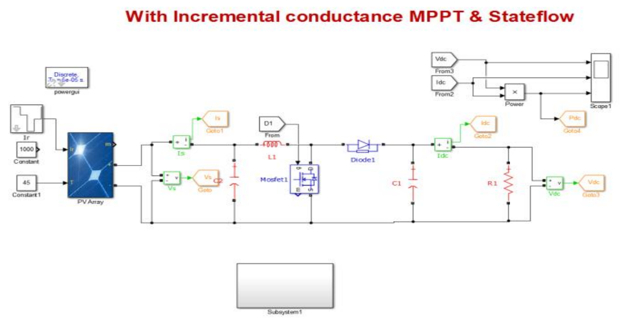
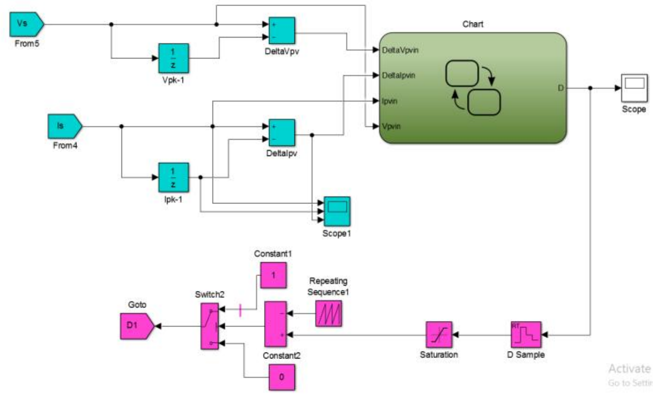
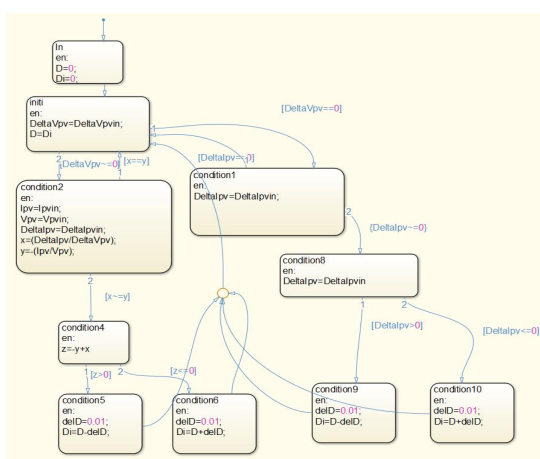


Fig. 10. A. Simulink model for PV system with IncCond MPPT



B. Matlab controller for IncCond MPPT



C. Control logic for IncCon using state flow.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 6, June 2022
Impact Factor: 6.252

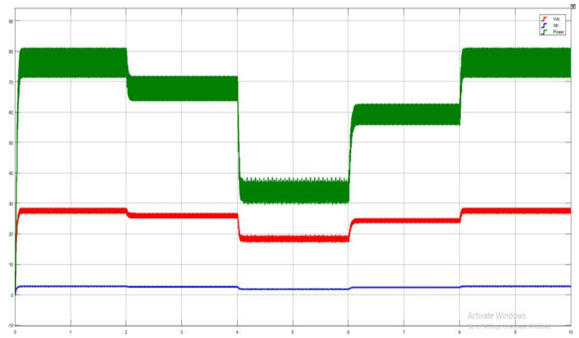


Fig. 11. Performance of PV system with IncCond MPPT

Analysis of PV system with P&O MPPT.

With P&O MPPT & Stateflow

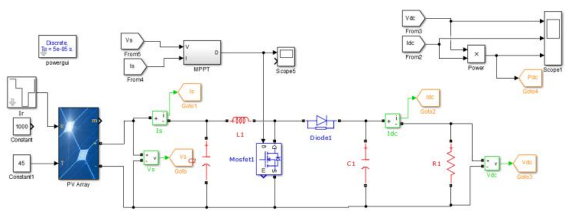
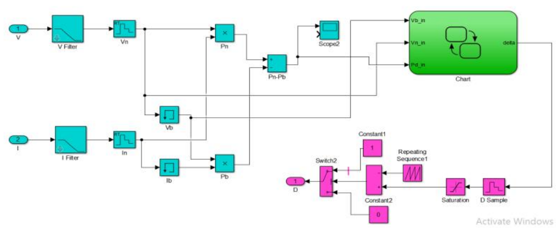
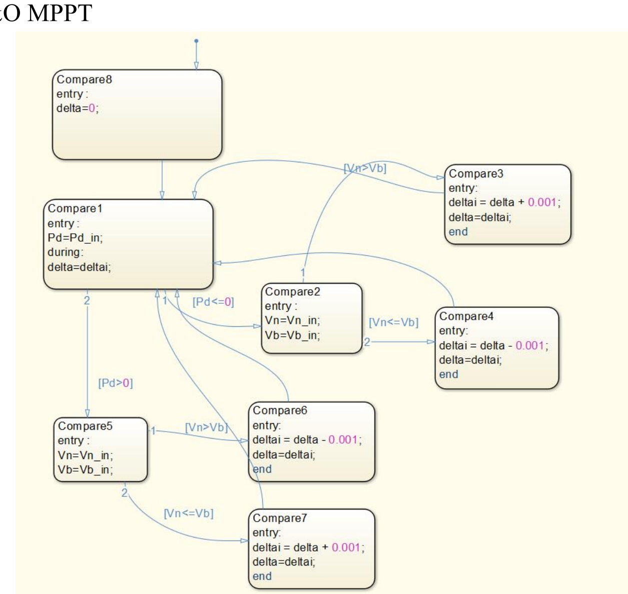


Fig. 12. A. Simulink model for PV system with P&O MPPT



B. Matlab controller for P&O MPPT



IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 6, June 2022
Impact Factor: 6.252

C. Control logic for IncCon using state flow.

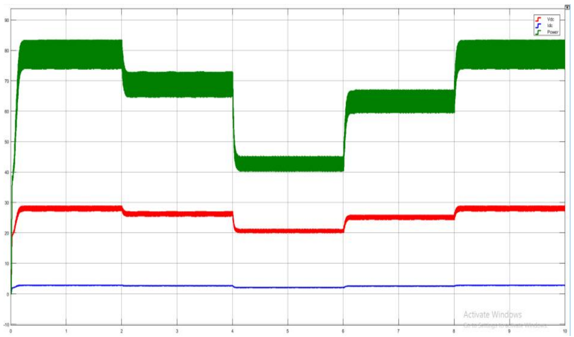


Fig. 13. Performance of PV system with IncCond MPPT

Analysis of PV system with Adaptive Voltage-Sensor-Based MPPT

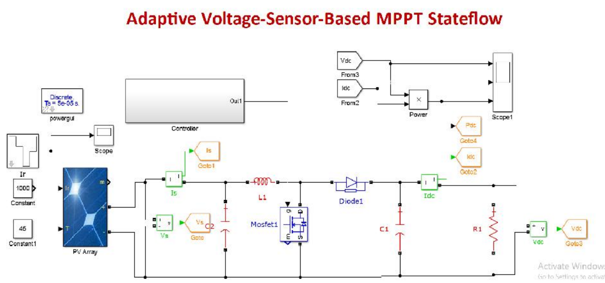
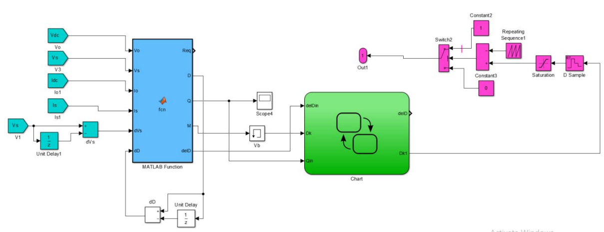
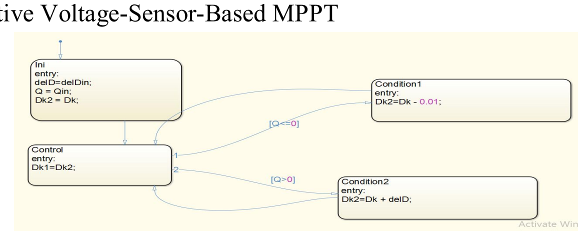


Fig. 14. A. Simulink model for PV system with Adaptive Voltage-Sensor-Based MPPT



B. Matlab controller for Adaptive Voltage-Sensor-Based MPPT



C. Control logic for IncCon using state flow.

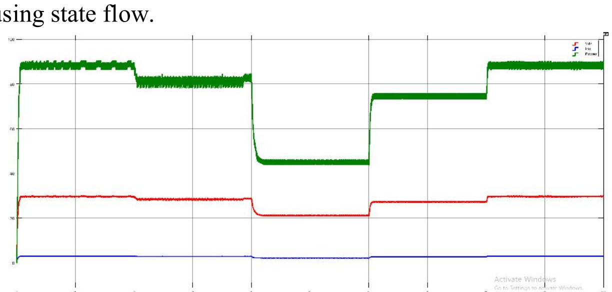


Fig. 15. Performance of PV system with IncCond MPPT

Performance Comparison

Output Voltage

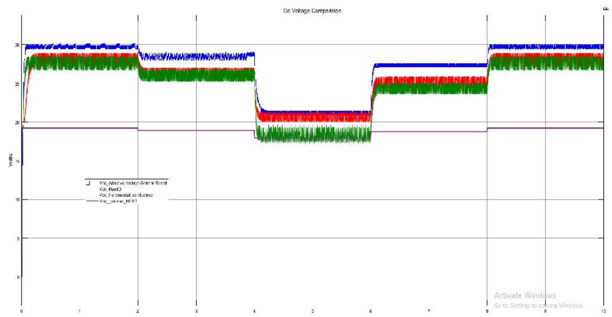
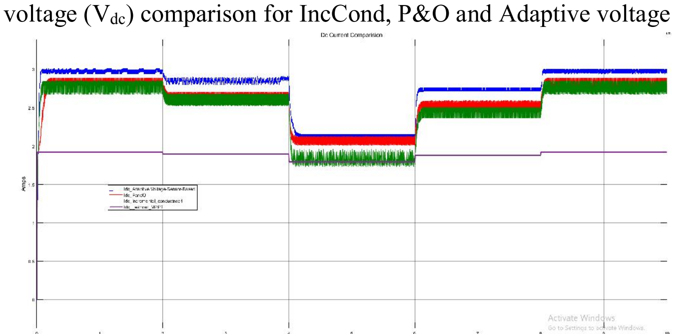
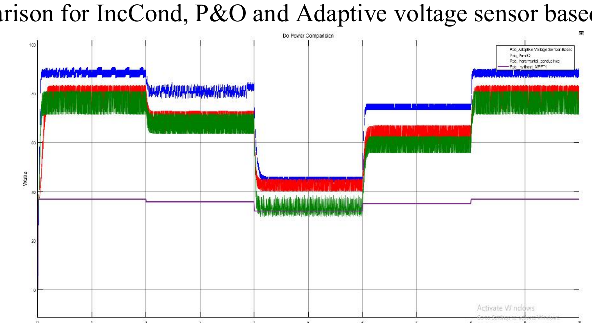


Fig. 16. A. Output voltage (V_{dc}) comparison for IncCond, P&O and Adaptive voltage sensor based MPPT



B. Output current (I_{dc}) comparison for IncCond, P&O and Adaptive voltage sensor based MPPT



C. Output power (P_{dc}) comparison for IncCond, P&O and Adaptive voltage sensor based MPPT

Solar Irradiations	Without MPPT	incremental conductance	P&O	Adaptive Voltage -Sensor-Based
1000	19.2	27.49	27.88	29.7
800	18.93	25.79	25.99	28.37
400	17.92	18.5	20.36	21.17
700	18.76	24.05	24.93	27.29
1000	19.2	27.49	27.88	29.7

Table 3: Comparison of voltage values for different solar irradiance for IncCond, P&O, and adaptive voltage sensor based MPPT

Solar Irradiations	Without MPPT	IncCond	P&O	Adaptive Voltage-Sensor-Based
1000	1.92	2.74	2.78	2.97
800	1.89	2.57	2.59	2.83
400	1.79	1.85	2.03	2.11
700	1.87	2.40	2.49	2.72
1000	1.92	2.74	2.78	2.97

Table 4: Comparison of current values for different solar irradiance for IncCond, P&O, and adaptive voltage sensor based MPPT

Solar Irradiations	Without MPPT	IncCond	P&O	Adaptive Voltage-Sensor-Based
1000	36.87	75.56	77.73	88.21
800	35.85	66.5	67.57	80.5
400	32.11	34.21	41.46	44.8
700	35.21	57.82	62.15	74.49
1000	36.87	75.56	77.73	88.21

Table 5: Comparison of power measurement for different solar irradiance for IncCond, P&O, and adaptive voltage sensor based MPPT

IV. CONCLUSION

In this paper an adaptive voltage sensor based MPPT algorithm with variable scaling factor by considering direct duty cycle control method for SEPIC converter has been implemented. The proposed system is designed and the functionality of MPPT control has been proved. The simulation and experimental results prove that the proposed system is able to track the maximum power from the PV module and moreover

the steady state 2-level operation and the drift free phenomena are the merits of this tracking algorithm. Hence, this method improves the efficiency of the PV system and reduces power loss in steady state. From the results obtained it is noticed that with a well-designed system including a proper converter and an efficient MPPT algorithm, the MPPT can be developed with less complexity and reduced cost.

REFERENCES

[1] M. G. Villalva, J. R. Gazoli, and E. R. Filho, “Comprehensive approach to modeling and simulation of photovoltaic arrays,” IEEE Trans. Power electron., vol. 24, no. 5, pp. 1198–1208, May 2009.

[2]K. Manikandan, A. Sivabalan, R. Sundar and P. Surya, “A Study Of Landsman, Sepic And Zeta Converter By Particle Swarm Optimization Technique,” 2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS), 2020, pp. 1035-1038

[3] M. Verma and S. S. Kumar, “Hardware Design of SEPIC Converter and its Analysis,” 2018 International Conference on Current Trends towards Converging Technologies (ICCTCT), 2018, pp. 1-4

[4] M. A. G. de Brito, L. Galotto, L. P. Sampaio, G. d. A. e Melo and C. A. Canesin, “Evaluation of the Main MPPT Techniques for Photovoltaic Applications,” in IEEE Transactions on Industrial Electronics, vol. 60, no. 3, pp. 1156-1167, March 2013

[5] M. A. S. Masoum, H. Dehbonei, and E. F. Fuchs, “Theoretical and experimental analyses of photovoltaic systems with voltage and current-based Maximum power-point tracking,” IEEE Trans. Energy Convers., vol. 17,No. 4, pp. 514–522, Dec. 2002.

[6] M. Killi and S. Samanta, “Voltage-sensor-based MPPT for stand-alone PV systems through voltage reference control,” IEEE Journal of Emerging and Selected Topics in Power Electronics, vol. 7, no. 2, pp. 1399-1407, Jun. 2019.

[7] C. Urayai and G. A. J. Amaratunga, “Single sensor boost converter-based maximum power point tracking algorithms,” 2011 Twenty-Sixth Annual IEEE Applied Power Electronics Conference and Exposition (APEC), 2011, pp. 1238-1243

[8] M. Killi and S. Samanta, “Output voltage sensor based maximum power point tracking for PV system using SEPIC,”

2015 IEEE International Conference on Industrial Technology (ICIT), 2015, pp. 1112-1116
[9] M. Killi and S. Samanta, "An adaptive voltage-sensor-based MPPT for photovoltaic systems with SEPIC converter," IEEE Transactions on Industrial Electronics, vol. 62, no. 12, pp. 7609-7619, Dec. 2015.