MODELLING AND ANALYSIS OF MPPT TECHNIQUE FOR PV ARRAY WITH NON-SEPARATED DC-DC CONVERTER FOR HIGH VOLTAGE GAIN APPLICATION

T. Sreelakshmi¹, A. Naveen reddy², N. Bharath kumar³, Ch.Umamaheswararao⁴

Vignan's Foundation for Science, Technology and Research University
Electrical and Electronics Engineering

E-mail: t.sree0235@gmail.com

https://doi.org/10.26782/jmcms.2019.12.00042

Abstract

This paper shows the exhibiting and examination of trouble and watch (P and O) figuring for isolating the power structure photovoltaic group (PVA). In perspective on non-straight characteristics of PV cell, the best power can be remove under one explicit voltage conditions. In this way, most outrageous power point following (MPPT) computations is used in PVA to extend the yield control. In this paper the MPPT computations is executed using DC-DC bolster converter (adventure up converter) sustaining a resistive weight. The component of PVA is reproduced at different sun situated irradiance and cell temperature.

Keywords: Photo Voltaic Array (PVA), most extreme Power Point Tracking (MPPT), DC-DC Boost Converter.

I. Introduction

Photovoltaic are best known as a procedure for making electric power by changing over sun based vitality into electrical importance by a movement of electrons with the photo voltaic effect [I].

Sun oriented cells produce direct flow as electrical vitality from light which can be used to run DC gear or to invigorate a battery [II]. The essential rational utilization of photovoltaic was to control surrounding satellites and other rocket; anyway today the vast majority of photovoltaic modules are used for cross section related with the assistance of intensity converters and to create enormous measure of intensity [III].

The yield typical for PV module depends upon the daylight based irradiance, air temperature and yield voltage of PV module depends upon the relationship of PV modules. Since PV modules have non-straight characteristics, such that the yield
relied upon the sun radiation, it is critical to show it and re-authorize for most prominent power point following (MPPT) of PV structure applications [IV].

Diverse MPPT procedures have been utilized in past yet bother and watch (P&O) calculation is most extensively acknowledged and ideally used by industry in view of its straightforwardness and simplicity of execution consequently this calculation remains the most utilized calculation [V].

Utilizing P&O calculation the controller changes voltage and measure control and if this deliberate power is more prominent or lesser than the past estimation of intensity alterations are made a similar way until there is no greater augmentation or decrement in power [VI].

II. PV Panel

Photograph voltaic cell is an electronic gadget which changes over sun based imperativeness into electrical essentialness.

The power rating of the sun powered board relies upon the size of the PV board and the modules association inside the board contingent upon this the voltage rating and current evaluations changes while power rating stays same.

Single PV panel may not produce a required amount of power, so we go for series or parallel connection of panel for our requirement.

Arrangement association of PV board increment voltage rating, parallel association of PV board increment current rating.

*Copyright reserved © J. Mech. Cont. & Math. Sci.*
*T. Sreelakshmi et al*
The yield current of a PV cell by applying KCL is appeared in above figure.

\[ I_{pv} = I_{ph} - I_d - I_{sh} \]

Where:
- \( I_{pv} \) = PV module current
- \( I_{ph} \) = Photo current (or) solar cell current
- \( I_d \) = Diode current
- \( I_{sh} \) = Shunt current

The current – voltage attributes condition of a PV module is depicted as underneath:

\[ I_{pv} = N_p I_{ph} - I_{rs} \left( \exp \left( \frac{q(V_{pv}+I_{pv}R_s)}{N_p e A K T} \right) - 1 \right) - \frac{V_{pv} + I_{pv} R_s}{R_{sh}} \]

Where:
- \( e \) = Electron charge (1.60217662*10^{-19} coulombs)
- \( N_p \) = Number of sun based cells related in plan in series
- \( N_e \) = Number of daylight based cells related in parallel
- \( I_{rs} \) = Reverse saturation current
- \( T \) = Total temperature
- \( K \) = Boltzmann consistent (1.38*10^{-23} J/K)
This equation shows that PV module.

\[ I_{ph} = I_{sc} + K_i(T - 298)G/100 \]

Where \( I_{sc} \) is short out current of PV module at standard test states of 25°C and 1000w/m², \( K_i \) is the temperature coefficient of short out current, \( G \) is the sun based lights.

\[ I_0 = I_s \left( \frac{T}{T_0} \right)^3 \exp \left( \frac{qE_0}{nNKT} \left( \frac{1}{T} - \frac{1}{T_0} \right) \right) \]

The turnaround immersion current of the PV module is:

\[ I_s = \frac{I_{sc}}{\exp \left( \frac{qE_0}{nNKT} - 1 \right)} \]

Where \( n \) is dreamer factor of the diode 1.3, \( V_{oc} \) is open circuit voltage.

The current through shunt resistor of the above PV module is:

\[ I_{sh} = (V_{pv} + I_{pv}R_s)/R_{sh} \]

![Fig: 3 I-V and P-V characteristics of the PV module.](image-url)
Applications of photo voltaic systems are normally seen on the roof tops and in building integrated circuits, concentrator photo voltaic, photo voltaic thermal hybrid solar collector, rural electrification, standalone systems, spacecraft applications, specialty power systems [VIII, IX].

III. DC-DC Boost Converter

Lift converter is a converter that has yield voltage higher than the data voltage. It is moreover called as undertaking up converter [XII, XIII]. It isn't limited converter the circuit structure of regular dc-dc help converter appeared in underneath fig: 4.

It is a trading converter that works by here and there opening and closing of a power electronic switch. Lift converter contains dc voltage source, $V_s$, inductor L, controlled semiconductor switch S, diode D, capacitor C, load containment R. Semiconductor switches are used MOSFET, IGBT, and BJT. In this converter MOSFET utilized on the grounds that it is a voltage controlled gadget and its trading recurrence is higher and it moreover requires little data current, trading rate is high and it works is in MHZ recurrence. In this converter two modes movement is theirs [X, XI].

3.1 Methods of activity

Mode-1:
Fig: 5 Circuit diagram of conventional dc-dc bolster converter in on – state (Switch shut).

Precisely when switch S is shut, diode D is turned uneven. The inductor is in parallel to the source and gets charged and the inductor current expanded. The voltage of the inductor is comparable to the data voltage.

$$V_s = L \frac{di_L}{dt}$$

$$\Delta I_{L(opened)} = \frac{DTV_s}{L}$$

Mode-2:

Exactly when switch S is opened, diode D is in forward uneven. The present streams towards the stack making the regard escape centrality from the inductor and information. The figure: 6 demonstrate the Circuit diagram of typical dc-dc support converter when the turn is opened in OFF state.

Fig: 6 Circuit outline of traditional dc-dc help converter in off – state (Switch opened).

$$V_L = V_s - V_0$$
\[ V_s - V_0 = L \frac{di_L}{dt} \]

\[ \Delta i_{L(\text{closed})} = (V_s - V_0)(1 - D)T/L \]

Steady state operation

\[ \Delta i_{L(\text{opened})} + \Delta i_{L(\text{closed})} = 0 \]

The yield voltage condition of the lift converter is:

\[ V_s T_{on} + (V_s - V_0)T_{off} = 0 \]

\[ V_s T_{on} + V_s T_{off} = V_0 T_{off} \]

\[ V_s (T_{on} + T_{off}) = V_0 T_{off} \]

\[ \frac{V_o}{V_s} = \frac{T_{on} + T_{off}}{T_{off}} = \frac{T_s}{T_{off}} = \frac{1}{1-D} \]

\[ V_o = \frac{V_s}{(1-D)} \]

The output current equation of the boost converter is:

During off time it delivers output circuit. Full time delivers to load. During on time inductor free wheels on the source side so no current is being deliver to load.

\[ I_s T_{off} = I_o T_s \]

\[ \frac{I_s}{I_{off}} = \frac{1}{1-D} \]

\[ I_o = I_s (1-D) \]

\[ V_s I_s = V_o I_0 \]

\[ V_s I_i = \left( \frac{V_s}{1-D} \right) \left( \frac{V_s}{1-D} \right) / R \]

From the above condition we can discover normal inductor current

\[ I_i = \frac{V_s}{R(1-D)^2} \]

The most extreme inductor current can be composed as

\[ I_{L_{\text{max}}} = I_L - \frac{\Delta i_L}{2} = \frac{V_s}{R(1-D)^2} - \frac{V_s}{DT2L} \]
The base estimation of the inductance and the base estimation of capacitor for predictable current mode can be formed as

\[ I_{L_{\text{min}}} \geq 0 \]

\[ L_{\text{min}} = D(1 - D)^2TR/2 \]

\[ L_{\text{min}} = \frac{D(1-D)^2R}{2} \]

The swell factor and the base estimation of capacitor for nonstop current mode can be formed as

\[ \Delta Q = \frac{V_0DT}{R} = C\Delta V_0 \]

\[ \Delta V_0 = \frac{V_0DT}{RC} = \frac{V_0D}{RCF} \]

\[ r = \frac{\Delta V_0}{V_0} = \frac{D}{RCF} \]

\[ C_{\text{min}} = \frac{V_0D}{\Delta V_0RF} \]

IV. MPPT Controller

MPPT (Maximum Power Point Tracking) estimations that fuse into charge controller used for evacuating most extraordinary open power structure PV module under explicit conditions. The voltage at which PV module can convey most outrageous power is called most noteworthy power point.

MPPT (Maximum Power Point Tracking) as utilized in PV board charge controllers. A greatest power point following (MPPT) is an electronic DC-DC converter that overhauls the match between the sun based showcase (PV sheets) and battery bank or utility structure.

MPPT is definitely not a mechanical after structure that physically moves the module to make them point even more authentically at the sun. MPPT is a totally electronic/modernized system that the electrical working reason for the module Most present day MPPT charge controller are around 93-95% effective in the transformation, be that as it may, the absolute best MPPT charge controllers can even be up to 97-99%.

In MPPT controller various calculations are there in this the first is P&O calculation, gradual conductance. In this paper utilizing P&O calculation in light of annoy and watch calculation is straightforward and does not requires any past learning of the PV generator qualities or the estimation of sunlight based force and cell temperature and
is anything but difficult to actualize with simple and advanced circuits. It annoys the working purpose of the framework causing the PV exhibit terminal voltage to vary around the MPP voltage regardless of whether the sun powered irradiance and cell temperature are constants.

Furthermore, it is the most extensively used and workhorse MPPT counts in light of its agreement among execution and ease. Be that as it may, it experiences absence of speed and versatility which is vital for following the quick transient under fluctuating natural conditions. It is straightforward and straightforward procedure yet debased execution is accomplished because of the exchange off between accuracy and speed after choosing the progression size. Figure: 7 demonstrate the P&O calculation graph.

![Flowchart of perturbation and observation](image)

**Fig: 7 Flowchart of perturbation and observation**

**Draw backs:**

1. The P&O technique is moderate to discover the MPP if the voltage is far away from MPP.
2. P&O strategy utilize little (and fixed) gradual changes in the balance file which results in huge transient following time ('t'). 't' is characterized as the time taken by a MPPT calculation to reach inside 95% of the most extreme normal power accessible at MPP.
V. Simulation Results

Fig: 8

numerical displaying of PV board

Fig: 9 recreation chart of PV board
Fig: 10 I-V traits of PV board

Fig: 11 P-V attributes of PV board

Fig: 12 recreation of typical lift converter

Copyright reserved © J. Mech. Cont. & Math. Sci.
T. Sreelakshmi et al
Fig: 13 After-effect of lift converter

Fig: 14 Shut circle of lift converter

Fig: 15 Consequence of shut circle of lift converter
Fig: 16 PV with shut circle of lift converter

Fig: 17 consequence of PV with shut circle help converter
VI. Conclusion

The main conclusion of this paper is the converters require the operating at high duty cycle ratio. The proposed converter is very simple and simple control structure. It is most typical, in spite of the way that this procedure and can achieve movements of force yield. It is implied as an incline climbing technique, since it relies on the ascending of the bend of power against voltage underneath the best power point, and the fall over that point. Trouble and watch is the most conventionally used MPPT system in view of its effortlessness of execution. Trouble and watch system may achieve top-level viability.
References

I. A. Naveen Reddy,; “Performance and Improvement of Induction Motor by Using Multilevel Inverter” IJCTA, 9(10), 2016, pp. 4211-4219 International Science Press.

II. A.R.VijayBabu, V.Rajyalakshmi, K.Suresh, Renewable Energy Integrated High Gain DC-DC Converter with Multilevel Inverter for Water Pumping Applications, Journal of Advanced Research in Dynamical and Control Systems, Volume 9, Issue 1, PP. 172-190, 2017.

III. H.F. Abdul Wahab and H. Sanusi, “Simulink Model of Direct torque control of induction machine,” American Journal of Applied Sciences 5 (8): 1083-1090, 2008, ISSN 1546-923, 2008 Science Publications.

IV. Maheswararao, Ch Uma, YS Kishore Babu, and K. Amaresh. "Sliding mode speed control of a DC motor." 2011 International Conference on Communication Systems and Network Technologies. IEEE, 2011.

V. Mohan Reddy K.; Naveen Reddy A.; “Solar PV Array Fed Four Switch Buck-Boost Converter for LHB Coach,” IJCTA, 9(29), 2016, pp. 249-255 International Science press.

VI. P. Satya Prakash,; Srikanth Gollapudi,; Alla Naveen Reddy,; K. Bala Krishna,; “Design and Implementation of Modified Septic Converter for Battery Charging Application” Journal of Advanced Research in Dynamical and control systems vol. 9. (2017).PP.100-109.

VII. Sharma, Neelam. "Analysis of Lactate Dehydrogenase & ATPase activity in fish, Gambusia affinis at different period of exposure to chlorpyrifos." International Journal 4.1 (2014): 98-100.

VIII. Sukumar, Durga, JayachandranathJithendranath, and Suman Saranu. "Three-level inverter-fed induction motor drive performance improvement with neuro-fuzzy space vector modulation." Electric Power Components and Systems 42.15 (2014): 1633-1646.

IX. Toh, C.L.; Idris, N.R.N.;Yatim, A.H.M., “Torque ripple reduction in direct torque control of induction motor drives,” power engineering conference, 2003, PECon 2003 Proceedings. National 15-16 Dec. 2003.