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An Improvised P & O Method for extracting Maximum Power in PV applications with Moving Average Filter using a Boost Converter

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***Abstract:** As the population is growing , there is a rapid utilization of electric energy either in industries or house-hold sectors . Due to scarcity in conventional energy resources could not meet the power demand. Non conventional energy combining with conventional resources are needed for satisfying the energy demand. The best alternative is the Solar energy. In order to extract large amount of power from incoming solar emission an optimized and redundant control strategy is developed to remove the existing straits. From photovoltaic module maximum possible power is extracted using MPPT and it is fed to the step up converter which boosts up the voltage and later given to load. Modified Perturb & Observe method regulates duty cycle of step up converter for changing load in accordance to MPPT tracking.*

***Index Terms:** Incremental Conductance(INC), MPPT, MAF, P&O.*

I. INTRODUCTION

Due to fast expending of the natural fuels such as coal ,gas the energy consumption and production are not met to one another. The sudden increase in energy demand can only be satisfied with renewable energy resources. Utilization of such resources not only enhance demand and supply ratio power but also eradicate global warming.The renewable energy resources do not pollute the environment which makes the world towards the green revolution . The configuration modules are simple and easy to use for extracting solar power. Solar energy potential is surplus available that can achieve for harvesting in India. About 4.5 Kwh of solar irradiance per day is received by most of Indian. Abundant power can be extracted from solar resources but due to available technology of it is limited to an extent. This is affected with conversion efficiency. As per the study done from the available technology the maximum efficiency is less than 2.2%.The growth in power electronics & renewable sources of energy systems assisted engineers to built small & solid network configurations for enhancing the energy . Due to increase in
power density make these system nonvisible. MPPT methods are the optimization techniques for power helped in increasing the operational efficiency in the utilization of non conventional energy resources.

In PV standalone system , Perturb & Observe method which is a simple and uncomplicated application suffers with certain demerits such as problem of oscillations. The efficiency of INC is better than P&O but it is complex. Therefore, for better efficiency & eradicate demerits of P&O method, a modified P&O algorithm for PV system is implemented in this paper.

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II. LITERATURE SURVEY

Anmol Ratna Saxena, et al., [1]. Here an experimental and simulink model has been developed for MPPT using P&O & INC techniques. As per the study, step up converter controlled by INC MPPT is 3 times faster than controlled by P&O MPPT technique.

Ahmed M. Atallah, et al., [2]. Here buck, buck boost topologies are used in combining with P&O for enhancing the output of photo voltaic module. As per the study, there is lagging in performance of PV module in buck boost than the buck converter controlled by P&O. This is due to effect of instantaneous variations in operating conditions like irradiance, temperature etc.

Salch Elkelani baba, et al., [3]. In this paper, the analysis of INC , P&O have been discussed by taking certain operating conditions. For different operating conditions and at varied temperatures the results are tabulated & studied. Here, characteristic behaviour of P&O is faster at certain range of operating conditions when compared to INC technique.

Emmanuel Kwaku Anto, et al., [5] [6]. Here , the authors discussed about various converter topologies like cuk, boost, buck boost with PID controller & other control strategies subjected at various operating conditions to analysis the performance of P&O and other methods. Researches clearly showed that these techniques are suffering from drift, instability, speed, cumulative errors etc. However these unstable characteristics will be an effect to the applications.

To obtain good amount of power from the input side an appropriate operating point has to be selected by the tracker. Hence to get output power maximum (P_{MPP}) MPPT tracker automatically ascertains its voltage & current to reach their peak values for a given irradiance & temperature.

P&O method is very simple algorithm and popular technique but there is efficiency reduction due to swinging of operating point, as a result there is an effect in battery lift due to poor charging process.

The Current-Voltage and Power -Voltage output in photo voltaic module for a given Irradiance ,Temperature is observed in fig 1. At low operating voltages and currents the PV setup is a constant source of current and a steady voltage source respectively.

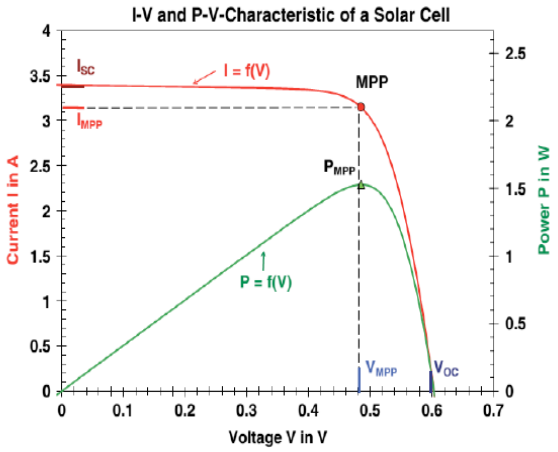

Fig. 1. I–V and P –V characteristics of PV panel at a given Irradiance &Temperature

As per the study, efficiency is decreased due to instability, drift & oscillations of operating point. With the help of a simple Low Pass MAF controlled with P&O algorithm , these problems can be outcomed .

III. PROPOSED CONFIGURATION OF P&O WITH MAF TECHNIQUE

The method proposed has the basic P&O with MAF as an extinction algorithm thus forming an improvised P&O MPPT technique with this method oscillations & drift in operating point are eliminated. In general, MAF is a preprocessing filter and a data averaging method. It facilitates to eliminate noise in the communication systems. A MAF can be a weighted or a simple MAF. Among these, simple or direct moving average voltage method will be the workhorse to many researchers that find its best way in reliability, and simple to use. The direct moving average voltage filter decreases ripple factor for PV voltage. This technique uses minimum operations per cycle and half the memory than that of compared to the other digital filters. Therefore to eliminate random sample harmonics and for predicting future data , SMVA find its role [7]. The model block system of SMVA with MPPT tracker along with flowchart is observed in fig. 2 and fig. 3 respectively.

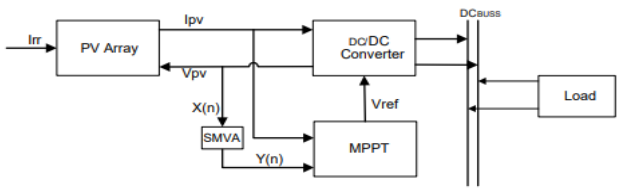

Fig. 2. P & O MPPT connected with a Simple Moving Voltage Average (SMVA) Filter

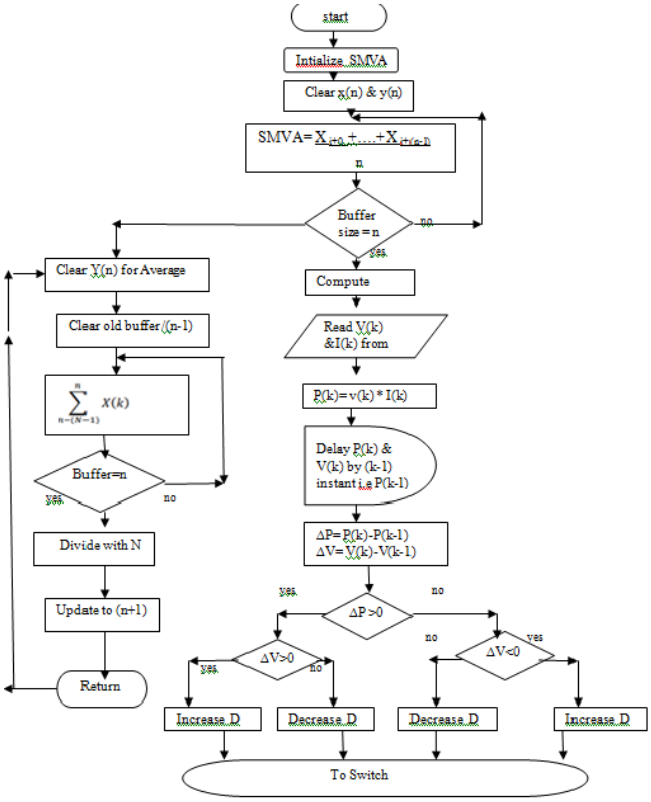

Fig. 3. Flowchart of SMVA with P & O Technique

Generally ,

$$\sum_{n-(N-1)}^{n} X(k) = \sum_{n-N}^{n-1} X(k) - X(n-N) + X(n) \quad (1)$$

$$Y(n) = \frac{1}{N} \sum_{n-(N-1)}^{n} X(k) \quad (2)$$

Equation (1), (2) represents input signal and output signal respectively. N denotes dimensions of the MAF window.The limiting number of samples of the source signal is carried with N [8] . The smoothing effect is proportional to N. There is a delay in moving average as it is based on the (n-1) PV data. Despite this disadvantage , moving average assists in filtering out the noise and smoothens the PV voltage. MAF is used to determine precision and mean value. In figure shown in (4), the harmonics are filtered out with SMA .

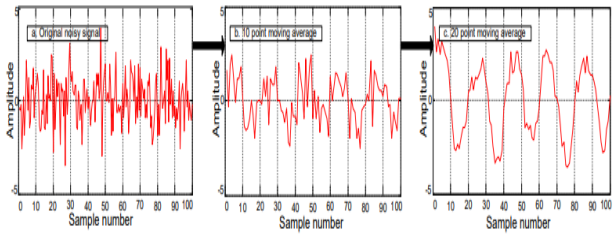

Fig. 4. Signal smoothing of SMA with different N points

PV module voltage as input to MPPT shown in fig.(5) without SMVA and with SMVA . SMVA performance with P & O MPPT method is satisfactory than with P & O MPPT.

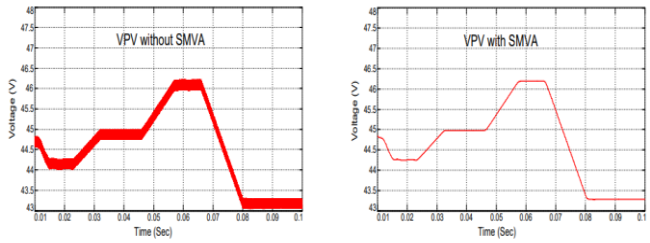

Fig.5. Input to MPPT (A) Without SMVA (B) With SMVA

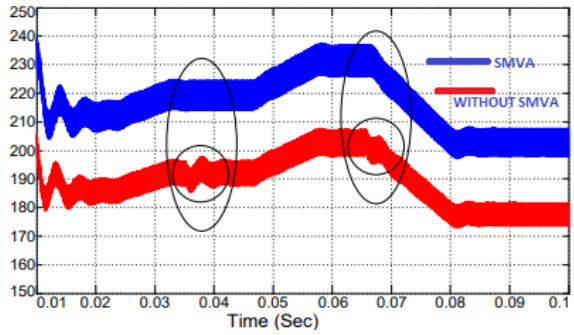

Fig.6. Output Voltage in PV string

Voltage response of PV string with SMVA (circled) is steady for a given irradiation. From figure 6, it is clear that, the output of the PV system has drift and oscillations without the application of SMVA and has an almost smooth curve with SMVA. It is observed that, the algorithm given with SMVA has no drift in power extraction as compared to the system without SMVA. The estimated efficiency of the system is well above 90% with operating condition 25 degree Celsius at 1000W/m^2.

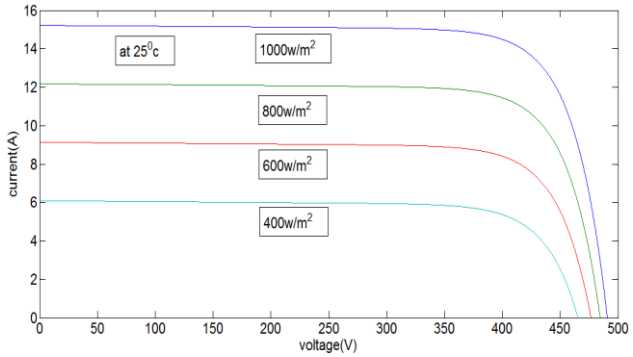

Fig. 7. Voltage-Current curve with solar irradiation

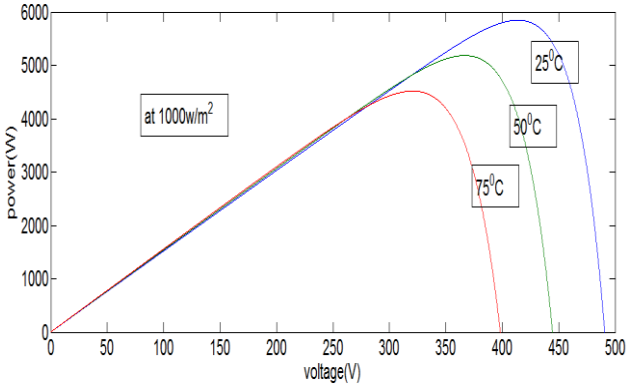

Fig. 8. Power-Voltage curve with temperature

The PV array has a non linear characteristics shown in fig.7, fig. 8 depends on temperature, irradiance and other ambient conditions. Photo Voltaic Array generated voltage is fed to the converter and later fed to load. Based on the converter circuit duty ratio , the voltage response of step up converter varies. The step up converter[12] has low conduction losses, high efficiency, high output voltage regulation when compared to the past isolated power converters.

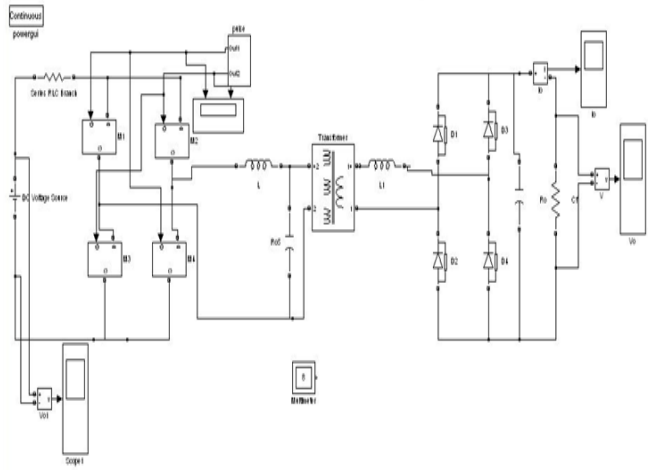

Fig. 9. Simulink model for Resonant Boost Converter

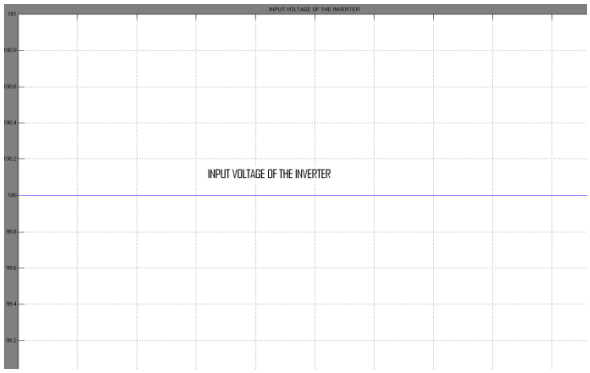

Fig. 10. Inverter Input Voltage

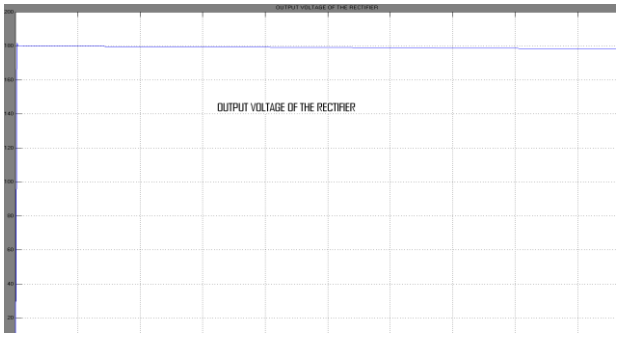

Fig. 11. Rectifier Output Voltage

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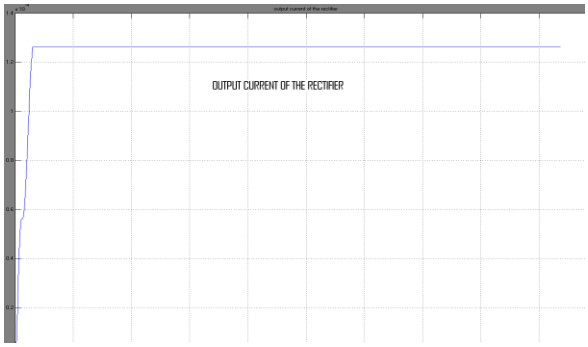

Fig. 12. Rectifier Output Current

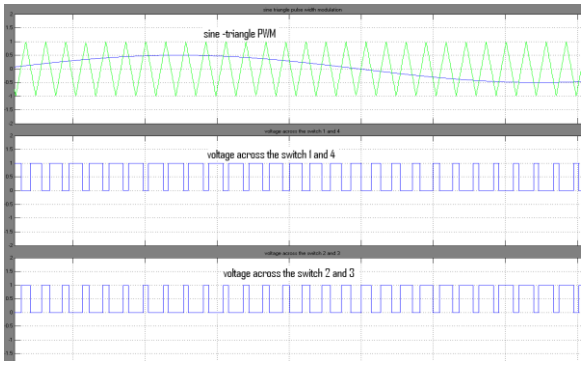

Fig. 13. Triggering pulses

IV. CONCLUSION

With different MPPT algorithms the maximum power can be extracted. And one among them is P&O algorithm. There is enormous drift in the power extracted by P&O algorithm for which oscillations do introduce inherently. This is the major drawback. To overcome this drawback of wide power drift, the fundamental P&O algorithm is improvised with MAF algorithm which uses a simple moving voltage average filter to enhance the system performance. The oscillations and power drift are eliminated by MAF. The position of the maximum point is near the peak for the proposed system and performs good results. To derive the extracted output , power converter is connected to the PV Array and later fed to load or battery.

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