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Modelling of Single Stage Inverter for PV System Using Optimization Algorithm

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Abstract

MPPT control algorithm and lossless inverter can be improving the efficiency of photovoltaic system. Amount of solar radiation exposed on the panel is affected by buildings and tree shadows. Such partially shaded cells lead to the existence of multiple mpps and the problem can be regarded as an optimization problem. The control algorithm named seeker optimization algorithm (soa) is implemented in this paper to find the global mpp instead local maxima obtained in case of conventional perturbation and observation (p&o) method, incremental conductance and other solution methodologies. Switching losses are minimized by single stage inverter configuration. The proposed system output voltage is a rectified sine wave. Simulation model is developed in psim that couples soa algorithm coded in matlab. Finally it will improve the overall efficiency and reduce the switching losses of the solar photovoltaic system.

***Keywords**: optimization algorithm (seeker), mppt, buck boost single stage inverter*

1. Introduction

Today's Power engineer focus on improving the usage of naturally replenished energy sources such as sunlight, wind, etc. Solar energy finds application in various areas like solar heater, solar cooker, day lighting and many.

Solar system converts sunlight into electricity, using photovoltaic (PV) cells. To overcome the drawbacks, particle swarm based control algorithms were developed for higher power utilization from panel [3].

The method we adopted is PSO that is an effective and simple Meta heuristic method for obtaining optimized solution. In section I of the paper, the proposed Single stage inverter configuration is discussed. Single stage buck boost inverter configuration can perform two tasks. It either bucks or boosts the panel's output DC voltage and converts it into AC. As a result, the entire circuit is reduced in configuration and is more compact. The advantages of proposed single stage inverter are that it has better gain, and less switching losses .The output voltage of a device can be adjusted as per the duty cycle. The converter is operated through MPPT controller that is coded with Optimization algorithm in order to obtain maximum power from the panel.

2. Single Stage Buck Boost Converter

An inverter operates to convert direct current (DC) to alternating current (AC).Use of inverter circuits plays a vital role to improve the efficiency of Solar panels. The variable DC output of the panel is converted into desirable DC and then to AC in order to connect it with the utility grid. PV system inverters can act as Maximum power point trackers when controlled with appropriate control algorithms. Efficiency of panel is improved by adopting single stage inverter configuration [4] as shown in Figure 1.

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2.1. Existing Converter Problems

Buck Boost converters operates hard switching which rise the switching losses and stress across the converter in conventional methods [5]. Output Power level from the inverter is reduced due to current ripples. Among the single stage and two stage inverter configurations, two stage system having more no of switches. Energy loss is more due to more stages of conversion. To overcome these problems, a buck boost converter is adopted.

2.2. Methodology Adopted

A single stage inverter comes out with reduced number of switching components which in turn minimizes the switching losses [6]. Loss reduction is also achieved due to single energy conversion stage. Switches are turned ON at fundamental frequency to reduce switching losses. Current ripples are reduced by including inductor topology. It is necessary to decide the desire value of inductor to increase the output voltage level. Output voltage of the converter is based on duty cycle. It operates in discontinuous mode to achieve unity power factor. The proposed converter's gain is increased by $\sqrt{2}$ than that of conventional converters. The converter effect

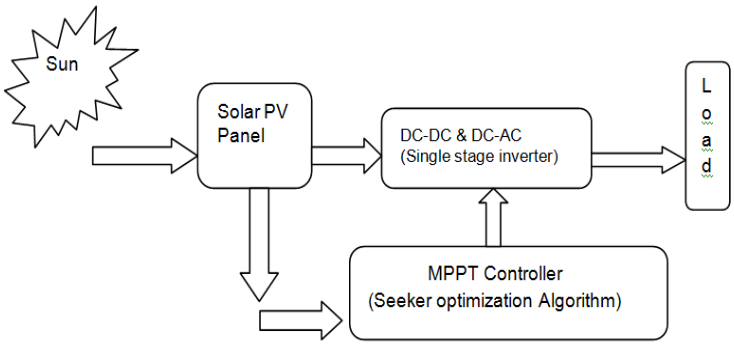

Figure 1. Block Diagram for Proposed Model

After the conversion stage the output of converter is boost DC voltage only. By using the H-bridge inverter we can obtain the sinusoidal AC voltage. Using semi sinusoidal PWM pulse we giving the gate pulse to the switches. And the output of the inverter connected with the load or grid. Because of this conversion we reduce the losses and improve the voltage gain. Here the main objective of the system is used to improve the efficiency of the system by reducing the system energy conversion by reducing the stages in the converter system also here we analyzed some papers for our reference there they mentioned different different methods they introduced to improve the efficiency of the system also there will be a problem in all the system is they are not able to extract the maximum power during day time too. But there the thing is in case if we used mechanical tracking means that need a separate power to operate the system and it too having two times one is single axis tracking system and another one is dual axis tracking system the main difference between the single axis and dual axis tracking system is they will track the sunlight in one direction only but in dual axis it will track both the axis ultimately the system will give more efficiency compare to single axis tracking but it consumes more power that need a servo motors to move the panel in two axis but ultimately it rises the initial cost of the system and that need more maintenance these much drawbacks are in the mechanical tracking system but incase if suppose it is standalone system means that not required just compare the overall efficiency of the mechanical tracking system and standalone system means that gives some difference in their output, but that also if it is a thermal based system if we need thermal energy as a output means that system gives more output and the mechanical tracking gives better efficiency but the overall cost of the system is somewhat high compare to their collector material. Here the system cost is somewhat different how means the solar photovoltaic generator that pv cost also high but the system gives very less performance and the efficiency also vary depends upon the material and cost also vary depend upon the type of material here we having these much problems we are facing to install the pv system for this we having a optimal solution is to extract the maximum power from the solar panel by using different types of electronic tracking method is called maximum power point tracking. The MPPT controller will get the input from the solar photovoltaic output and compare with the reference and generate a particular gate pulse and give to the switches. Then only we get the desired output. And we focused on the maximum power point tracking control using optimization algorithm.

3. Simulation Result

The working of the proposed model is verified for its efficiency using two simulation software, PSIM and MATLAB. MPPT control algorithm is developed in MATLAB environment. Results obtained proves that the proposed Seeker optimization based MPPT control algorithm in more effective in finding global optimal solution. The algorithm converges for reduced number of iterations as compared with that of PSO approach. Figure 2 indicates the circuit diagram drawn using PSIM software in this circuit diagram that comprises solar pv which is coupled with single stage converter which converts the low voltage dc to high voltage dc and that too converts in ac voltage in a single stage here we consider a load as resistive and inductive load also that connected with the grid. Also in this simulation that having a extra component is:

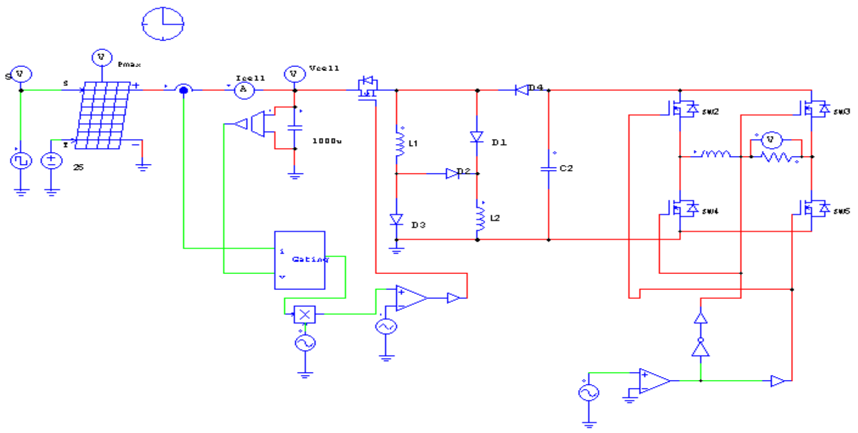

Figure 2. Proposed PSIM Model for Single Stage Inverter Configuration

Maximum power point tracker which extract the maximum power from the solar photovoltaic panel which continuously indicates the power according to their insolation. For the simulation purpose we can modify the isolation level according to our convenient because if we want to check the output for particular rating solar panel ou tput means we can change the rating and also change their insolation like for morning that will be less and mid noon is in peak and evening it reduces the level so easily we can check their output according to their input strategy and the parameters we have to give to set the open circuit voltage and short circuit current from the curve we can get the maximum power and due to the level of insolation easily we can get that maximum power output. And the remaining fig indicates the voltage and current level of the panel and output power from the converter. That need a feedback loop which gives the continuous monitoring to the mppt block which verify the output with the reference and gives the appropriate gate pulse produce and gives to the converter for the gate signal.fig 9 indicates the working operation of the converter and the cycles of the switching in the circuit and the remaining waveforms shows the output voltage and output current of the proposed system which simulated in power simulation software and the last figure shows the maximum power extraction from the panel using the proposed optimization algorithm which simulated in Mat lab which the coding having the man based search algorithm ultimately that is called seeker optimization algorithm. After this we will discuss the hardware implementation and results in next chapter.

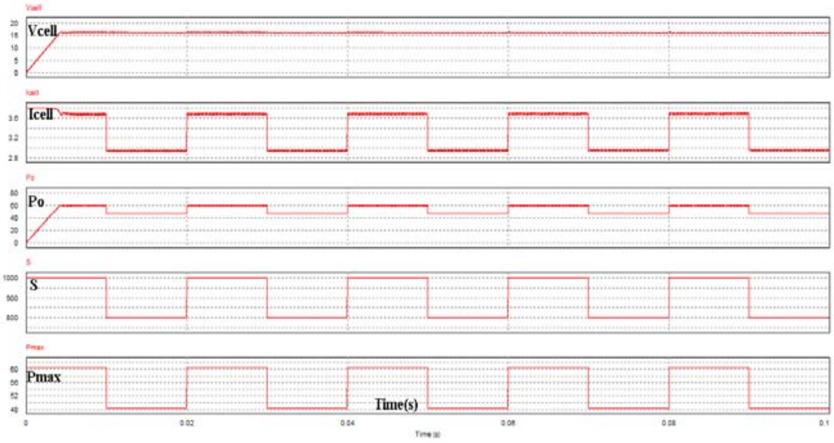

Figure 3. Input Waveforms of PV Panel

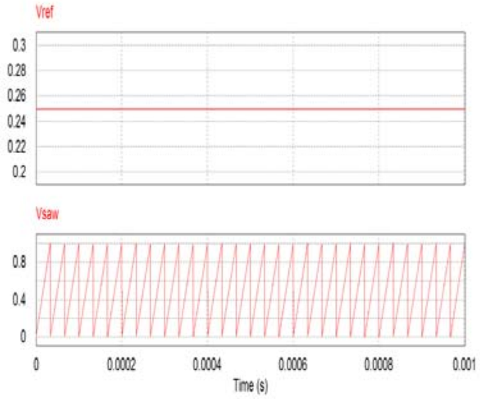

Figure 4. Reference and Carrier Waveform

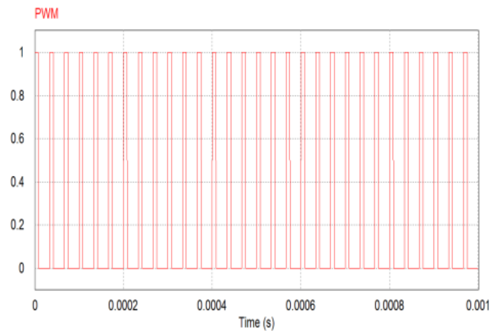

Figure 5. Pulse Width Modulation for Mosfet

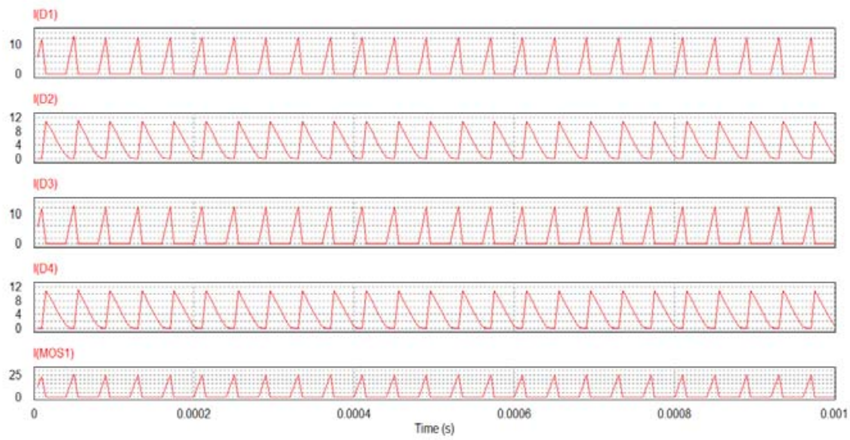

Figure 6. Modes of Operation for the Converter

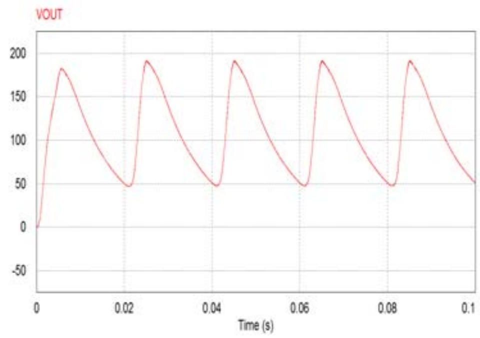

Figure 7. Output Voltage Across DC-DC Converter

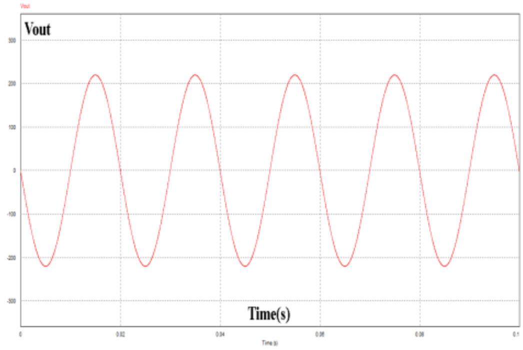

Figure 8. Output Voltage Across Single Stage Inverter

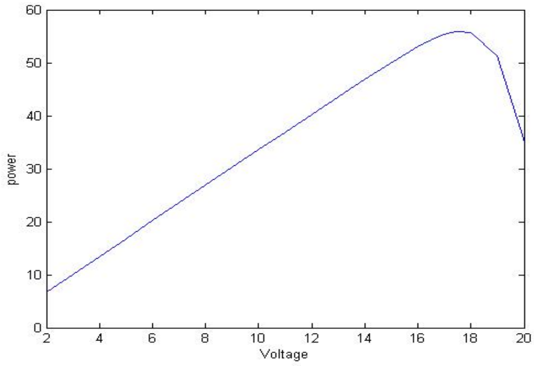

Figure 9. Output of Optimization Algorithm using Matlab

PV system simulation model is developed in PSIM software. PSIM provides facility of co simulation with MATLAB. Thus the MPPT control algorithm is interfaced with PSIM model through Sim Coupler Module

4. Experimentation And Result

Before implementing the hardware part first we analyzed the different types of analysis we analyzed in our local zone the know the performance of the solar insolation. So first initially we used the basic solar irradiation meter to collect the solar insolation in our area and we took in different timings in continuous manner and we understood that mid noon having more solar insolation.

Then we used the voltmeter and ammeter to analyze the open circuit voltage and short circuit current in different insolation which we analyzed and shown the graphical diagram which is particulary for the 100w solar panel which having thin film material amorphous. in the hardware part we used 3 inductors 2 95µH for the converter and one 3.4mH for the filter, 3 MBR40250G diodes and one RURG8060 diode, 2 capacitors 11mF and 1.2µF, was constructed using four switches while the converter switch. here we control the model by applied using PIC microcontroller kit to produce the PWM modulation signal for the switch. Figure 10, 11, 12, 13 shows the VI, solar radiation variation and output power of the solar panel is shown.

Figure 10. Experimental Setup to Find Panel VI Characteristics

Figure 11. Output Voltage of the Inverter with LC Filter

Figure 12. Output voltage of different panels

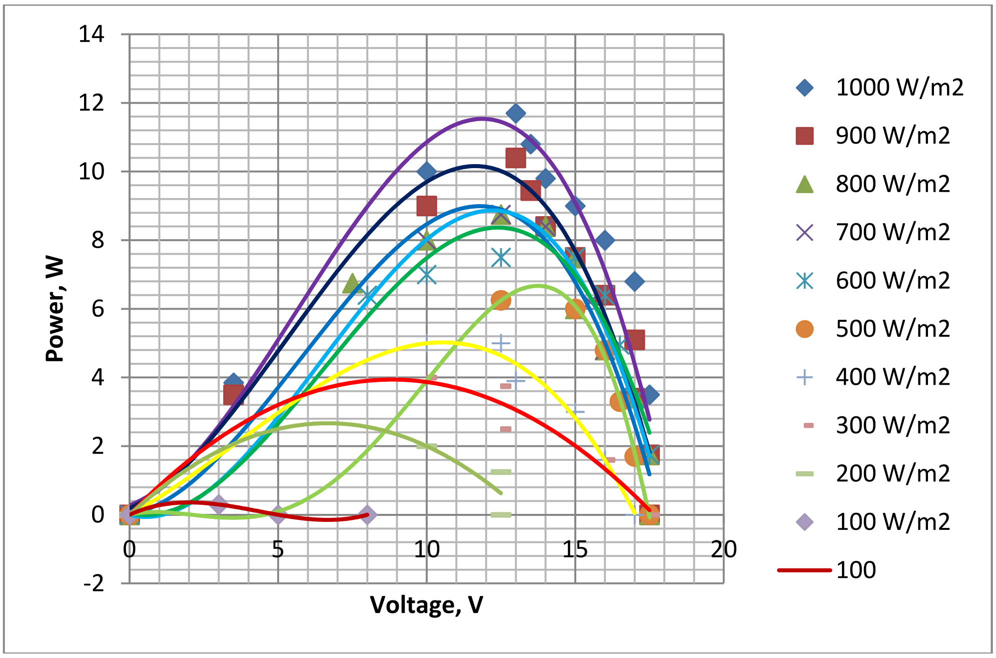

Figure 13. Power vs Voltage of the Solar PV Pane

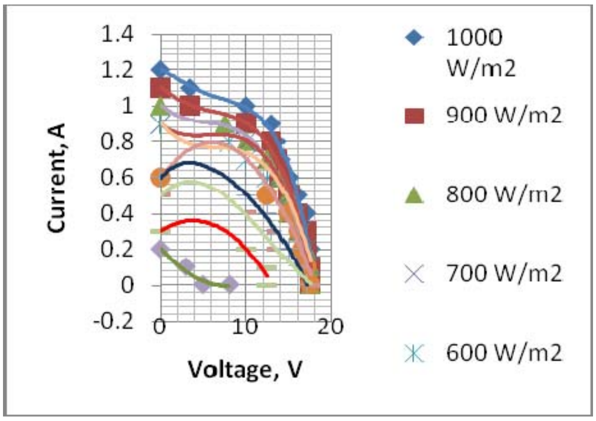

Figure 14. VI Characteristics of the Solar PV Panel

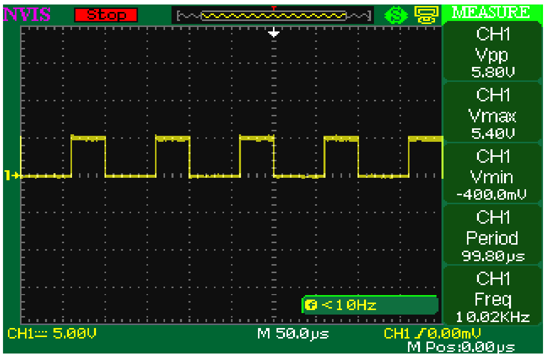

Figure 15. Output Pulse from the Optocoupler to Turn the Mosfet Switch

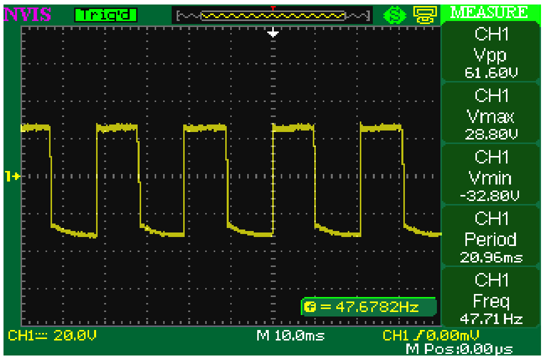

Figure 16. Output Voltage of the Inverter without LC Filter

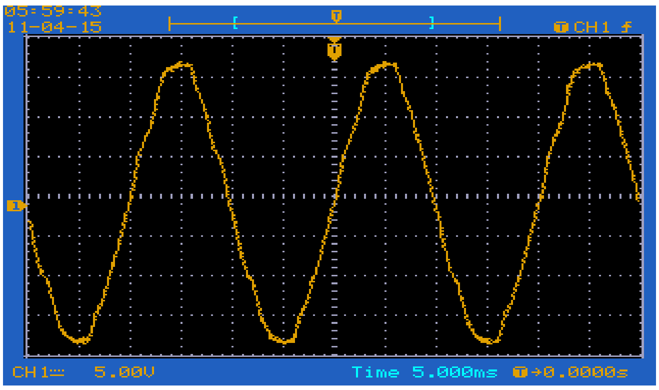

Figure 17. Output Voltage of the Inverter with LC Filter

The voltage output of the inverter is 95 ohm resistive load and the input voltage (PV voltage) of 18V. Figure 15 shows the pulse width modulation for the Mosfet, Figure 16 shows the output square waveform without LC filter, Figure 17 shows the output sine wave for the inverter with LC filter, the shape is sinusoidal and has a small voltage ripple. That waveforms taken from the digital signal oscilloscope which indicates the voltage, current and pulse with modulation of the hardware prototype system model

Finally, it is clear that the hardware system has the feature of more dc gain, and less cost, and less switching loss and high efficiency. The measured experimental efficiency was about 84%.

7. Conclusion

The technology indicates to give better efficiency to the system with the single stage inverter configuration that conversion losses are reduced. Since both DC-DC conversion and DC-AC conversion are performed in single stage, the overall circuit configuration is compact. Decrease in number of switches decreases the cost. Seeker optimization based MPPT control algorithm exactly tracks global optimal solution instead local optima, a major disadvantage of earlier proposed methods. Maximum power tracking is done even at partially shaded conditions of the cells. In future we can use the same inverter for different types of latest nano material solar pv to get the different types of performance.

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