International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 6 Issue 5, July-August 2022 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Analysis and Simulation of Solar PV Connected with Grid Accomplished with Maximum Power Point Tracking System

Sheikh Shadab, Dr. Ritesh Diwan

ET&T Department Raipur Institute of Technology, Raipur, Chhattisgarh, India

ABSTRACT

This paper deals with Solar PV module with maximum power point tracking system. The system used in this paper is based on perturbation and observation. As we know that the solar radiations are irregular or nonlinear as it depends upon time weather, location, place and climatic conditions. So to reach the maximum output we have to design a MPPT which is used to extract maximum power and in this paper we designed a P&O method to extract maximum power and to provide gate signal. Several other methods can also be used for this MPPT technique. The PV system is developed and simulated with help of MATLAB/ Simulink software environment.

KEYWORDS: *Maximum power point tracking system (MPPT), Pulse Width Modulation (PWM), Insulated gate bipolar transistor (IGBT), Total harmonic distortion (THD), static synchronous compensator (STATCOM),), and fuzzy logic control (FLC),Perturbation & Observation (P&O)*

How to cite this paper: Sheikh Shadab | Dr. Ritesh Diwan "Analysis and Simulation of Solar PV Connected with Grid Accomplished with Maximum Power Point Tracking System" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-6 | Issue-5, August 2022, pp.1157-1161, URL: www.ijtsrd.com/papers/ijtsrd50581.pdf

IJTSRD50581

INTRODUCTION

With more demand for electricity, continuously raising fuel costs and more concerns of global climate change have leads to more and more use of renewable energy sources. These energy resources have got more fame due to the depletion of non-renewable energy sources and their adverse impact on the environment. The energy extracted from Solar is one of the alternative renewable energy sources. In case of solar PV, the energy is collected as dc which, further can be converted into ac by the use of inverter and then subsequently fed to utility grid or it may be used in isolated load. The inverter output can be fed to the grid as well as standalone system. The main objective of Grid connected SPV system is to supply the local loads and any surplus power generation have to be injected into the grid [1]

Energy not only plays an important role in our life but also in the overall economy of the country. The requirement for energy is increasing in our daily life due to the industrial revolution. In the most developing country like India, the large share of energy generation mainly depends upon non-renewable energy sources. The gradual depletion of these sources such as fossil fuels, oils, etc. leading the developing countries towards the un-sustainability of civilization. Along with that, the generation of energy through conventional sources is also a reason for greenhouse gases. It has become a global challenge to reduce the emission of greenhouse gasses like CO2 and CO3 to ensured secure, clean, and affordable energy. Whereas clean and sustainable energy is perfectly generated through renewable energy sources [1]. There are many renewable sources of energy such as solar energy, wind energy, Hydro energy, etc. The Photovoltaic (PV) system is the most efficient renewable source of energy which has taken the great attention of the researchers.

The MPPT working principle is based on the maximum power transfer theory. The power delivered from the source to the load is maximized when the input resistance seen by the source matches the source resistance. Therefore, in order to transfer maximum

power from the panel to the load the internal resistance of the panel has to match the resistance seen by the PV panel. For a fixed load, the equivalent resistance seen by the panel can be adjusted by changing the power converter duty cycle [2].

The warming of global surface is increasing 0.6 degree Celsius per century. This warming caused by huge release of carbon dioxide and carbon monoxide. This causes acid rain, depletion of ozone layer and radioactive emission these effects can be minimized by searching some effective solution, this solution also include energy conservation with improved energy efficiency.

Now As per the financial terms electricity generation using renewable sources have higher price as compared to the non-renewable resources. But now a days the major challenge is to generate a good quality power with lesser incremental cost as much as possible and with lesser carbon emission. In that case we use renewable sources to generate power with good quality. So we should adopt the most convenient and cheapest way for generation transmission and distribution. In order to get an optimum power generation hybrid electricity is used so that increase in price may get compensated by the use of renewable assets. Many government schemes are running for the incentives in installation of renewable sources worldwide that will also be considered in planning of incremental cost of the project as well as payback period from the savings of electricity bills revenue.

MODELLING OF PV ARRAY

Major aim is to reduce carbon footprints and now a days solar PV also installing in the commercial as well as residential buildings.

Proposed Model

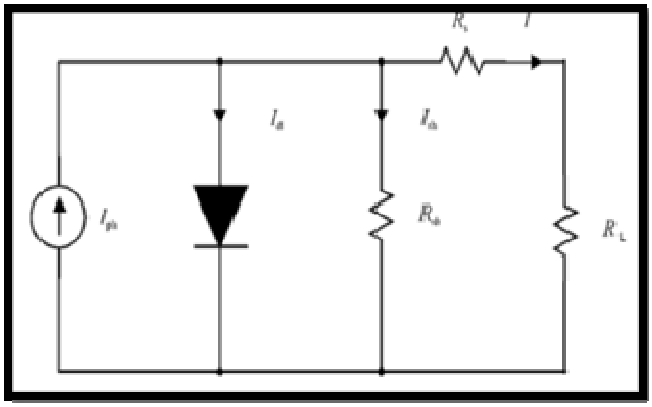

Figure 1 PV Cell Model

Implements a PV array built of strings of PV modules connected in parallel. Each strings consists of strings connected in series. Parallel strings 40 and series connected modules per strings 10. With open circuit voltage 37.14V and short circuit current 8A.

The mathematical model of PV cell is represented by a current source with a diode connected in parallel as shown in figure 2. The intrinsic series resistance whose value is very small. The equivalent shunt resistance whose value is very high, applying Kirchhoff's law to the node where I_{ph}, diode, R_p and R_s meet. [2]

$$I = I_D - I_{RP} - I_{ph} \quad \ldots\ldots (1)$$

$$I = I_{ph} - I_0 - \left[exp\left(\frac{V+IRs}{V_T}\right) - 1\right] - \left[\left(\frac{V+IRs}{R_p}\right)\right] \quad \ldots\ldots (2)$$

$$I = n_p I_{ph} - n_p I_{rs} - \left[exp\left(\frac{q}{KTA} * \frac{V}{n_s}\right) - 1\right] \quad \ldots\ldots (3)$$

$$I_{rs} = I_{rr}\left[\frac{T}{T_R}\right]^3 exp\left(\frac{qE_G}{KA}\left[\frac{1}{T_r} - \frac{1}{T}\right]\right) \quad \ldots\ldots (4)$$

$$E_{G=} E_G(0)\frac{\alpha T^2}{T+\beta} \quad \ldots\ldots (5)$$

$$I_{ph} = [I_{scr} + K_i(T - T_r)]\frac{s}{1000} \quad \ldots\ldots (6)$$

Where, Iph is the Insolation current, I is the Cell current, I0 is the Reverse saturation current, V is the Cell voltage, Rs is the Series resistance, Rp is the Parallel resistance, VT is the Thermal voltage (KT/q), K is the Boltzmann constant, T is the Temperature in Kelvin, and q is the Charge of an electron. [3]

In this paper a review of major MPPT techniques used in major PV standalone system are presented and gives a detailed review on various MPPT techniques used in this work. The I-V and P-V characteristics with different irradiation and temperature variation are shown in figure below.

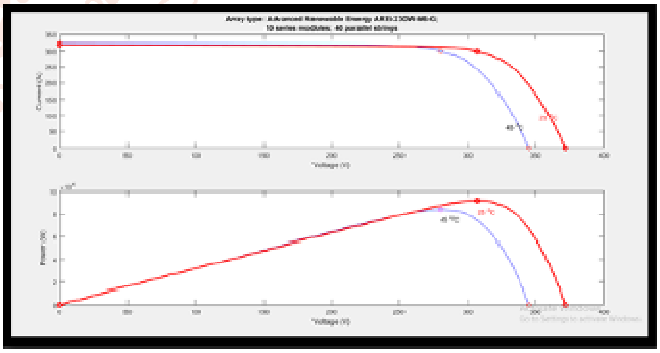

Figure 2 I-V and P-V Characteristics

BOOST CONVERTER

The PV array system generates DC voltage in nonlinear conditions. The generated voltage is low and variable so it must be of constant amplitude and high in value at the input of the inverter. So the boost converter is necessary to boost the voltage

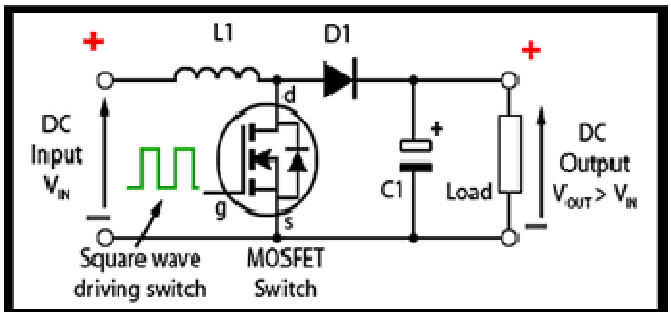

Figure 3 Equivalent circuit of boost converter

The Fig.3 shows a step up or PWM boost converter. It consists of a dc input voltage source Vg; boost inductor L, controlled switch S, diode D, filter capacitor C, and the load resistance R. When the switch S is in the on state, the current in the boost inductor increases linearly and the diode D is off at that time. When the switch S is turned off, the energy stored in the inductor is released through the diode to the output RC circuit. In this way we get the desired output voltage by this boost converter. We can easily regulate its output voltage by varying the output resistance. [4]

$$V_{out} = \frac{1}{1-D} V_{in} \quad \text{..... (7)}$$

$$R_{pv} = (1-D)2R_{out} \quad \text{..... (8)}$$

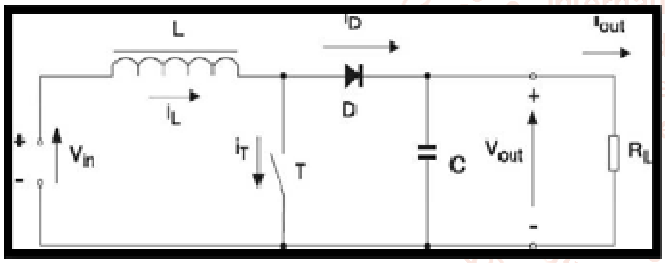

Figure 4 Circuit diagram of boost converter

$$Gs = \frac{Vo}{1-D} * 1 - \frac{\frac{Ls}{(1-D)^2 * R}}{\frac{LCs^2}{(1-D)^2} + \frac{Ls}{(1-D)^2 * R} + 1} \quad \text{..... (9)}$$

Maximum Power Point Tracking

The MPPT control is a fundamental in order to obtain a good performance on the overall system. The MPPT techniques can be categorized as direct and indirect methods. The direct method includes perturbation and observation method, fuzzy logic method, neural network method and incremental conductance method. In this work we review two different fuzzy logic control methods and trying to achieve optimum output by comparison in the overall installed system of such rating.

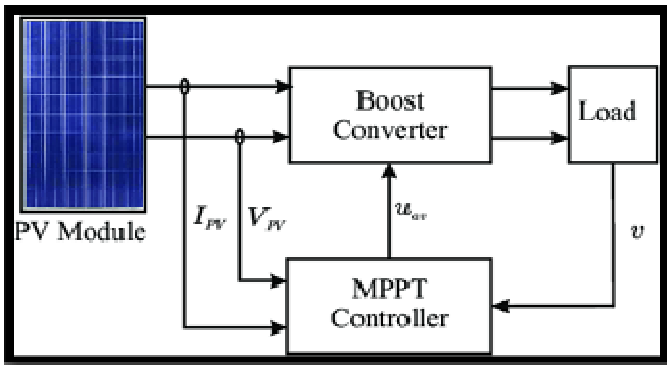

Figure 5 Maximum power point tracking

Perturbation and observation method

Voltage and current from the PV module are fed into the Algorithm. The power output increases when the operating Voltage increases. The system increases the operating voltage until the power output begins to decrease. Once this happens, the voltage is decreased to get back to the maximum power output value. This algorithm applied in the DC–DC buck converter as shown in Figure proposed model.

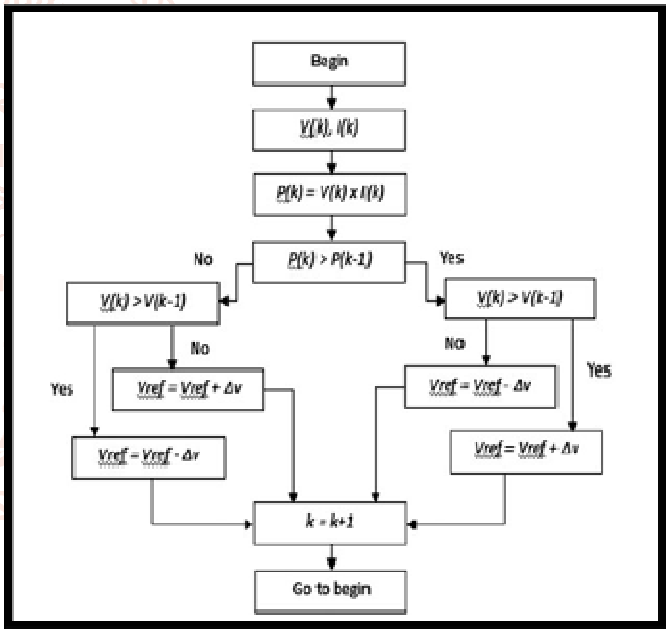

Figure 7 Flow chart of the P&O method

Incremental Conductance algorithm

This algorithm compares increase in conductance to the present conductance of the PV system. According to the result, the voltage will be incremented or decremented to attain the maximum power point. Maximum power point is achieved when equation (10) is satisfied. When maximum power point is the voltage remains stationary, whereas for Perturb & Observe maximum power point algorithm, after attaining maximum power point the voltage oscillates around the maximum power point. [5]

$$\frac{dp}{dv} = I + v\frac{dI}{dv} \quad \text{..... (10)}$$

$$\frac{dI}{dv} = \frac{I}{V} \quad \text{..... (11)}$$

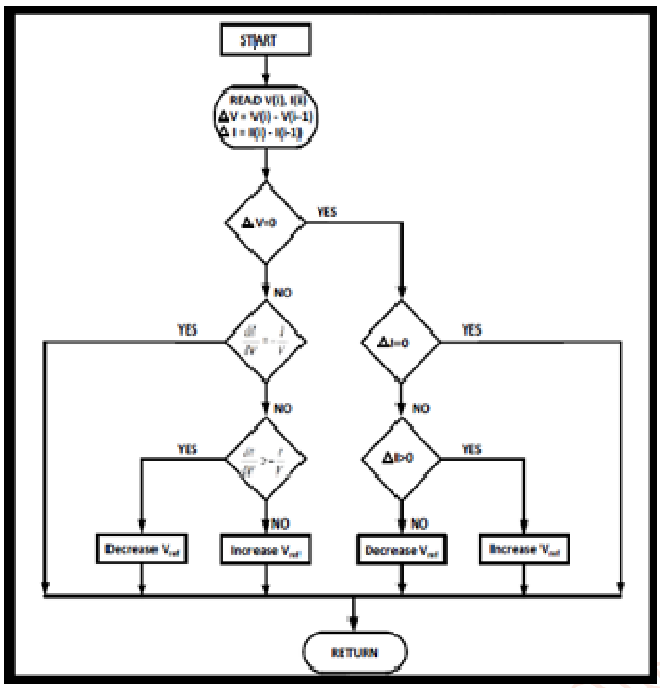

Figure 8 Flowchart for Incremental Conductance Maximum

Fuzzy Logic algorithm

Renewable energy sources has a wide range of applications by using fuzzy control system. From the last few years the requirement of fuzzy has been increased due to it's easy to design and understand factors. FLC system also deals with the imprecise or inaccurate inputs which does not need any accurate mathematical model for controller.

Fuzzy logic controller process can be assorted into three categories:-

1. Fuzzification
2. Rule Evaluation
3. Defuzzification.

The First Category i.e. Fuzzification it takes the crisp input, for example, the change in input voltage levels. After taking the Crisp Input, it converts into fuzzy input with the stored membership function. When the fuzzy values are designed then, the first stage of FLC i.e. fuzzification takes place. [8]

Triangular membership function are used as they are easier to implement and quicker to process. In the proposed fuzzy system, seven fuzzy sets have been considered for each input: negative very big (NVB), negative big (NB), and negative medium (NM), negative small (NS) zero (ZE), positive small (PS), positive medium (PM) and positive big (PB), positive very big (PVB). Before fuzzification, the input variables are normalized using base values.

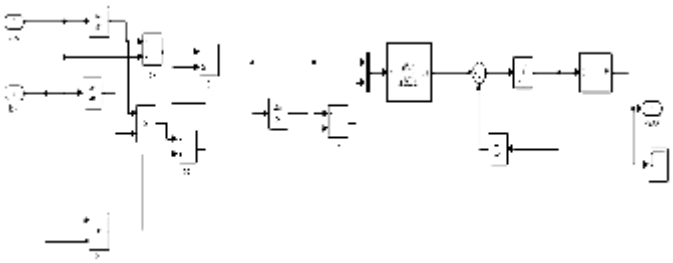

Figure 9 MPPT based on fuzzy logic system

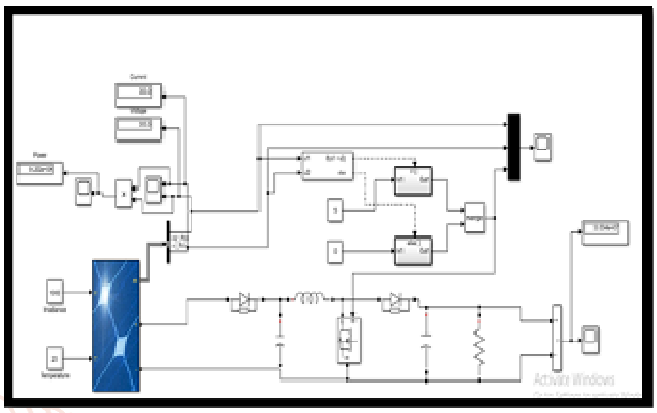

Figure 10 Proposed model

The proposed model describes the solar PV with 40 parallel strings and series connected modules per string is 10 comprising of 230 watts. In this model to enhance the output we use maximum power point tracking system by P&O algorithm to get the maximize output. In our next step we are going to connect this DC output voltage as the input of the inverter with the PWM based control system and connect it to the grid or load to analyze the outputs.

We can also use incremental conductance algorithm for the maximum power point tracking system and fuzzy logic system. Now a day's fuzzy logic system is used frequently as it is based on predetermined database of the solar irradiations and we get predefined outputs according to the fed input.

Various measurement system has been placed at various stages to measure all the parameters for the research and analysis at various stages of the system.

RESULTS

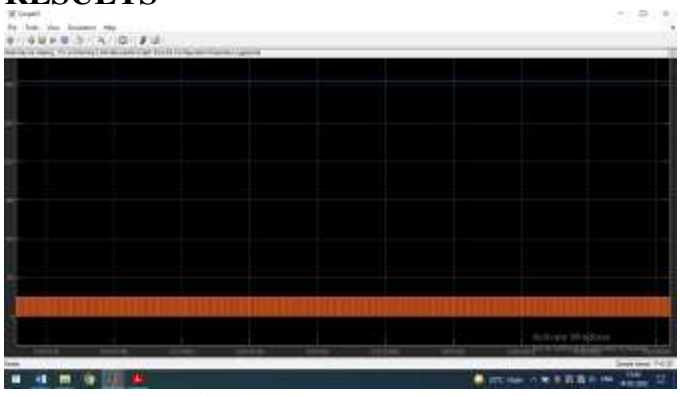

Figure 11 Mux output

Figure 12 Output voltage

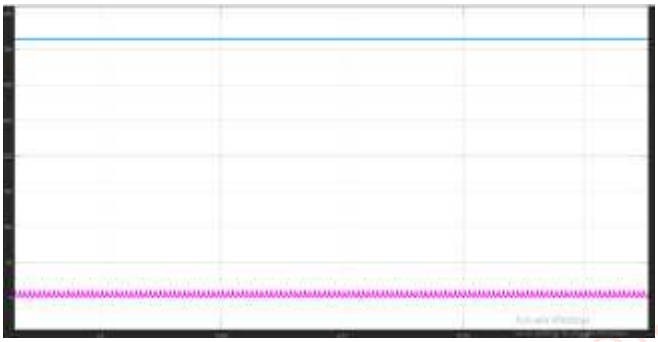

Figure 13 Voltage and current output

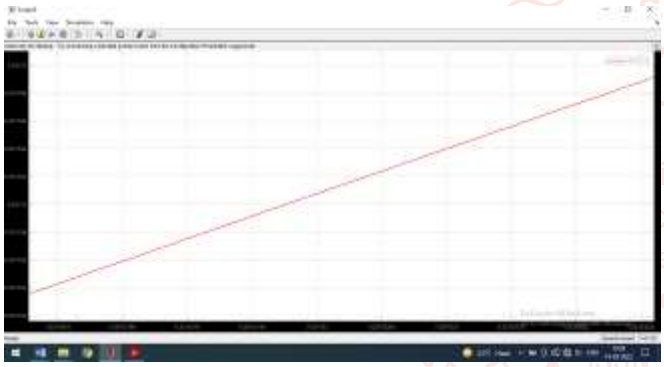

Figure 14 Power

Parameters	
Solar PV open circuit voltage	37.14 V
Short Circuit Current	8A
Resistance	50Ω
Inductance	350µH
Capacitance	560µF

CONCLUSION AND FUTURE SCOPE

This paper represents a solar PV module with maximum power point tracking system in which we have used perturbation and observation technique and in the same way we can get the output pwm signal for the chopper by using fuzzy logic control system and compare the outputs. After this point the output is ready to connect to the inverter and to supply the grid with suitable control system in future. Several advanced technologies can be used for making the output harmonic free and smooth waveform of output voltage and current as well as power by using FACTS devices like SVC and STATCOM.

References

[1] Subramanian Krithiga, Nanjappa Gounder Ammasai, "Power electronic configuration for the operation of PV system in combined grid-connected and stand-alone modes," IET Power Electronics, 2014, Vol. 7, Issue 3, pp. 640–647.

[2] E. Aranda, J.Gala´ N, M. Cardona, and J. Rquez, "Measuring the I-V curve of PV generators," *IEEE Ind. Electron. Mag.*, vol. 3, no. 3, pp. 4-14, September 2009.

[3] J.A. Gow, C.D. Manning "Development of a Photovoltaic Array Model for Use in Power Electronics Simulation Studies", IEE Proceedings on Electric Power Applications, Vol. 146, No. 2, pp. 193

[4] Journal of University of Shanghai for Science and Technology ISSN: 1007-6735 Design and Simulation of MPPT Control Strategy for Solar PV by Using Fuzzy Control Abhishek Verma1, Brahma Nand Thakur2,

[5] M. Vinay Kumar, U. Salma, Modelling and simulation of a three phase grid connected photovoltaic system," European journal of molecular and clinical medicine Volume-7 Issue-5, January 2020

[6] Nema, S., Nema, R., & Agnihotri, G. (2010). "Matlab / simulink based study of photovoltaic cells / modules / array and their experimental verification." International Journal of Energy and Environment, Vol. 1, Issue 3, pp. 487-500.

[7] Rahim, O. A., Orabi, M., & Ahmed, M. E. (2010). "Development of High-Gain High-Efficiency Grid-Connected Inverter for PV Module." 2010 2nd IEEE International Symposium on Power Electronics for Distributed Generation System, Egypt, pp. 368-373.

[8] Reinaldos, L., González, R., Borrega, M., & Balda, J. (2009, November). "Fuzzy Switching Technique Applied to PWM Boost Converter Operating in Mixed Conduction Mode for PV Systems." IEEE Transaction on Industrial Electronics, pp. 4363-4373.

[9] Manju Khare, Ganga Agnihotri Yogendra Kumar, & V. K. Sethi, "Performance Analysis of a Grid connected Wind Energy system,"in American Journal of Engineering Research (AJER) e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-03, Issue-02, pp-204-208,2014.

[10] Puneet K. Goel1, Bhim Singh2, Senior Member IEEE, S.S. Murthy3, Senior Member IEEE and Navin Kishore4, "Autonomous Hybrid System Using PMSGs for Hydro and Wind Power Generation" in IEEE 978-1-4244-4649-0, 2009.