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Advanced power control strategy in grid connected PV systems for constant power generation

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Abstract- *Each solar cell has a voltage-current (V-I) characteristic reflecting its response to both temperature and the incident light level. This is generally achieved using the algorithmic method for continuous maximum power point tracking (MPPT) i.e. the product between Voltage and Current shall be maximum. This can also ensure a fast and smooth transition between maximum power point tracking and Constant Power Generation (CPG). Regardless of the solar irradiance levels, high-performance and stable operation are always achieved by the proposed control strategy. It can regulate the PV output power according to any set-point, and force the PV systems to operate at the left side of the maximum power point without stability problems. The main goal of this paper is to implement the MPPT algorithm in advanced technique like fuzzy logic and determine if the algorithm implemented by fuzzy logic is optimal for controlling MPPT in order to establish the maximum power generated by the PV systems.*

Index Terms-Maximum Power Point Tracking, PV Systems, Power Control, Converters, Constant Power Generation.

I. INTRODUCTION

DUE to the world energy crisis and environmental problems caused by conventional power generation, renewable energy sources such as photovoltaic (PV) and wind generation systems are becoming more promising alternatives to replace conventional generation units for electricity generation [1]-[2]. Advanced power electronic systems are needed to utilize and develop renewable energy sources. In solar PV or wind energy applications, utilizing maximum power from the source is one of the most important functions of the power electronic systems [3]–[5]. In three-phase applications, two types of power electronic configurations are commonly used to transfer power from the renewable energy resource to the grid: single-stage and double-stage conversion. In the double-stage conversion for a PV system, the first stage is usually a dc/dc converter and the second stage is a dc/ac inverter. The function of the dc/dc converter is to facilitate the maximum power point tracking (MPPT) of the PV array and to produce the appropriate dc voltage for the dc/ac inverter. The function of the inverter is to generate three-phase sinusoidal voltages or currents to transfer the power to the grid in a grid-connected solar PV system [3]–[5].

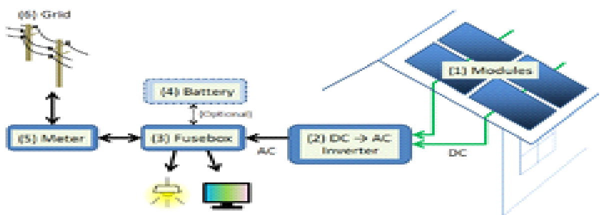

Fig: Basic PV System

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Now-a-days, Maximum power point tracking technique has become compulsory for grid-connected PV systems for maximum power yield. But for more power generation we need to install more PV systems, which results in high cost factor, so the easy and better way to generate maximum power is nothing but modifying the MPPT technique at the PV inverter level. So that we can yield constant power generation (CPG)

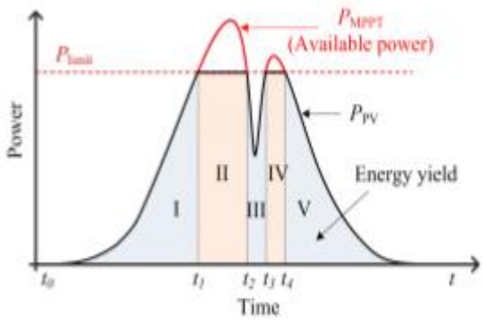


Fig: MPPT Mode during 1,3,5 & CPG mode during 2,4.

Among all algorithms CPG based on Perturb & Observe algorithm was introduced in single stage PV configuration. But controlling operation of that algorithm is limit only to the right side of the Maximum power point (MPP) of the PV arrays because of its single stage configuration. Because of this drawback the complete system performance gets decreased when there occurs any sudden change in its irradiance conditions. Even we also experience open-circuit condition .So; we go for two stage grid -connected PV system configuration in order to tackle the above issues and achieve stability factor.[5]-[9]

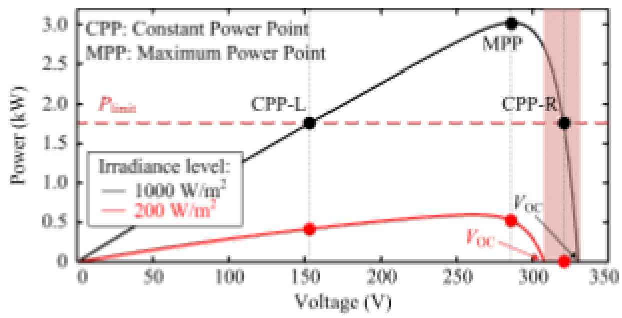


Fig: Stability issues of conventional CPG algorithm, when operating point is located at right side of MPP.

II. Conventional CPG Algorithm

A. System Configuration

The Basic configuration of the two stage grid connected PV system and its control structure is discussed in detail and shown below. Its control is implemented in the boost converter and the inverter is realized using a cascaded control where the DC-Link is maintained constant throughout the configuration. The PV Systems operate at the unity power point which means that only the active power is injected to the grid.

As mentioned earlier, the two-stage configuration can extend its operating range for both MPPT & CPG techniques.Even if the voltage level is lower than required in the two-stage configuration then we can boost the voltage using the boost converter to the required voltage level and fed the voltage to the PV inverter. We also place L-C-L filter in order to remove any kind of harmonics or ripples in the system in order to ensure smooth power delivery to the grid.[10]

B. Control structure

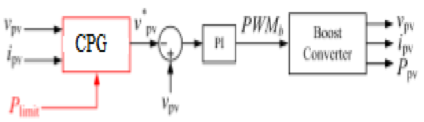


Fig: Control structure of Perturb & Observe algorithm based on the CPG Technique where Proportional Integral (PI) is adopted.

C. Issues of P&O-CPG Algorithm

The P&O-CPG method has satisfied performance under the slow changing irradiance conditions i.e., during a clear day, when the operating point is at the left side of the MPP. But when the irradiance fluctuates there results in several power losses and overshoots .We can analyse these overshoots and power losses using operational trajectory of the PV systems.

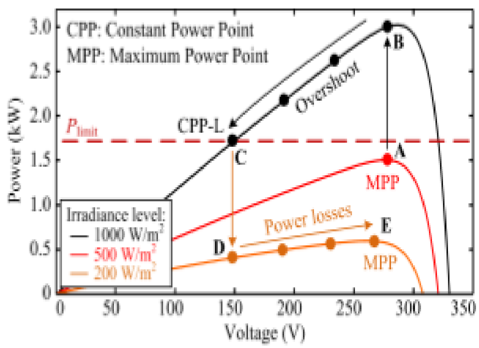
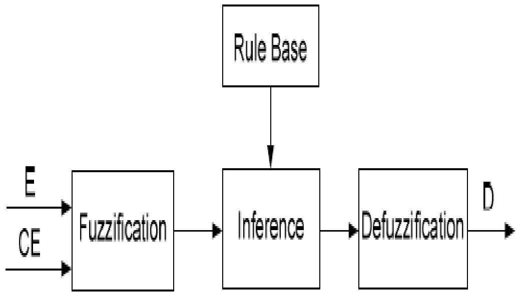


Fig: Operating trajectory of the algorithm during fast changing irradiance condition.

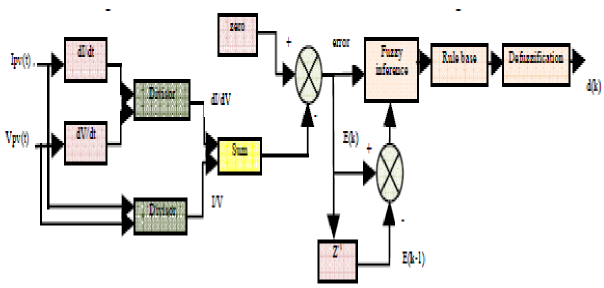
These power losses and overshoots can be minimized by using advanced technique like simulink based on fuzzy logic technique. Even the system performance can also be developed using this technique. Simultaneously the Simulink results are mentioned below in detail.

III. FUZZZY LOGIC

Recently, FLC are introduced for MPPT in the PV system. These controllers are robust and advantageous as in their design procedure exact model information is not required. [11]. The main parts of a fuzzy logic controller are fuzzification, inference, rule base and defuzzification, are shown in figure.



The scheme of P&O –CPG control is as shown below:



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IV. Simulation Results

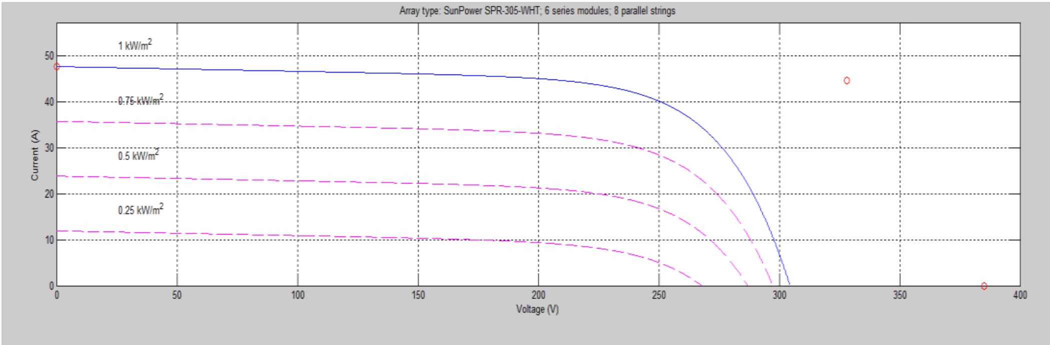

Fig: V-I Characteristics of PV module

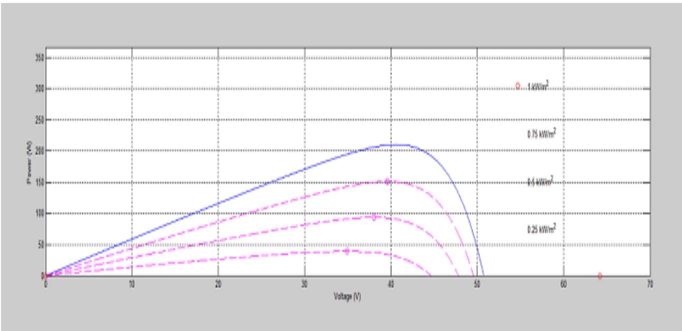

Fig : P-V Characteristics of PV module

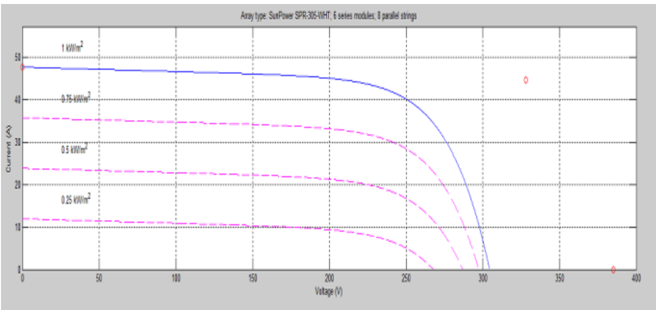

Fig: V-I Characteristics of PV Array

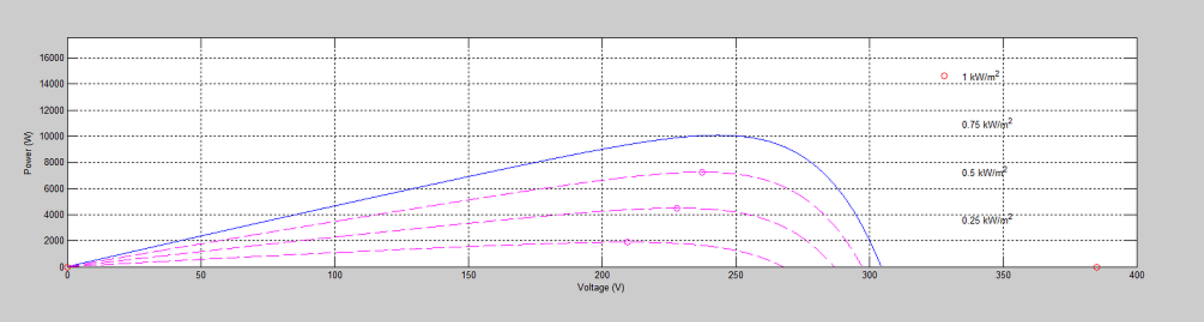

Fig: P-V Characteristics of PV Array

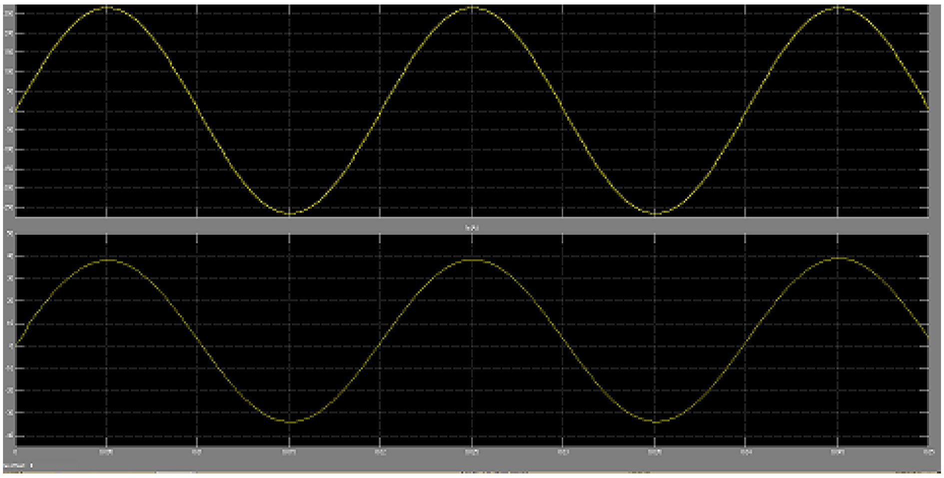

Fig: Grid voltage and currents

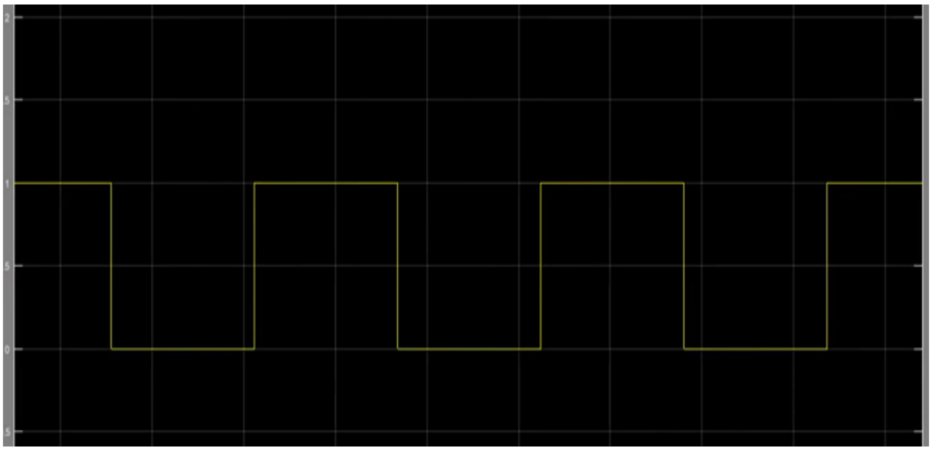

Fig : PWM Technique

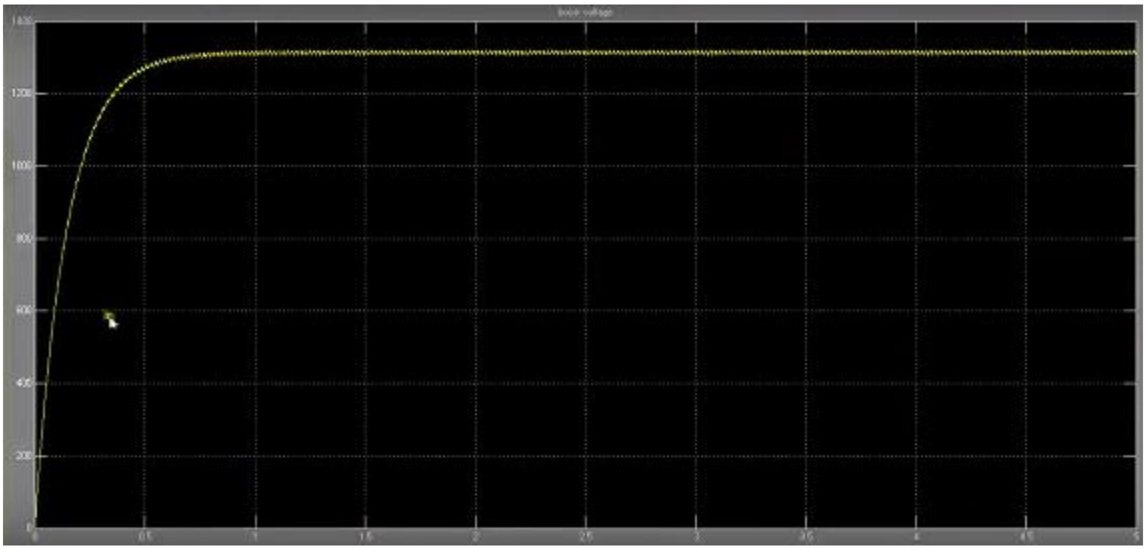

Fig : Constant power generation in CPG algorithm.

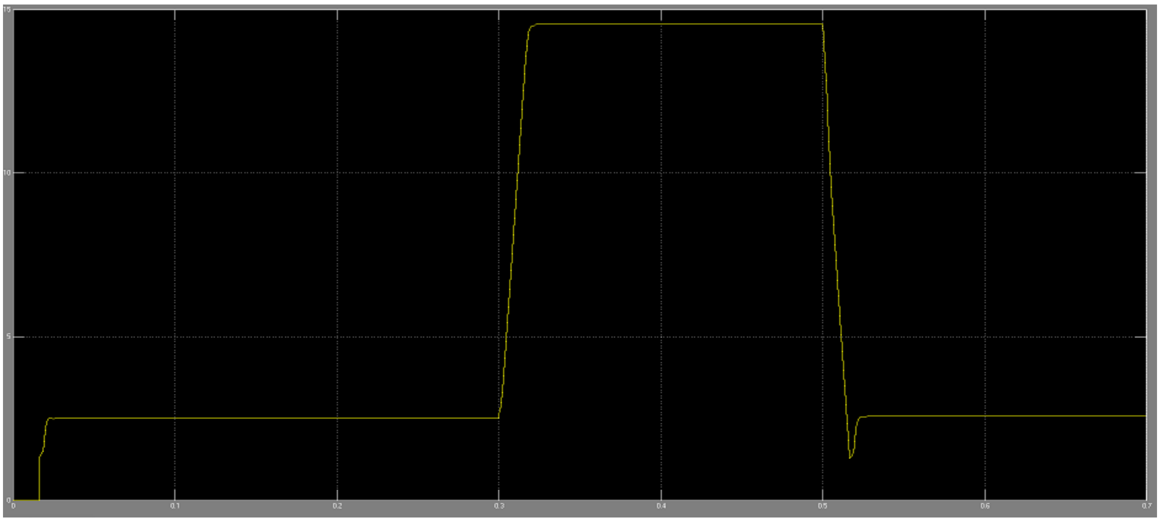

Fig: Constant power generation using fuzzy logic

V. CONCLUSION

A high performance active power control scheme for maximum feed in power has been developed in this paper. This proposed paper provides a solution to operate the PV system at the left side of the MPP and provide the stability for the system. Even using the fuzzy logic we can improve the system accuracy and also the system performance. It also minimizes the power losses and also minimizes the overshoots.

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