

Comparative Study of Applications of CR Principle in Maximum Power Point Tracking of Solar PV Array

Amit Chouksey¹ S. Awasthi² S. K. Singh³

¹Research Scholar

^{1,2,3}JVWU Jaipur, Jayoti Vidyapeeth Women's University, Vedaant Gyan Valley, Village-Jharna, Mahala Jobner Link Road, India

Abstract— The investigations on the photovoltaic (PV) control age are widely expanding, since it is considered as a basically endless and comprehensively accessible vitality asset. In any case, the yield intensity of the photovoltaic modules relies upon sun oriented radiation and temperature of the sun oriented cells. Thusly, to augment the productivity of the sustainable power source framework, it is important to track the most extreme power purpose of the PV exhibit and influence the cluster to work close it. Greatest power task is a testing issue, since it requires that the framework stack is equipped for utilizing all power accessible from the PV framework constantly. The I-V normal for the heap must meet the focal point of most extreme power focuses on the I-V qualities of the PV exhibit for fluctuating insolation and temperature levels. Fluffy Cognitive Networks (FCN) have been proposed as an operational augmentation of Fuzzy Cognitive Maps (FCM), which work in persistent connection with the framework they depict and might be utilized to control it. In this section FCN is utilized to build a most extreme power point tracker (MPPT), which may work in participation with a fluffy MPPT controller. The proposed conspire outflanks other existing MPPT plans of the writing giving great most extreme power activity of any PV exhibit under various conditions, for example, changing insolation and temperature. Additionally it can adjust to various changes that may occur amid the existence cycle of the PV module, for example, a demolished cell of the PV exhibit.

Key words: PV Array, MPPT, Perturb & Observe Algorithm, Fuzzy Logic, Simulink

I. INTRODUCTION

Shortage of vitality and ecological issues, for example, a worldwide temperature alteration and contamination, have caused an incredible consideration towards the sun powered photograph voltaic (PV) frameworks in inquire about. Right now more research works has been cantered around how to separate more power adequately from the PV cells to expand the productivity of the sunlight based photograph voltaic frameworks. As of now more research works has been cantered on how to separate more power successfully from the PV cells to expand the productivity of the sun based photograph voltaic frameworks. The primary downside of the sun powered PV frameworks is the variety in yield voltage with the progressions in sunlight based illumination and temperature. Most extreme Power Point Following (MPPT) is a procedure which tracks one greatest power point (MPP) from photograph voltaic (PV) cluster input. The primary test by MPPT methods is to consequently discover the voltage VMPP or current IMPP at which a PV exhibit should work to acquire the most extreme power yield PMPP under a given temperature and irradiance. It is noticed that under halfway shading conditions, the P-V attributes of the PV exhibit get

more mind boggling and bear various pinnacles [1]. There are part of MPPT following methods are by and by and the correlation of a large portion of the MPPT procedures regarding the measure of vitality separated from the PV board have been proposed in the writing [2-3]. The most prominent MPPT calculations are Irritate and Watch (P&O) and Incremental conductance (IC) calculation [4].

Be that as it may, for all intents and purposes P and O control is simple and achievable to execute [14-15]. In this paper, the fundamental attributes of the PV cell and the recreation model of the circuit are created with the assistance of MATLAB/Simulink programming in segment II. The essential task of P&O MPPT calculation with its stream diagram steps is talked about in segment III. The segment IV depicts the plan ventures of actualizing the fluffy rationale MPPT calculation. The area V thinks about the recreation consequences of both P and O controller and Fluffy rationale MPPT controller.

II. PV SYSTEM MODELING

A. Equivalent Circuit of PV Cell

A solar PV cell is nothing but basically a p-n junction fabricated in a thin wafer of semiconductor. The electromagnetic radiation of solar energy can be directly converted to electric power through photovoltaic effect. Being exposed to the sunlight, photons with energy greater than the band-gap energy of the semiconductor creates some electron-hole pairs proportional to the incident irradiation. To achieve higher voltage and current, multiple cells are used as needed. The PV cell can be represented by a simple equivalent circuit shown in figure 1. The series resistance R_s represents the internal losses due to the current flow, whereas the shunt resistance R_{sh} corresponds to the leakage current to the ground and it is normally ignored.

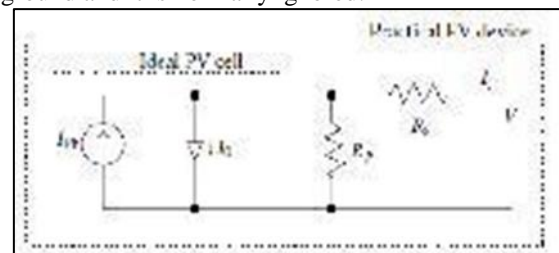


Fig. 1: Equivalent Circuit of PV Cell

The output current is a function of solar radiation, temperature, wind speed and coefficients that are particular to the cell technology. The authors [5-6] present a detailed analysis of solar cell and its electrical equivalent model is created in MATLAB /Simulink. The net current equation of the PV cell (eqn.1) is the difference between the photocurrent I_{ph} and the normal diode current I_D .

$$I = I_{ph} - I_D = I_{ph} - I_0 \exp\left(\frac{e(V + IR)}{mkT_c}\right) \quad (1)$$

Where:

- m - Idealizing factor
- k - Boltzmann's gas constant
- Tc - The absolute temperature of the cell
- e - Electronic charge
- V - The voltage impose across the cell
- I_o - The dark saturation current

B. Characteristics of Solar Cell

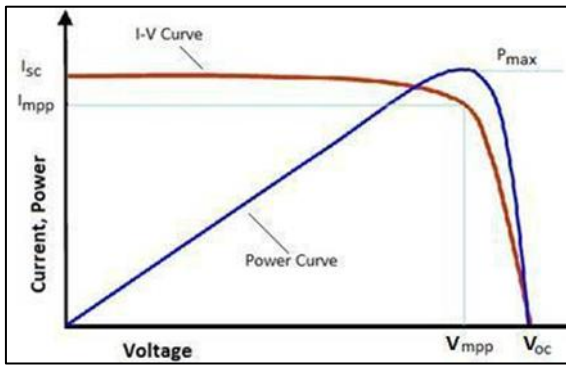


Fig. 2: PV-IV Curves of Solar Cell

III. P & O MPPT ALGORITHM

A. Algorithm

This calculation is an iterative method and extremely basic one. It quantifies the board working voltage and current intermittently and figures the immediate power. This quick power contrasts and the past yield control, at that point the working voltage is resolved and changed by changing the obligation proportion of the converter. The indication of progress of yield control is additionally seen to track the MPP. On the off chance that the yield control increments by expanding the working voltage, at that point the working voltage is additionally irritated a similar way until the point that it achieves the purpose of MPP or $dp/dv=0$. In the event that the yield control diminishes by expanding the working voltage, i.e the working point is in the negative incline district of the PV bend. At that point the working voltage is annoyed in the turnaround bearing to track the MPP.

B. Flow Chart

The flow chart of the P&O algorithm [7] is shown in the figure 3.

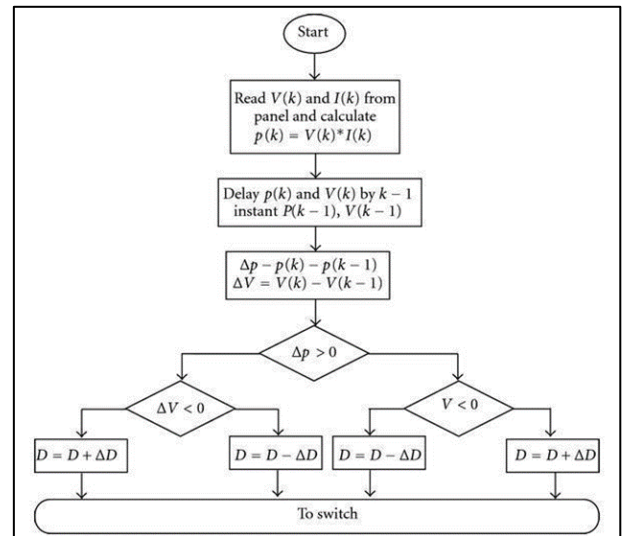


Fig. 3: Flow Chart of P & O Algorithm

The fundamental desirable position of this method is totally basic and effortlessly actualized

[16]. Be that as it may, the weakness is the working point is very swayed around the MPP point and not settled on the correct MPP. The writing survey uncovers that in the event that we increment the progression size of the calculation, the motions around the MPP will be increasingly and dynamic. On the off chance that we diminish the progression measure, the meeting place will be less and can't ready to track the MPP at different environmental conditions. A few scientists [8-9] in the survey recommended or changed the P&O calculation to have better effectiveness contrast with the traditional.

IV. FUZZY LOGIC BASED MPPT

A. Fuzzy Logic

The Fluffy rationale controller utilizes the fluffy rationales to settle on the choices and to control the yield of the controller. The principle parts in fluffy rationale based MPPT controller are fuzzification, manage base, derivation and defuzzification [13] as appeared in figure 4

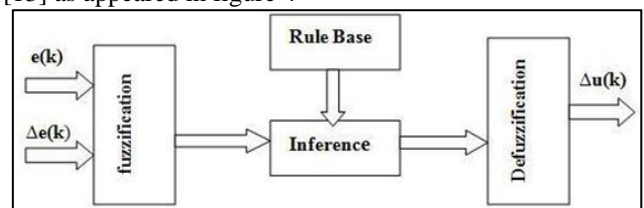


Fig. 4: Fuzzy Logic Block Diagram

There are two contributions to the controller – blunder $e(k)$ and change in mistake $\Delta e(k)$. The Fuzzification square changes over the fresh contributions to fluffy information sources. The guidelines are shaped in lead base and are connected in derivation square. The de fuzzification changes over the fluffy yield to the fresh yield. The fluffy derivation is done by utilizing Mamdani's technique, and the de fuzzification utilizes the focal point of gravity to process the yield of this FLC which is the adjustment in duty cycle.

The contributions to the Fluffy controller are change in PV exhibit Power (ΔPPV) and change in PV cluster current (ΔIPV) comparing to the two inspecting time moments [11-12]. The two data sources are prepared by the Fluffy

controller and the yield of the Fluffy controller is the incremental reference current (ΔI_{ref}). This yield is given to the Dc-Dc control converter. The primary information variable (ΔP_{pv}) for the fluffy rationale controller is separated into seven Fluffy sets: PB (Positive Enormous), PM (Positive Medium), PS (Positive Little), ZZ (Zero), NS (Negative Little), NM (Negative Medium) and NB (Negative Huge). The second information variable (ΔI_{pv}) for the fluffy rationale controller is partitioned into 3 Fluffy sets: N (Negative), Z (Zero) and P (Positive). The just a single yield variable (ΔI_{ref}) is separated into 7 Fluffy sets: PB (Positive Enormous), PM (Positive Medium), PS (Positive Little), ZZ (Zero), NB (Negative Huge), NM (Negative Medium) and NS (Negative Little). The tenets [10] are framed as appeared in table 1.

ΔP_{pv}	PB	PM	PS	ZZ	NS	NM	NB
ΔI_{pv}	PB	PM	PS	ZZ	NS	NM	NB
P	PB	PM	PS	PS	NS	NM	NB
Z	PB	PM	PS	ZZ	NS	NM	NB
N	NB	NM	NS	NS	PS	PM	PB

Table 1: Rule Base

The input, output membership functions are shown in figures V, VI & VII respectively

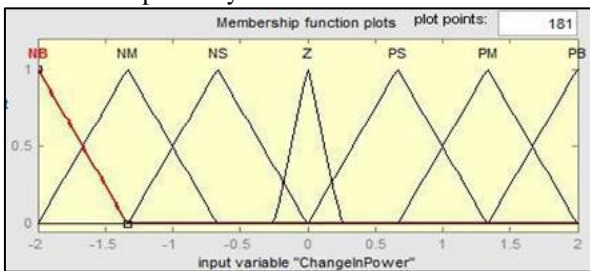


Fig. 5: Membership Functions of "Change in Power" Input

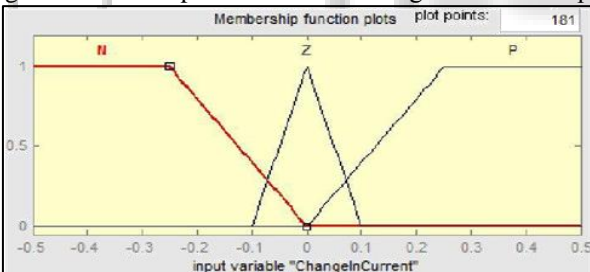


Fig. 6: Membership Functions of "Change in Current" Input

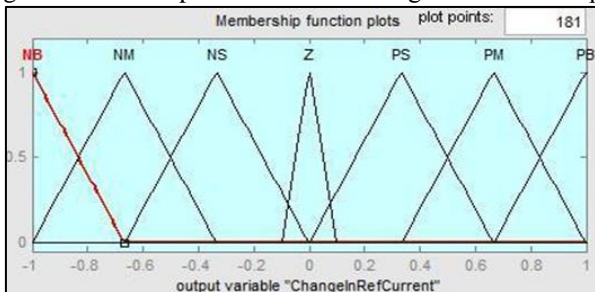


Fig. 7: Membership Functions of "Change in Reference Current" Output

V. RESULTS OF SIMULATION

The P & O MPPT controller and Fluffy method of reasoning MPPT controllers are arranged shown and completed in the MATLAB/Simulink programming as showed up in the figure

8 and 9. The reenactment setup is sorted out to such a degree, to the point that at first having a reliable temperature of 25oC with the direct augmentation of insolation from 500 watts/m2 to 1300 watts/m2. By then at a comparative condition, the insolation will be reduced from 500 watts/m2 to 1300 watts/m2. By then the tests can be driven for the reliable insolation, with brisk augmentation or decrease the temperature from 25oC to 50oC. The assurance of the PV module used as a piece of this propagation is ordered in table 2.

Short Circuit Current	13.5 A
Open Circuit Voltage	48 V
Current at Pmax	11.2 A
Voltage at Pmax	35.6 V

Table 2: PV- Module Specifications

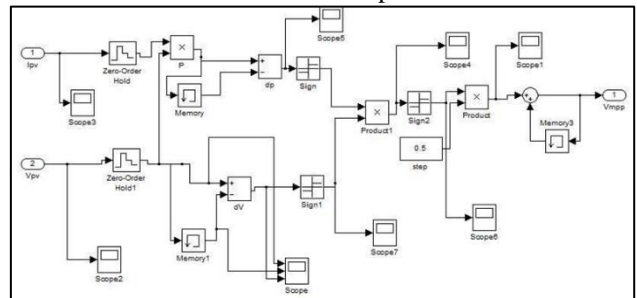


Fig. 8: P & O Algorithm based MPPT

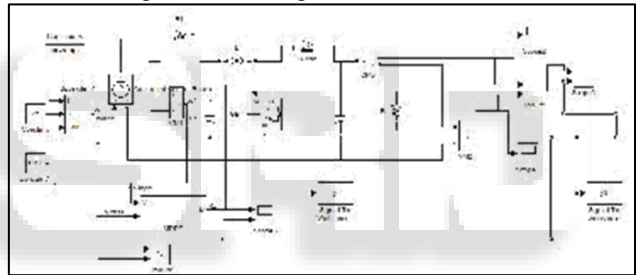


Fig. 9: Fuzzy Logic Control based MPPT

Fig.10 and Fig.11 shows the results of the fuzzy logic controller PWM output and the output power of the PV Module with the irradiation of 500, 800, 1000 and 1300 watts/m². The fig.11 shows the performance of the PV system using Fuzzy logic controller under fast changing of irradiance. It is clear that energy gained by the proposed fuzzy logic technique is giving better efficiency compare to the conventional technique P&O technique.

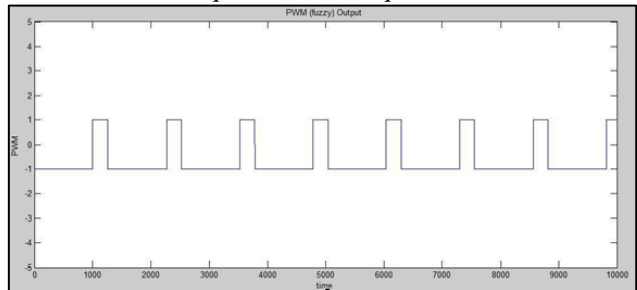


Fig. 10: Proposed Fuzzy Logic Control PWM Output

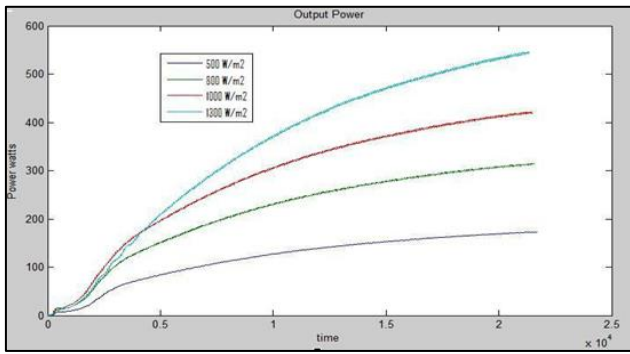


Fig. 11: Output Power at Different Irradiations

VI. CONCLUSION

All above plots demonstrates the consequences of the fluffy rationale controller PWM yield and the yield intensity of the PV Module with the illumination of 500, 800, 1000 and 1300 watts/m². The fig.11 demonstrates the execution of the PV framework utilizing Fluffy rationale controller under quick changing of irradiance. Plainly vitality picked up by the proposed fluffy rationale procedure is giving better proficiency contrast with the ordinary system P&O methodology.

