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INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
Vol. 01, Issue 01, Oct. 2021, pp: 1-5

e-ISSN : xxxx-xxxx
Impact Factor : xxxx-xxxx

SOLAR CHARGE CONTROLLER WITH POWER SUPPLY TO CHARGE BATTERY FOR LOW-POWER SOLAR APPLICATIONS

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ABSTRACT

The aim is to reduce the limitations of a standard P&O and INC algorithms i.e., consistency of condition, flexible sequence direction and the inability to obtain maximum power during partial shading conditions. The proposed concept is validated using the MATLAB simulation by incorporating military warranty tests and partial testing. The performance of the algorithm is compared to the four main MPPT methods: incremental conductance, optimization-perturb & observe give the best performance among all.

Keywords: MPPT, P&O algorithm, MATLAB, Solar, PV

I. INTRODUCTION

Since the conversion efficiency of PV arrays is very low, it requires maximum power point tracking (MPPT) control techniques to extract maximum power. Despite having higher potency, it's tough to overlook the complexness, procedure burden, implementation value and slow trailing speed related to them. Consequently, in many recent work,

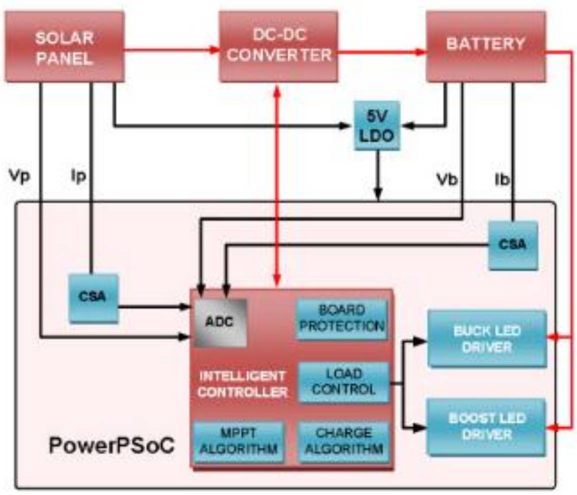

Figure1: Block Diagram of Proposed Model

II. METHODOLOGY

Maximum Power Point Tracking

The maximum power point tracking could be a technique/algorithm that is often used with grid connected solar photovoltaic (PV) to maximize extraction of power under all conditions. The values of Isc and Voc square measure detected at every sample in keeping with the sample rate and consequently the controller provides gating pulse to the switch within the convertor. This gating pulse can have a requirement cycle that may be controlled by the MPPT controller. Ultimately, at the output is that the desired voltage in keeping with the P&O algorithmic program. In the figure, curve represents the variation of Current and Power with relation to voltage. Maximum Power Point is tracked once the curve attains the utmost value of power i.e. the product of current and voltage becomes the maximum.

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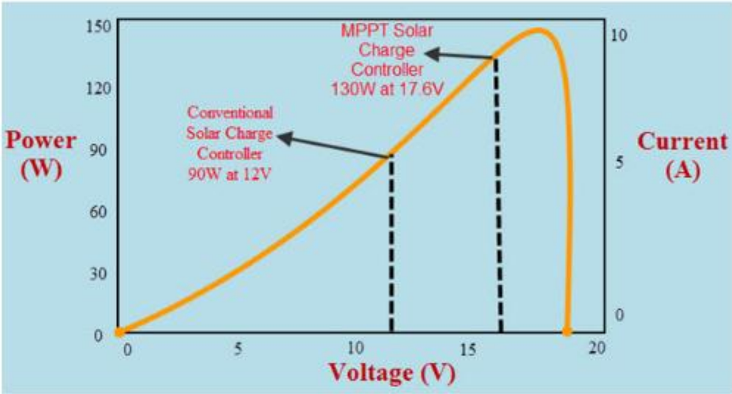

Figure 2: Solar PV Module V-I Characteristics graph

Acc. to Ohm's law: V = I * R

Power equation given by: P = I*V

Where:

V = voltage [volts]

I = current [amperes]

R = resistance [Ohms]

P = power [watts]

Classification Based On Architectures-

A. Overall Architecture Of Mppt System

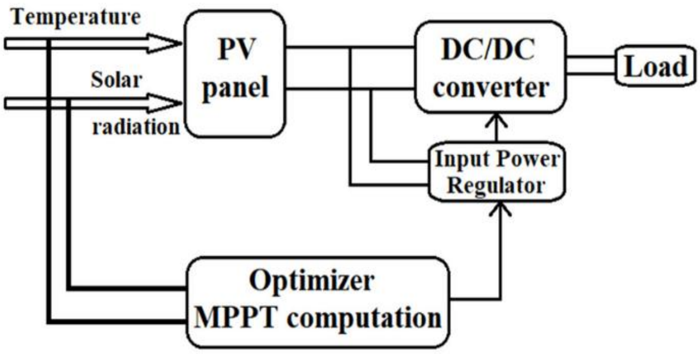

Figure3: Overall Architecture of MPPT System

B. Distributed MPPT (DMPPT) Architecture

In DMPPT architecture, each cell, string or module has its own MPPT controller as shown in fig. There is an analog technique which is suitable for DMPPT applications called TEODI [33], explained in the text section. Operating points of two identical PVs are evenly matched in this technique [2].

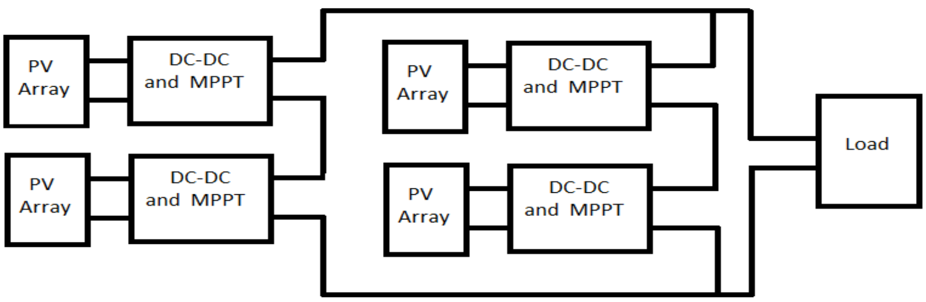

Figure 4: Distributed MPPT (DMPPT) Architecture

C. Differential MPPT Architecture

In differential power processing (DPP) approach, converters located between adjacent PV modules provide the current differences at the MPP of the two PVs as shown in fig. The MPPs are local maxima in neighboring PVs and can be tracked applying any simple conventional MPPT method. Depending on P system applications, MPPT architecture is selected [2].

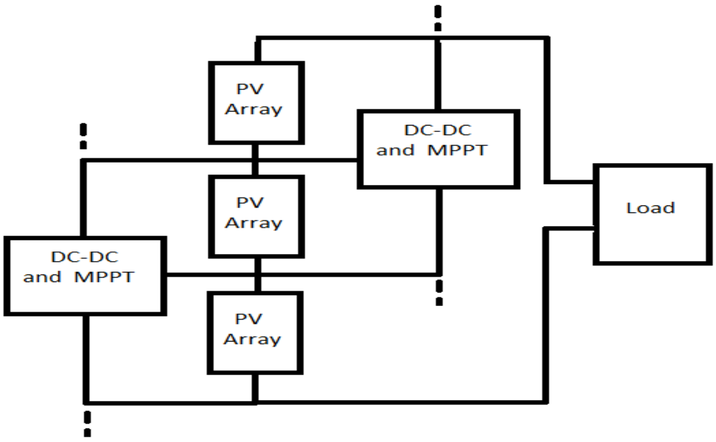

Figure 5: Differential MPPT Architecture

III. MODELING AND ANALYSIS

1) Proposed MPPT Algorithms And Explanation

There are various methods or techniques used for tracking algorithm like Peturb and Observe(P&O), Incremental Conductance (INC), Constant Voltage, Fractional Open-Circuit voltage, ripple correlation technique etc. in which P&O algorithm is having high efficiency and holds good results.

Classification Based On Algorithms:

A) Perturb and Observe (P&O)

In this algorithm voltage and current sensors measures voltage and current and calculate the power, then they compares threshold/reference power to the power output of the PV panel, if both are equal i.e., it is equal to zero then algorithm ends the execution otherwise it will compare is difference is greater than zero or not. If it is greater than zero it will compare Vk and V (k-1), if the difference is greater than zero it will decrease the duty cycle and if difference is smaller than zero it will increase the duty cycle. As shown in the flowchart fig. [4], [6].

There are four branches during this algorithmic program that result in two signs of the increment. If (Pk-Pk-1>0 and Vk-Vk-1>0) and if (Pk-Pk-1<0 and Vk-Vk-1<0) the increment is positive. The worth of the increment is negative if (Pk-Pk-1<0 and Vk-Vk-1>0) and if (Pk-Pk-1>0 and Vk-Vk-1<0). By careful review one could conclude that the sign of the increment is associated to the sign of Qk=(Pk-Pk-1)(Vk-Vk-1). If Qk>0, the increment is positive and if Qk<0, the increment is negative. This expressing method simplifies the entire diagram and possibly the electronic circuitry implementing the algorithmic program.

B) Incremental Conductance (INC)

To predict the effect of change in voltage. The flow chart of the incremental conductance algorithm can be shown as: - In this algorithm, the controller measures and calibrates incremental changes in voltage and PV array current.

$(dP/dV)_{mpp}=d(VI)/dV$

$0=I+V\,dI/dV_{mpp}$

$dI/dV_{mpp} = -I/V$

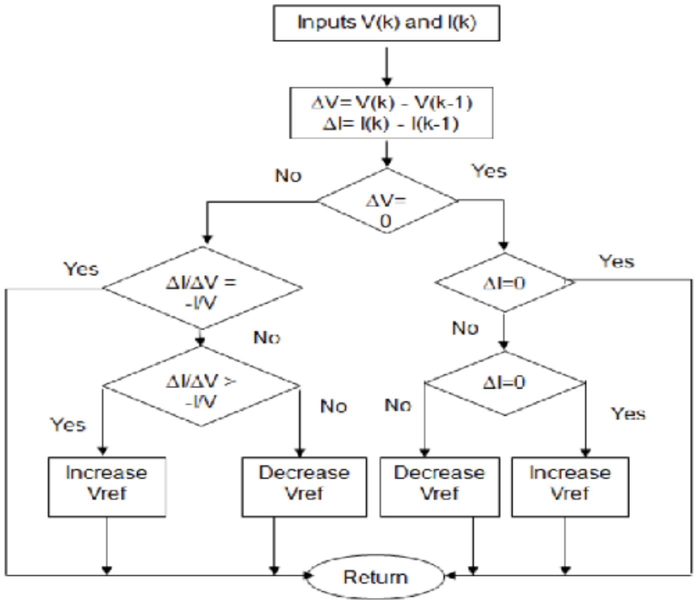

Figure 7: Incremental Conductance (INC) Algorithm.

The variable conditions can be tracked faster by the perturb and observe methodology (P&O), however this methodology needs a lot of computation within the controller, just like the P&O algorithm, it additionally produces oscillations in power output.

When these two parameters are the same (I / V = ΔI / ΔV), the output voltage is declared as the MPP voltage. The controller maintains this voltage until the irradiation varies and the process is repeated [6].

C) Fractional Open-Circuit Voltage

This technique uses the conception that the magnitude relation of the array voltage admire most electric receptacle and also the electrical circuit voltage (Voc) is nearly constant.

$$\frac{V_{mp}}{V_{oc}} \sim 0.78$$

Sensed voltage from the PV panel and also the reference voltages measure compared so as to come up with an error signal which is able to manage the duty cycle to stabilize desired output. The duty cycle of DC to DC device is adjusted in such the simplest way that the PV array voltage is adequate to 0.78*Voc [1].

IV. RESULTS AND DISCUSSION

Table 1: Comparison of Various MPPT Algorithms For Cost Reduction

S. No.	Algorithm	Efficiency	Sensors	Remark
1	Fixed duty cycle	Poor	-	Open-loop control, very limited utility
2	Constant voltage method	Average	Voltage	Poor scalability due to wide variations in solar cell characteristics
3	Perturb & Observe	Excellent	Voltage, Current	Standard method for MPPT

V. CONCLUSION

The paper concludes the detailed analysis of various maximum power point tracking solar charge controller modals, their hardware parts and algorithm implemented were carried out. Among all other algorithms Perturbation and observation (P&O) algorithm holds good performance under normal or varying weather conditions. Power output obtained from Perturbation and observation method is high as compared to other methods under varying atmospheric conditions.

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