# Optimal Control Strategy for a Solar Photovoltaic Power System using MATLAB Simulink

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**Abstract:** In this paper, the Maximum Power Point Techniques to track the Maximum Power is investigated. PV power generation systems have one big problem that the amount of electric power generated by PV module is always changing with weather conditions. The weather and load changes cause a nonlinear I-V and P-V characteristics of a solar array which depends on the solar radiation and array temperature. In this paper, proposed an improved InC algorithm for tracking a MPP on the V-I characteristic of the solar PV panel. The simulation obtained results validated the effectiveness of the proposal under various atmospheric conditions using Matlab Simulink software.

**Keywords: PV, MPPT, Irradiation.**

## I. Introduction

As sun oriented power increments in notoriety, the requirement for this energy to end up noticeably more proficient is apparent. It is imperative with photovoltaic age to work the system at high power productivity by guaranteeing that, the system is continually working at the eak power point paying little heed to changes in load and climate conditions. As the sun oriented board yields control, its most extreme created control changes with the sun powered radiation and temperature and the electrical normal for the heap may likewise change. Besides, the solar cell V-I trademark is nonlinear and fluctuates with light and temperature. When all is said in done, there is a remarkable point on the V-I or V-P curve, called the maximum Power Point (MPP), at which the whole PV system (array, converter, etc ) works with most extreme proficiency and produces its greatest yield control. As the area of the MPP on the I-V bend shifts in an erratic way it can't be characterized in advance because of changes of light and PV board temperature. As needs be, the utilization of MPPT calculation or computing model is required to find this point. There are a few techniques to track the MPP of the photovoltaic system that have been precisely contemplated, created and distributed in the course of the most recent decades. There are varieties between these methods regarding, effortlessness, sensor necessities, cost, scope of proficiency, merging pace and equipment usage. Some MPPT calculations beat the others under the same working conditions. This proposition proposes an enhanced InC calculation for following a MPP on the V-I normal for the sun powered PV board. In light of the ST and MPPT, the sunlight based PV board is constantly ensured to work in a versatile and ideal circumstance for all conditions.

## II. Renewable Energy

Renewable energy (RE) derived from natural sources such as wind, solar, hydro and biomass has potential to meet diverse and growing energy requirements. Traditionally, Renewable Energy sources have been used for heating, cooking, steam production, moving ships and also for powering mills to grind grains. Examples of Conventional Power Sources are Coal, nuclear, oil, and natural gas and Renewable Power Sources are Wind, solar, biomass geothermal, and ocean etc. An alternative to the nuclear and fossil fuel power is renewable energy technologies (hydro, wind, solar, biomass, geothermal, and ocean). Among the other renewable power sources, wind and solar have recently experienced a rapid growth around the world. The solar to electricity conversion is shown in Figure 1:

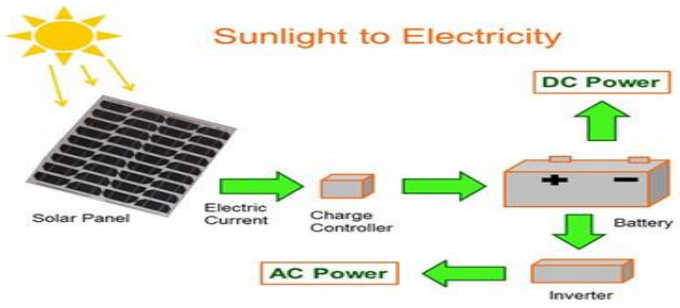



Figure 1: Solar to electricity conversion

Solar generated electricity has two main principles of operation; using the light from the sun to super- heat water and drive a steam turbine, or generating electricity directly via the photoelectric effect. The renewable compare well with the conventional in economy. Because of these benefits, many utilities and regulatory bodies are increasingly interested in acquiring hands on experience with renewable energy technologies in order to plan effectively for the future.

## III. SOLAR PHOTOVOLTAIC

The incorporation of a substantial number of installed PV generators will have expansive outcomes on the conveyance organizes as well as on the national transmission and age system. In the event that the PV generators are based on the rooftop and sides of structures, a large portion of them will be situated in urban regions and will be electrically near burdens. Then again, these PV creating units might be subject to regular mode disappointments that may cause the sudden or fast separation of an extensive extent of working PV limit. Sun oriented vitality is the daylight vitality gathered and used to give electricity, warming, cooling homes, organizations or industry. It is a feasible source as in it doesn't give ozone depleting substance outflows and turns out to be natural inviting wellsprings of vitality. It is free and maintainable as the sun is here to stay. Photovoltaic is regarded as a phenomenon.

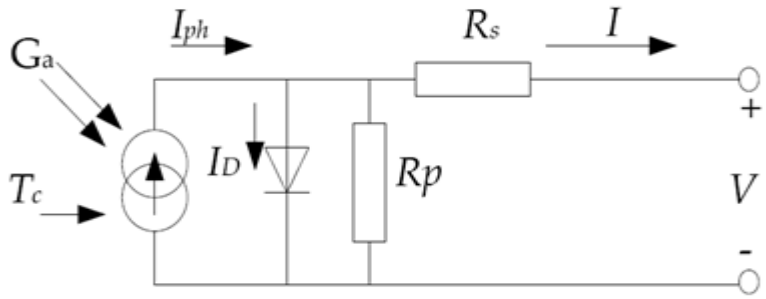
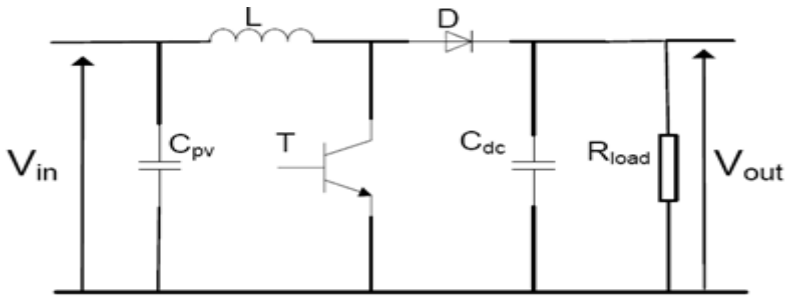



Figure 2: Equivalent circuit of solar cell with one diode

A PV cell is usually embodied by an electrical equivalent of one-diode, resistance series Rs and resistance parallel Rp as shown in figure 2.




The datasheet which gives the electrical characteristics is calculated under standard test condition STC when the temperature T is 25°C and the irradiance G is 1000 W/m$^2$. Figure 3 shows the Boost converter. In continuous conduction mode (CCM), the switch is ON for period t to ton as shown Fig.3.10.

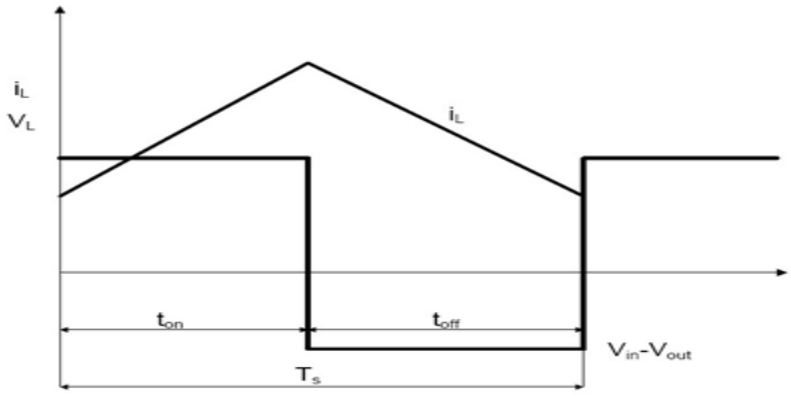



Figure 4: Continuous conduction mode

In this paper, two of the most prevalent MPPT algorithms, perturb and observe as well as incremental conductance, were used to control the converter and solar panel so that the panel operated at its MPP.

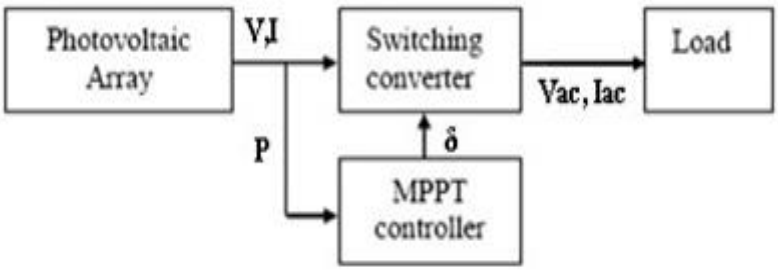



Figure 5: Basic MPPT system

Perturb and observe is probably the most commonly utilized MPPT method. The basic premise for P&O is to continually perturb or alter the power converter's operating point and then to observe or sense the ensuing effects. Utilizing the P&O algorithm has several benefits. For one, it is a reliable approach to MPPT, which means that it finds the MPP in almost all circumstances. The Incremental conductance method eliminates the drawbacks of the Perturb and Observe method. It uses the advantage that the derivate of the power with respect to the voltage at the maximum power point is zero. Furthermore the derivative at the left of the MPP is greater than zero and less than zero to the right of the MPP. The incremental conductance can determine that the MPPT has reached the MPP and stop perturbing the operating point.

## IV. Simulation Result Analysis

This section presents detailed simulation results of the proposed solar photovoltaic using improved InC MPPT & will be compared with conventional MPPT. The simulated system is shown in Figure 6. Simulation studies are carried out in the MATLAB/SIMULINK environment.

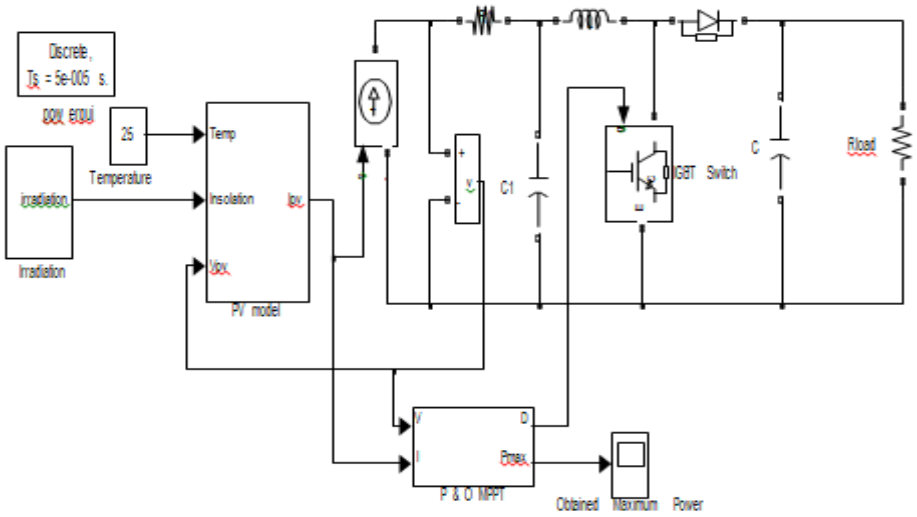



Figure 6: Matlab Simulink model for solar PV system

Table 1: Simulation parameters

| S. No. | Description | Values |
|---|---|---|
| 1. | Maximum power, $P_{max}$ | 22 W |
| 2. | Short-circuit current, *Is* c | 1.34 A |
| 3. | Open-circuit voltage, *Voc* | 21.99 V |

Simulations are performed using MATLAB/SIMULINK software for tracking MPPs of the solar PV array whose specifications and parameters are in Table 1.

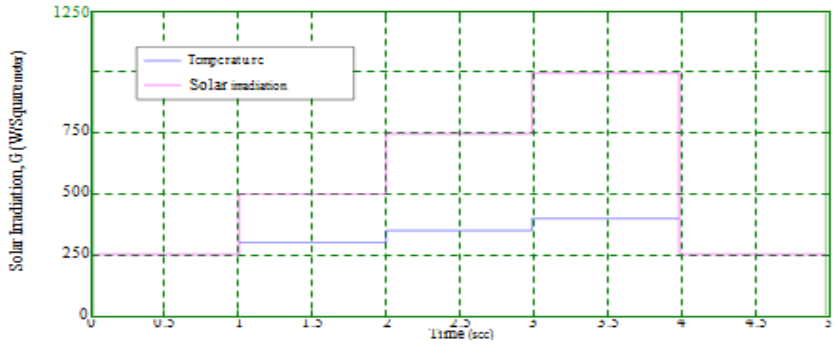



Figure 7: The variations of the solar irradiation and temperature

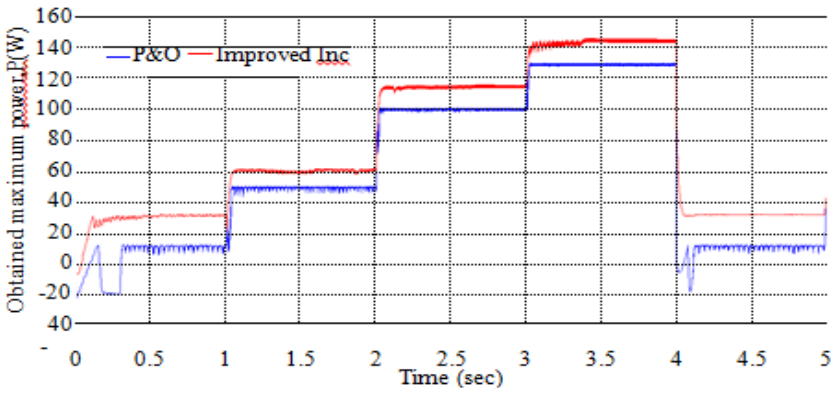



Figure 8: OMP with the P&O and improved InC algorithms under the variation of the solar irradiation

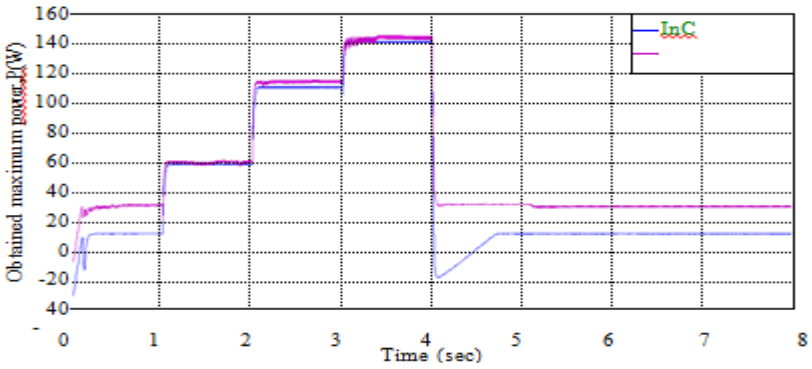



Figure 9: OMP with the InC and improved InC algorithms under the variation of the solar irradiation

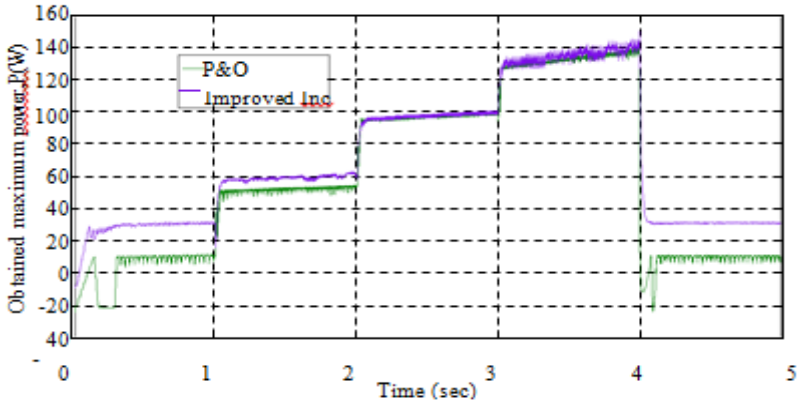



Figure 10: OMP with the P&O and improved InC algorithms under both the variations of the solar irradiation and temperature

The obtained output powers are shown as in Figure 7 & 8 using the P&O, InC and improved InC algorithms under the variation of both the temperature and solar irradiation. It can be realized that the simulation results of the cases using the improved InC algorithm are always better than the cases using the P&O and InC algorithms, Figure 8-9.

## V. Conclusion

In this paper, the proposed InC algorithm improves the conventional InC algorithm with an approximation which reduces the computational burden as well as the application of the CV algorithm to limit the search space and increase the convergence speed of the InC algorithm. This improvement overcomes the existing drawbacks of the InC algorithm.

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