MPPT Methods For PV String under Partially Shaded Conditions Along with Particle Swarm Optimization

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Abstract

Many techniques are improvised with the help of maximum power point tracking but now we are examining the combination of global maximum power point tracking (GMPPT) with search- skip-judge method (SSJ) and rapid method (R) by forming a (SSJ-GMPPT) and (R-GMPPT) Which helps to track maximum power from PV string. And Particle Swarm Optimization algorithm (PSO) is used to reduce the tracking time. The mentioned methods are reduces the searching voltage range on current and voltage (I-V) and power and voltage (P-V) characteristics of PV string under partially shaded conditions (PSC).

Keywords: Maximum power point tracking (MPPT), partially shaded conditions (PSC), global maximum power point (GMPPT), particle swarm optimization (PSO)

I. INTRODUCTION

In present climatic conditions conventional energies are polluting the environment and fossil fuel is only generating the huge electricity, on the other hand renewable energies are improving day by day but we are not utilizing it in properly. From solar energy we can generate electricity by conversion of solar energy into electricity. Solar panel is the fundamental energy conversion component of photovoltaic (PV) system. The conversion efficiency depends on insolation levels, temperature and load conditions. The current – voltage and power – voltage relations of the PV array possess non-linear characteristics that are affected by irradiance intensity and temperature. So, to avoid these problems we have maximum power point (MPP) on PV array characteristics.

The object of MPPT is to ensure that, in varying environmental condition the system is always generating energy from PV panel. In MPPT many techniques are proposed like perturb and observe (P&O), Incremental conductance (IC), Global maximum power point (GMPPT). From the global maximum power point (GMPPT) we are used search- skip – judge global maximum power point (SSJ–GMPPT) and rapid global maximum power point (R–GMPPT) are more helpful in tracking the solar energy from PV string. While SSJ-GMPPT method can track the real maximum power point (MPP) under any shading conditions and achieve high accuracy and fast tracking speed and R-GMPPT method elaborates the tracking speed. Since 130 years the development of the first functional PV cell.

Electrical characteristics of a silicon PV cell are non-linear and have only one point at which the maximum power can be obtained, the maximum power point (MPP). Voltage and power at MPP of a single cell are relatively low. Due to low voltage and power ratings, a certain amount of PV cells are typically connected in series to form PV modules. PV module can further be connected in series and parallel to increase the voltage and power levels of the whole PV power generator. The effects of partial shading conditions on PV power generator has been noticed to be a major cause of power losses and lower-than-expected system efficiencies the effects of partial shading has been extensively investigated.

II. MAXIMUM POWER POINT TRACKING

There has been a great amount of research and development in the field of MPPT techniques. The operations of different MPPT techniques differ for example in convergence speed, range of effectiveness, complexity, required amount of sensors for measurement and implementation hardware. Direct methods ensure that the operating point is really at least at some of the MPPs. A conventional and popular direct method is the P&O algorithm. The basic idea is to perturb the operating point of the PV and observe the change in power. If power increases, the operating point is varied in the same direction also in the next step. If power decreases, the direction of the perturbation is changed. The algorithm does not recognize when it is at the MPP but keeps on oscillating around the MPP.

The MPPT is an instrument that extracts the maximum power available from the PV array at any given instant. The power available from a PV module passes through a peak at a particular operating point and this peak also changes with atmospheric conditions. The changing peak power needs to be continuously tracked. The below figure illustrates the load mismatch during

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direct connection that results in operation at a sub-optimal point. The maximum power MP hyperbola intersects the I-V curve at a particular insolation level, at the MP point M1 and the actual load curve intersects the source curve at point I and the hyperbola at Imax where it is supposed to be utilizing the entire available power. Tracking algorithms thus have the task of virtually varying the slope of the load line to intersect the I-V curve at M1. The ideal load curve that intersects all the PV curves at maximum power points (M1, M2, etc.) is also shown in figure for illustration.

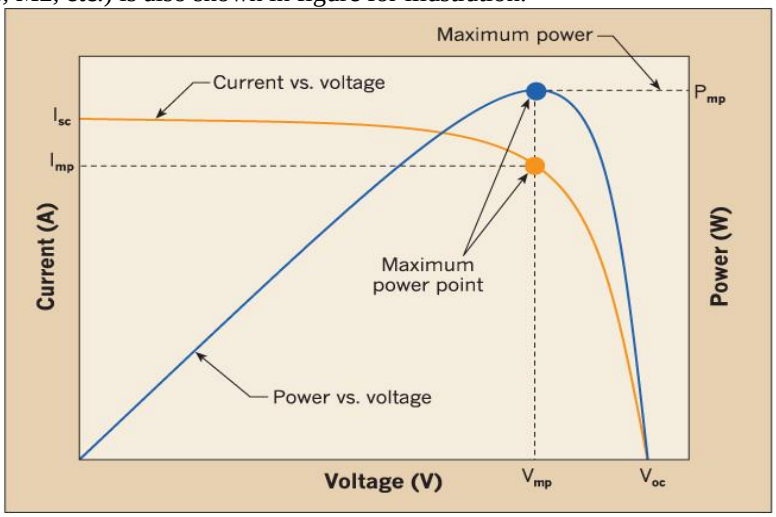

Fig. 1: Typical current and power versus voltage curves of a solar module.

III. PARTIALLY SHADED CONDITION

If a module in a string fails due to some reasons or comes under the shadow of some object is called partially shading, then the current in that module will have reduce drastically and will limit the current from the other which pass through it, simply current through a string will reduce in that case it will bypass the diode associated with that module will allow the current to pass through itself. Under some special requirements the flow chart is designed mentioned in fig:2

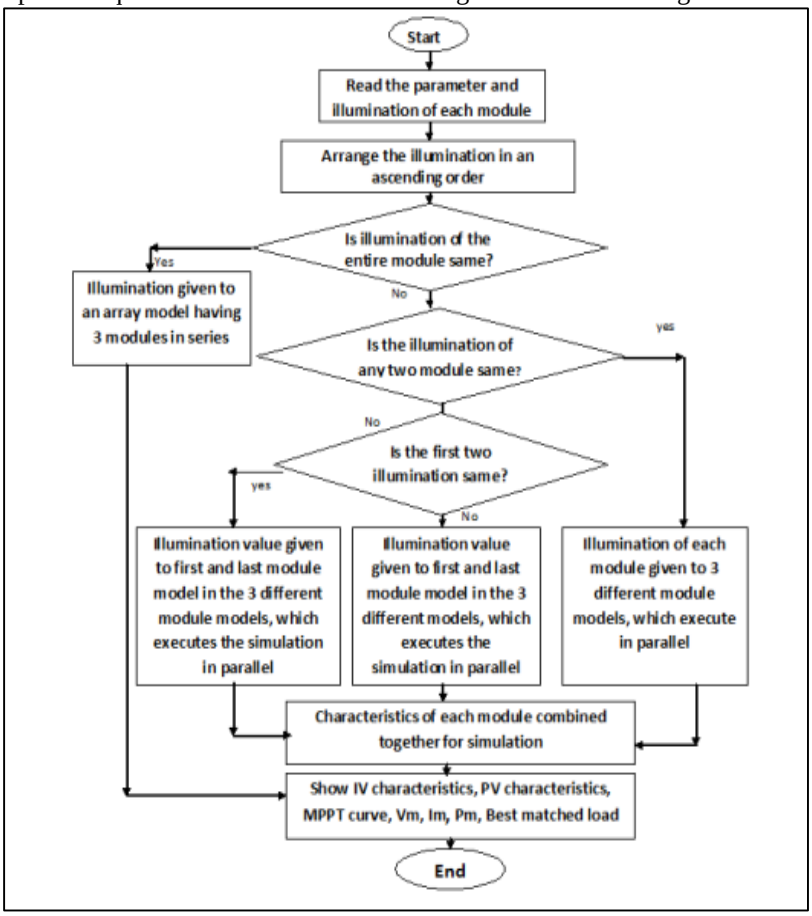

Fig. 2: Flow chart for the development PV array model at PSC

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IV. GLOBAL MAXIMUM POWER POINT

Initially the global tracking process is performed and the voltage magnitude corresponding to each maximum power point is identified. There will be global maximum power point among the local maximum power point. On the global maximum power point tracking mentioned a flowchart as shown in figure 3 basically the GMPP has PV array. In this it has power converter control method so that the power an adjustable constant power loads.

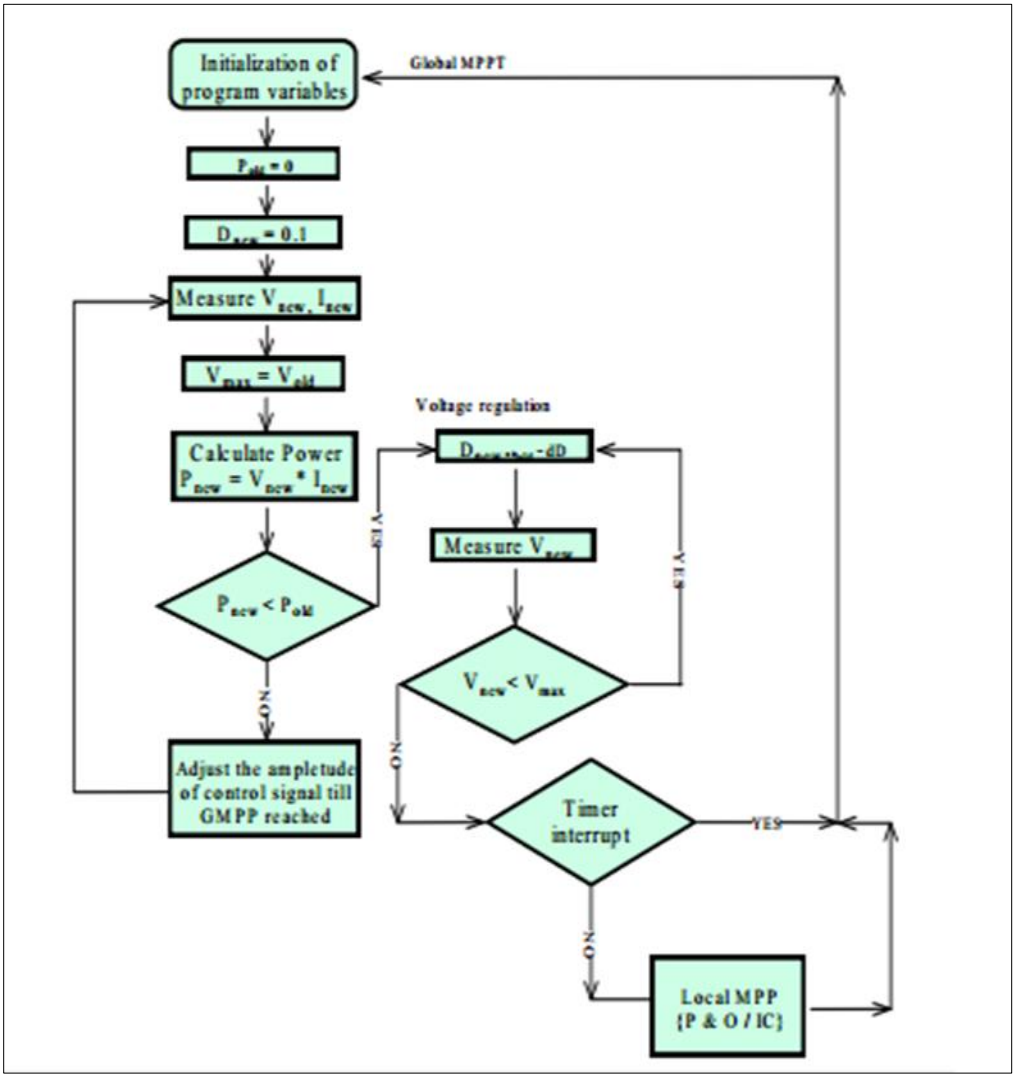

Fig. 3: Flow chart of Global Maximum Power Point Tracking

V. SEARCH SKIP JUDGE GLOBAL MPPT AND RAPID GLOBAL MPPT

The mentioned methods are search skip judge MPPT (SSJ-MPPT) and rapid global MPPT are special methods to track the solar power in less time from the C-MPPT and M-MPPT from this we can track more solar power from every shaded conditions and every time in day time. Simply we track Maximum solar power at every instant. So, time is reduced and drags more power in short time.

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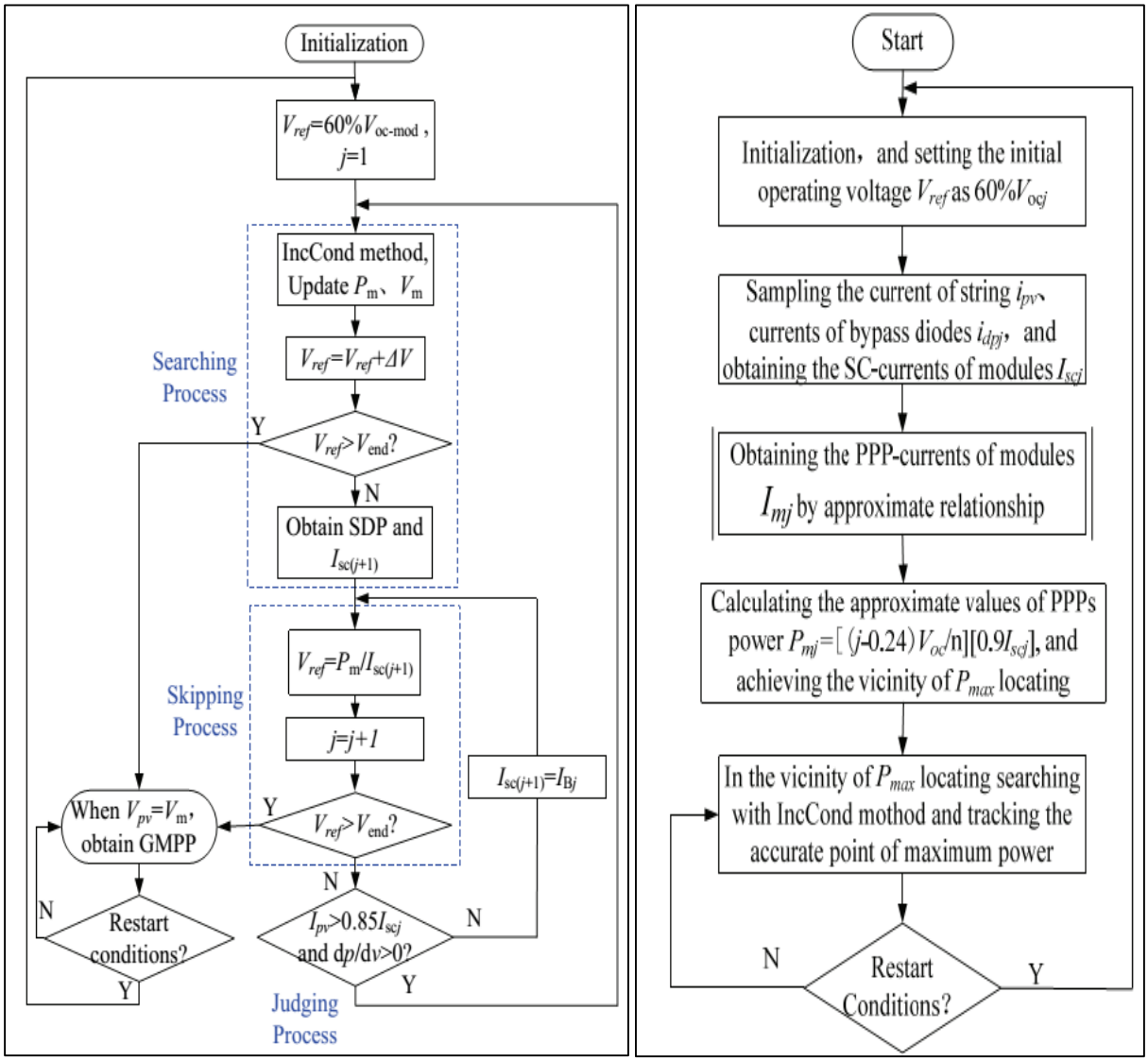

Fig. 4: Complete algorithm flowchart of SSJ-GMPPT and Complete algorithm flowchart of R-GMPPT

VI. PARTICLE SWARM OPTIMIZATION (PSO)

There are many algorithm techniques to optimize the method but particle swarm optimization is one of the best algorithm technique to solve this problem in required time. The coding of PSO is the main part of the algorithm the flowchart of the PSO is mentioned in below figure which gives you entire in formation in it.

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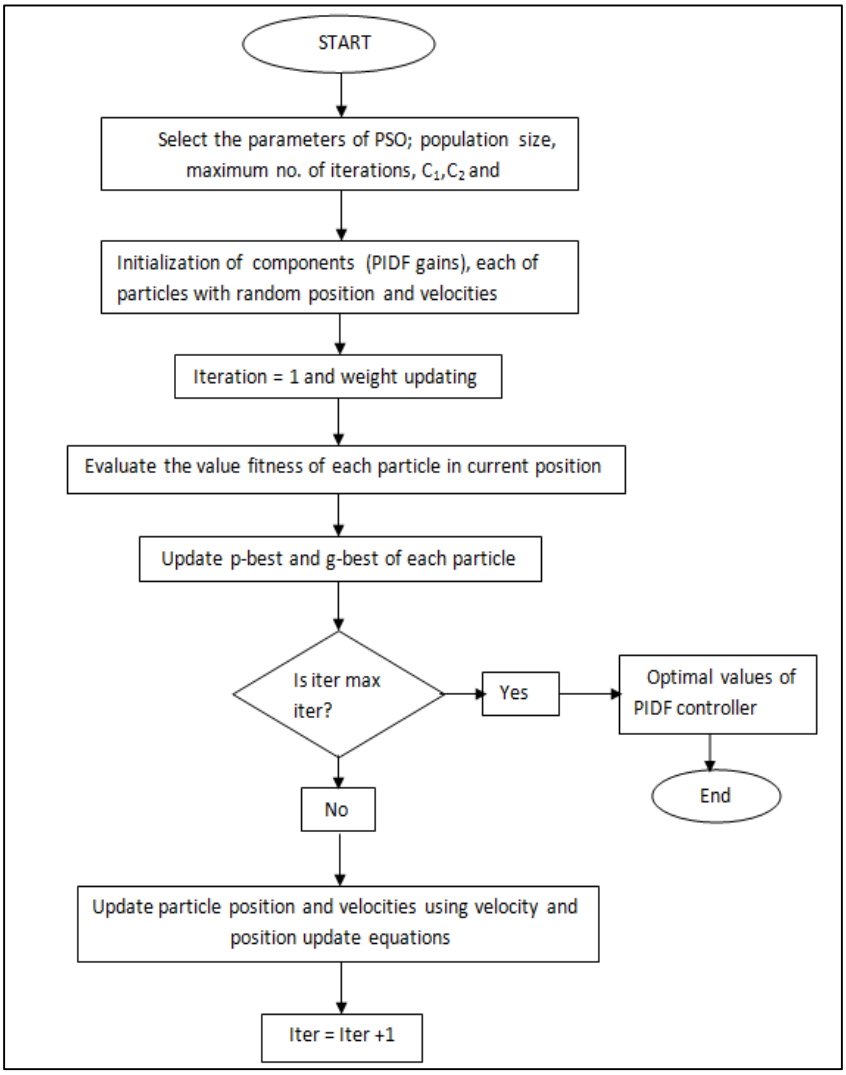

Fig. 5: Flow chart for PSO

The experimental setup and system block diagram are mentioned below for this system. Which is implemented in MATLAB Simulink for that simulation module adds particle swarm optimization (PSO) coding to reduce the tracking time and accuracy of the system.

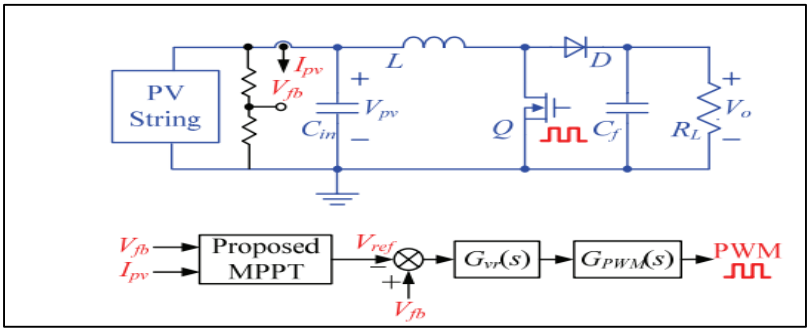

Fig. 6: Experimental setup and system block diagram

VII. SIMULATION RESULTS

Here the simulation results for GMPPT of PSO optimization for considering all conditions divided into patterns based on their irradiances values individually each condition are simulated in below corresponding figures elaborately.

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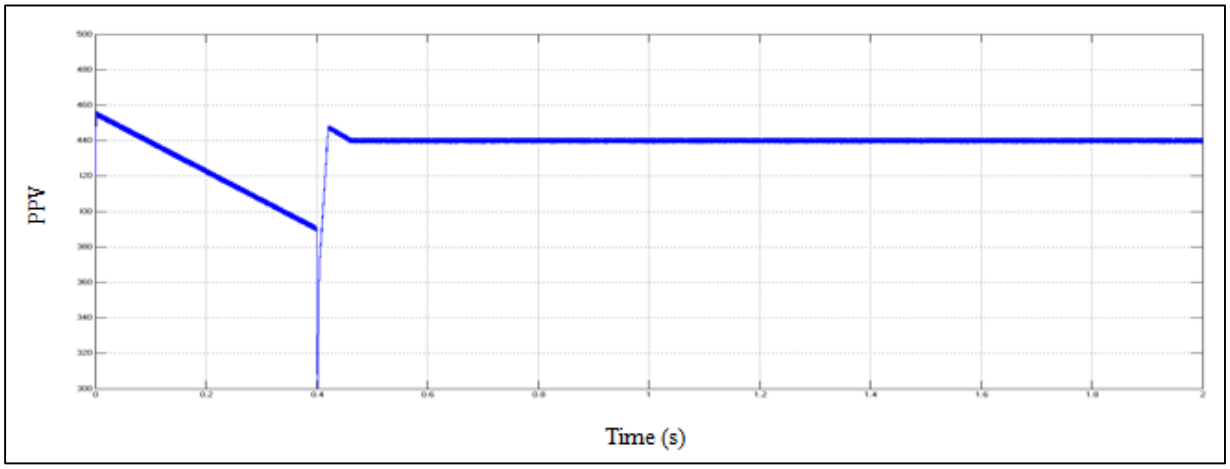
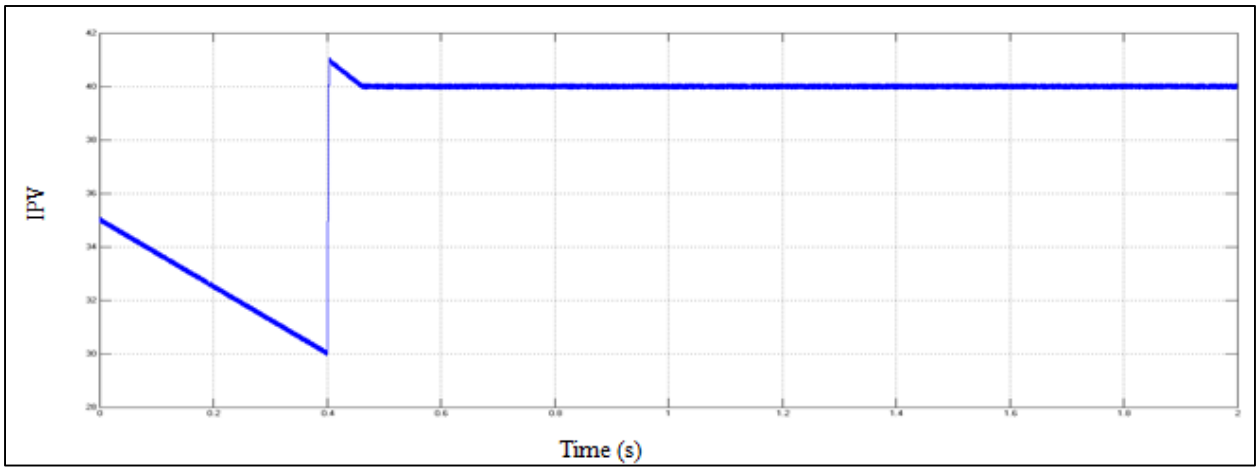
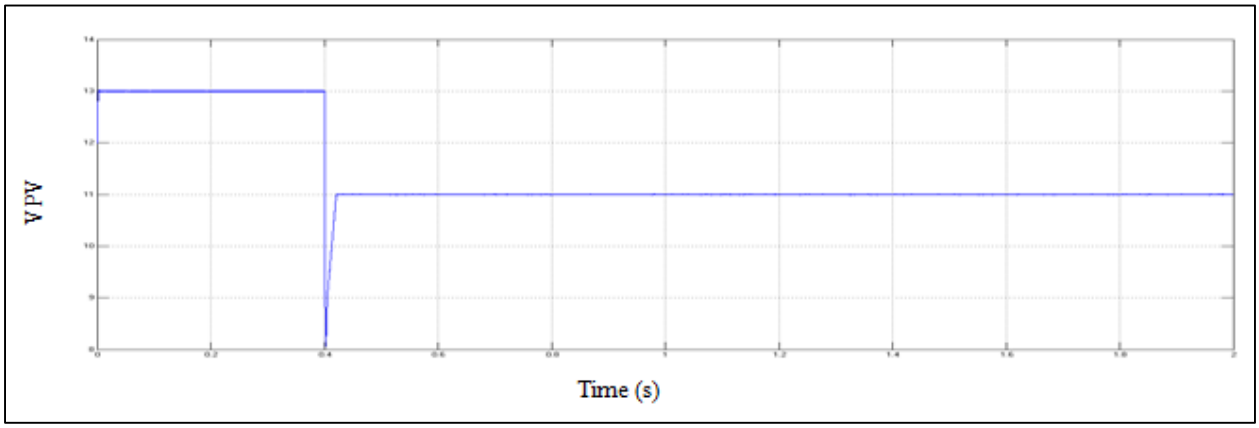


(a)



(b)



(c)

Fig. 7: (a), (b) and (c) Simulation results for PSO GMPPT pattern

VIII. CONCLUSION

In PV string under partially shaded conditions of GMPPT various methods are used as C-GMPPT, M-GMPPT, SSJ-GMPPT and R-GMPPT which are high accuracy and fast tracking speed from these are the most exceed methods for tracking speed. Now introducing particle swarm optimization (PSO) algorithm in this method for reduces the tracking time compared to the above methods and this algorithm is validated with experimental results.

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