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A Research Study and Comparative Analysis of MPPT Controllers for PV Cells with Algorithmatic Structures

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ABSTRACT

Due to continues increase in usage of various sources of Energies, Solar energy becomes very popular source of renewable energy due to its several advantages. Systems such as Photovoltaic (PV) power systems have been widely used in many applications of generation and utilization of energy in many countries. But also, there are many urgent problems to cop up with the applications of PV Cells for the purpose of Power Generation and in the power systems such as low efficiency, high cost etc. The main Concentration is to how to improve efficiency. Since generally Photovoltaic (PV) arrays exhibit a nonlinear power–voltage (P–V) characteristic curve which have a variation with isolation and temperature. To achieve good efficiency, Maximum Power Point Tracking (MPPT) is a very important technology. There are various conventional MPPT schemes have been proposed and working on including Hill-Climbing (HC) , Perturb and Observe (P&O) , and Incremental Conductance (INC) etc. In this research work, the optimization methods for efficient tracking such as PSO and GSA are explored. The very essential and considered issue of this type of control (MPPT) is to how to achieve the best optimized status and this can be achieved by using evolutionary algorithms. PSO algorithm owns the characteristics methods like parallel processing, good robustness, and high probability of finding global optimal solution. By adding GSA with PSO ,it can be improved. Advantage of adding proposed GSAPSO algorithm greatly shortens the searching time, helpful in reducing the fluctuation of output waveform and thus improves the optimization and efficiency through particles dormancy and activation control, optimal number of particles algorithm and search sequence selection. It achieves a smooth starting for maximum power and achieves it in less time than the widely used other methods.

Keywords :- *MPPT, GSAPSO, PSO, PV*

I. Introduction

One of the main issues that industries are facing today is the increasing demand of power and its limitation when it comes to available sources to meet the power demand using conventional energy sources [1]. The search for alternative energy sources has become a concern in our time. Alternative renewable sources such as wind, solar, geothermal, and water energy have become more commonly used than few years back. Solar energy is widely used because it is mostly available everywhere, therefore it has become possible to be utilized properly. Environmentally, photovoltaic systems do not cause any noise or emit no pollution. Economically, they are low maintenance and last for such a long time (over 20 years) [3]. These photovoltaic systems are flexible; they can be implemented on building's rooftops as well as rural areas where the availability of grid is very limited. But on the other hand, they are very expensive and low in efficiency. It is very important to obtain as much power as possible from a PV system, at a given solar irradiance and temperature level, each PV cells supplies a certain maximum power at a particular operating point called the maximum power point (MPP) [4]. It is desirable to operate the PV system at its maximum power point since the PV generated power is maximized. Many methods have been developed in order to track the MPP and operate the PV array at the MPP point. These methods are commonly called maximum power point tracking (MPPT) techniques. This specific technique is often implemented by means of switched mode DC-DC converters in combination with an embedded MPPT algorithm that monitors the PV input voltage and current. Different algorithms have been proposed in the past to track the MPP, but the most widely used one is the "Perturb & Observe" (P&O) [4][15], where the duty cycle of the converter is controlled so that the maximum power will be sent to the load from the source. A solar panel only converts a relatively low percentage of its incident solar irradiation into electrical energy, which means its efficiency is very low. In order to increase the efficiency, Maximum power point tracking technique is used to obtain the maximum possible power from a varying source. Each curve has a unique point called the maximum power point (MPP), at which the module operated with maximum efficiency and produces the maximum output power depending on its operating conditions (radiation and temperature) [7][1][12]. The MPPT method is a technique that constantly tracks the power curve and keeps the solar panel operating voltage at the point where most of the power is obtained. Different MPPT algorithms have been used previously to achieve that task along with a DC-DC converter whose duty cycle is varied and it is being used on the load side powered by a solar panel [11][09][14]. There are different techniques to track the maximum power point. One of the most popular one and the one that is going to be used in this thesis is the perturbation and observation method.

The perturbation and observation method is one of the most popular algorithms that is based on the "hill-climbing" principle, which basically consists of moving the operation point of the PV array in the direction in which power increases. It is a fairly easy method.

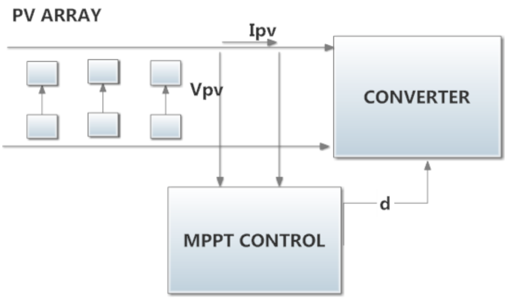

Figure 1.1: General block diagram of an MPPT system [2]

II. LITERATURE REVIEW

Yona et al. [2] proposed the power output forecasting for PV system based on insulation prediction by using NN. The merit of the proposed method is that it does not require complicated calculations and the mathematical model with only meteorological data. At that time of insulation forecasting, it can be possible to shorten the forecast time by using only meteorological data. **Ge et al. [8]** developed a simulation system based on MATLAB/Simulink. pointThe characteristics of electrical phenomenon array area unit relate to some environmental factors like temperature and radiation intensity, load and therefore the aging degree of the battery.**Joo et al. [10]** presents a new technique for the PV allocation problem using a discrete PSO. The proposed discrete PSO includes a novel quantization scheme to handle multi-valued discrete variables in the mixed integer nonlinear programming problem. **Dubey et al. [13]** proposed the sun tracking algorithm is developed to track sun position to receive maximum radiation. DC power from solar array is fed to the buck-boost device for the adjustment of voltage at load finish.**Babu et al. [3]** proposes a novel simplified two-diode model of a photovoltaic (PV) module. The main aim of this study is to represent a PV module as a perfect two-diode model. **Majumdar et al. [5]** Photovoltaic energy has been playing a key role among the renewable energy sources of the future. Converting this energy, which is trapped into a low voltage battery, to a higher voltage for appropriate use, is an area of present day research. **Schuss et al. [6]** presents a modeling tool for photovoltaic (PV) cells, which can build and optimise a simulation model based on measured data, and can plot the I-V (CurrentVoltage) and the P-V (Power-Voltage) curve. **Kulkarni et al. [1]** presents a photovoltaic system incorporating one such technique: Solar Position Tracking. The goal was to style AN economical and efficient star following system for little electrical phenomenon panels, such as those used in domestic applications like water heating.

III. PROBLEM FORMULATION

Maximum wall socket chase (MPPT) could be a technique that grid connected inverters, solar battery chargers and similar devices use to get the maximum possible power from one or more photovoltaic devices, generally star panels, though optical power transmission systems can benefit from similar technology. Solar cells have a fancy relationship between star irradiation, temperature and total resistance that produces a non-linear output efficiency which can be analyzed based on the I-V curve. It is the aim of the MPPT system to sample the output of the cells and apply the correct resistance (load) to get most power for any given environmental conditions .MPPT devices area unit generally integrated into an electrical power device system that gives voltage or current conversion, filtering, and regulation for driving varied masses, including power grids, batteries, or motors. Controllers typically follow one among 3 kinds of ways to optimize the facility output of associate array. Maximum wall socket trackers might implement completely different algorithms and switch between them supported the operative conditions of the array. In this work we will simulate the controller behavior using PSO and GSA separately [07] and will work on new method based on combination of PSO and GSA. The implementation will be carried out in MATLAB SIMULINK.

IV. RESULTS

MPPT with Perturb and Observe method

In Perturb and observe (P&O) method, the MPPT algorithm is based on the calculation of the PV power and the power change by sampling both the PV current and voltage. The hunter operates by sporadically incrementing or decrementing the electrical device voltage. The rule works once fast PV array voltage and current square measure used, as long as sampling occurs only once in each switching cycle. The process is recurrent sporadically till the MPP is reached. The system then oscillates about the MPP. The oscillation are often decreased by reducing the perturbation step size. However, a smaller perturbation size slows down the MPPT. To overcome the problem of this slow response in reaching to MPP, a new algorithm has been developed so that MPP can be reached faster compared to that of conventional P&O. Below is simulation block for P & O method MPP tracker.

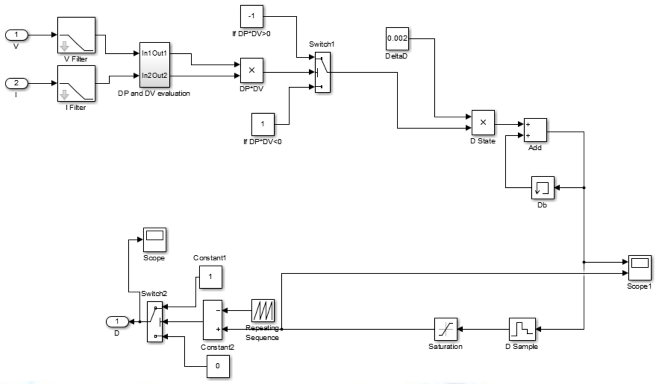

FIGURE 4.1 MPPT SIMULATION BLOCK

MPPT with hybrid method

The proposed method for MPP tracking uses PSO and GSA to provide duty cycles to IGBT. To start the optimization process, the GSOPSA algorithm transmits three duty cycles i d (i=1, 2, 3) to the boost converter. These values serve as the best values for the first iteration. For the next iteration, the new duty cycle is calculated from the previous duty cycles by decreasing or increasing linearly its value with regard to the change in array power by the ratio Q1. The amendment in array power and duty cycle are often obtained victimization

$$d_{new} = d_{old} * Q1 \quad \text{.........................16}$$

here dold is the previous best V duty cycle and Q1 is given by

$$Q1 = \frac{P(d_i^{k})}{P(d_i^{k-1})} \quad \text{...............................17}$$

To perturb the new duty cycle which is obtained through (17), d1 and d3 are equally displaced in positive and negative directions, respectively by a factor of Q2 . So new values for duty cycles will be Duty cycles=[d1-Q2,d2,d3+Q2].........................18

The objective function is defined as

$$P(d_i^{k}) > P(d_i^{k-1}) \quad \text{.......................19}$$

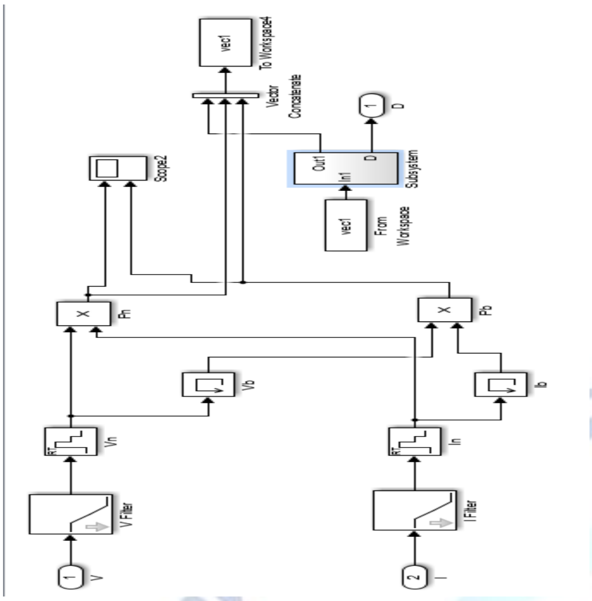

Figure 1.3: MPPT simulation block for hybrid method

Output waveforms using both methods

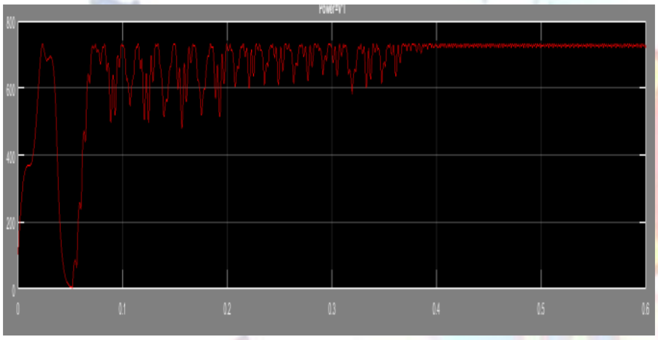

Figure 4.2: Power by perturb & observe method

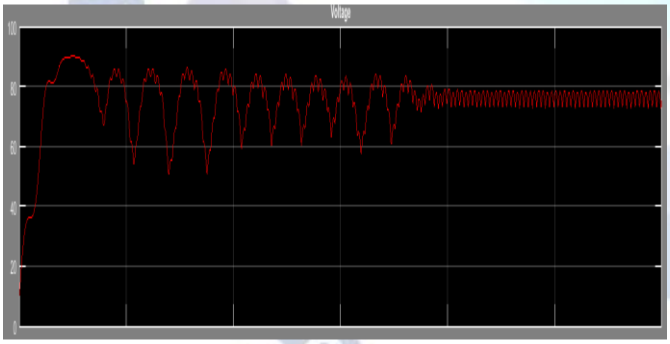

Figure 4.3: Voltage by perturb & observe method

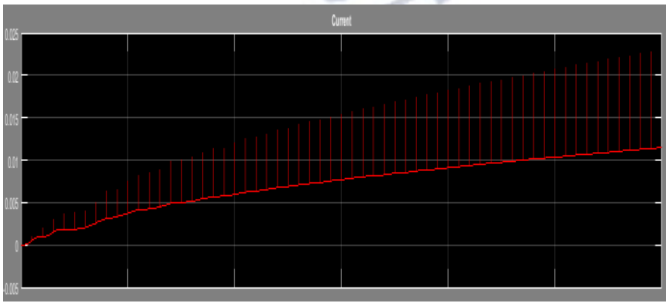

Figure 4.4: Current by perturb & observe method

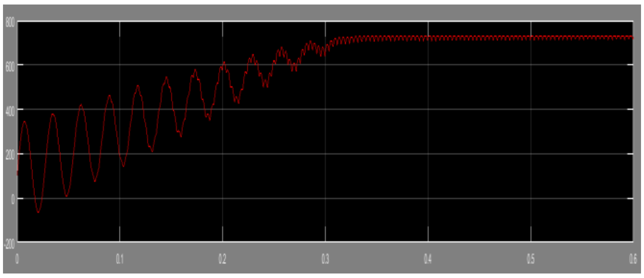

Figure 4.5: power by GSAPSO method

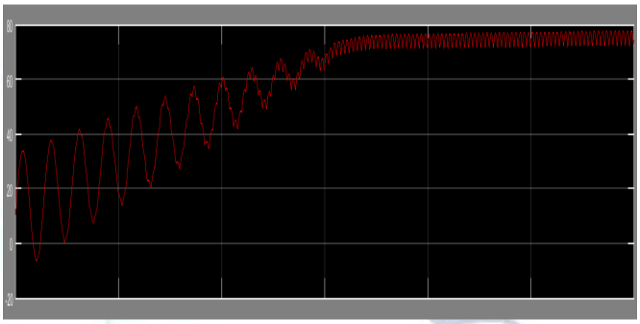

Figure 4.6: Voltage by GSAPSO method

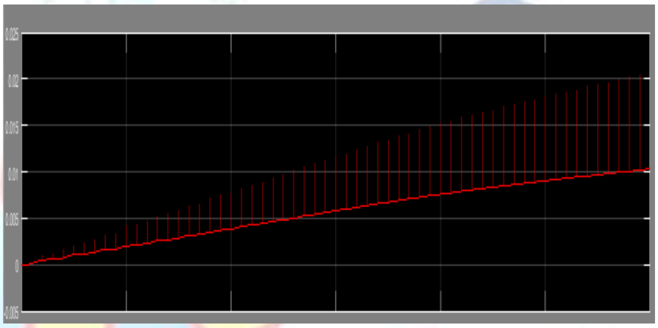

Figure 4.7: Current by GSAPSO method

V. CONCLUSION & FUTURE SCOPE

This work proposes an improved maximum power point tracking (MPPT) method for the photovoltaic (PV) system using a modified particle swarm optimization (PSO) algorithm and gravitational search algorithm (GSA). The main advantage of the strategy is that the reduction of the steadystate oscillation (to much zero) once the utmost outlet (MPP) is found. Furthermore, the proposedmethod has the flexibility to trace the MPP for the intense condition, e.g., massivefluctuations of insolation and partial shading condition. The algorithm is simple and can be computed very rapidly as it To evaluate the effectiveness of the proposed method, MATLAB simulations are carried out with perturb and observe method and with proposed method separately.Many different MPPT techniques have been proposed and the existing techniques vary in simplicity, popularity, accuracy, time response, cost, and other technical aspects. In perturb and observe (P&O) method, the perturbation in the operating voltage of the PV array depends on the difference of the array terminal voltage and the actual MPP voltage. But it cannot be compared to find the new operating voltage, since the change in power is only considered to be a result of the array terminal voltage perturbation. But in proposed hybrid method the power and previous duty cycles are factors on which new duty cycle has been evaluated. As there is very least variation needed in predicting the new duty cycle a change of .02 has been considered for new duty cycle depending upon the increase or decrease of the power.

REFERENCES

[1] Aneesh Kulkarni, Tushar Kshirsagar, Akash Laturia, P. H. Ghare, "An Intelligent Solar Tracker for Photovoltaic Panels, " Published in India Educators' Conference (TIIEC), 2013 Texas Instruments Date of Conference: 4-6 April 2013 Page(s): 390 – 339.

[2] Atsushi Yona, Ahmed Yousuf Saber, Hideomi Sekine, "Application of Neural Network to One-Day-Ahead 24 hours Generating Power Forecasting for photovoltaic System", The 14th International Conference on Intelligent System Applications to Power Systems, ISAP 2007, Kaohsiung, Taiwan November 4 - 8, 2007.

[3] B. Chitti Babu and Suresh Gurjar," A Novel Simplified Two-Diode Model of Photovoltaic (PV) Module." Published in IEEE JOURNAL OF PHOTOVOLTAICS, VOL. 4, NO. 4, JULY 2014.

[4] Bidram, Ali. Davoudi, Ali. Balog,Robert S."Control and Circuit Techniques to Mitigate Partial Shading Effects in Photovoltaic Arrays". IEEE Journal of Photovoltaic's, Vol. 2, NO. 4(2012).

[5] B. Majumdar, S. K. Biswas, " A Single Phase SPWM Boost Inverter With High Step-Up Ratio For Photovoltaic Energy Application." Published in IEEE International Conference on Control, Instrumentation, Energy and Communication (CIEC '14), At Kolkata, India, Volume: pp 384-386.

[6] Christian Schuss, Timo Rahkonen, "Adaptive Photovoltaic Cell Simulation with Maximum Power Point Tracking Simulation for Accurate Energy Predictions." Published in NORCHIP, 2011 Date of Conference: 14-15 Nov. 2011 Page(s): 1 – 4.

[7] Dipasri Saha," A GSA based improved MPPT system for PV generation." Published in: 2015 IEEE International Conference on Research in Computational Intelligence and Communication Networks (ICRCICN) Date of Conference: 20-22 Nov. 2015 Page(s): 131 – 136.

[8] Haoxiang Ge ; Cungang Hu ;Zhongyuan Wei ; Dengshan Hou," Research on a Photovoltaic System of MPPT Hysteresis Control based on Adaptive FIR Filter," Published in: Industrial Electronics and Applications (ICIEA), 2014 IEEE 9th Conference on Date of Conference: 9-11 June 2014 Page(s): 2101 – 2104

[9] Harjai, Arjav. Bhardwaj,Abhishek . Sandhibigraha ,Mrutyunjaya "Study of Maximum Power Point Tracking(MPPT) Techniques in a Solar Photovoltaic Array" BS thesis National Institute of Technology Rourkela, Orissa. Web. 01 April, 2013.

[10] Hwachang Song, Ryan Diolata and Young Hoon Joo, "Photovoltaic System Allocation Using Discrete Particle Swarm Optimization with Multi-level Quantization", Journal of Electrical Engineering & Technology Vol. 4, pp. 185-193, 2009

[11] Malki, Sihem."Maximum Power Point Tracking(MPPT)for Photovoltaic System" MS thesis U of M'hamed Bougara Boumerdes. Algeria, 2011. Web. 01 April, 2013.

[12] M. Berrera, A. Dolara, R. Faranda and S. Leva, "Experimental test of seven widelyadopted MPPT algorithms", 2009 IEEE Bucharest Powe r Tech Conference, June 28th -July 2nd

[13] Rahul Dubey, Dheeraj Joshi, " A Fuzzy Logic MPPT Control Scheme for Solar Photovoltaic Module Connected with DC Drive." Published in Power India Conference, 2012 IEEE Fifth Date of Conference: 19-22 Dec. 2012 Page(s): 1 -6.

[14] Muhammad Riazul Hamid, Jakaria Rahimi , Jakaria Rahimi, Sabrina Chowdhry,T.M. Moniruzzaman Sunny "Design and Development of Maximum Power Point Tracking Charge Controller for Photo- Voltaic PV Power Generation" American Journal of Engineering and Research Vol. 5, No. 5, pp. 15-22, 2016

[15] Kumar Ajit, Goel Vikas, "A novel method for MPPT in PV systems under partial shading conditions using fuzzy logic and PID controllers" International Journal of Advance Research, Ideas and Innovations in Technology Vol.4, issue 5 pp 287-292