Optimal control of solar PV system using Optimization methods

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Abstract— **In recent trends, there has been rapidly increase of demand in energy. For conserving energy, innovative solutions are being proposed for reducing it. An eco-friendly system should be created in order to save investment on electricity and then maximize the return cost on investment for investing in solar modules. The photovoltaic industry happens to be more efficient and less expensive systems so that it can be more competitive in nature when it is being compared with other conventional sources. For PV modules, irradiation and panel temperature faces more challenges because these parameters are unstable. Therefore, the electricity generations from PV panel are not stable in nature. So, Maximum Power Point Tracking (MPPT) technique is used for extracting maximum power from PV modules. A DC-to-DC converter has been used for matching the impedance between PV module or array of modules so as to extract maximum power from PV modules or strings of PV modules. In this paper, perturb & observe (P&O), Particle swarm 0ptimization (PSO) and Grey wolf optimization (GWO) methods have been applied. The performance of these algorithms has been verified for MPPT in MATLAB /Simulink environment.**

Keywords— **MPPT, P&O, PSO, GWO, Buck converter.**

I. INTRODUCTION

In 21 centuries the utilization of renewable sources of energy has been increased rapidly. Solar energy is one of the important renewable sources of energy since it is clean, pollution free and in exhaustible. Non-conventional energy sources act vital contribution in the field of electric power system. There are various types of Non-conventional resources, i.e solar energy, wind energy, Bio – gas, tidal etc. Non-conventional energy sources are used for generations of electric power. Solar system is one of the Non-conventional energy sources. it is used for electric power generation. The solar energy is converted heat energy into electrical energy by solar photovoltaic modules. Solar Energy is made up of silicon cells. Solar cells are connected in series and parallel. When solar cells connected in series in this condition Increases the rating of current in this modules, the cell area increased individual. Number of Solar PV modules is connected in the series and parallel combinations that is known as solar PV array i.e. is applicable for obtaining maximum output power.

Now days many researchers are working to improve the materials and methods for high output power. Solar Photo Voltaic panels generate electricity is called the "Photo-voltaic Effect". The simplest form the Photovoltaic Effect can be described as follows: when a solar cell is illuminated, electron-hole pairs are generated and the electric current is obtained. The electric current is the difference between the solar light generated current and diode current.

There are several accesses to obtain maximizing power extraction in solar systems. In is methods, we track the sun intensity to obtain the, maximum power point (MPPT) tracking or both. In this research, MPPT tracking techniques are apply and comparison has been done between with different optimization methods as like Perturb & Observe Particle Swarm Optimization and Grey Wolf Optimization for finding maximum power point.

II. RELATED WORKS

[1] Optimization methods are applied to obtain the track maximum power. A DC-.DC power converter is applied to step –up voltage of solar photovoltaic system. It containing at least semiconductor device as like a diode and a transistor. The boost converter also contains battery for storage the energy. Inductance, a capacitor. The capacitor reduces ripple voltage and filters.

Buck-Boost converter is applied to obtain the Z (impedance) matching between the Solar PV array and the load. There are many approaches to propose in this paper. The perturb and observe is based on technique are the most widely applicable in commercial products. The perturb and observe methods can be implemented.

Simulation result is verified by power sim simulator and experimental. Three MPPT methods, classical P&O and a new enhanced PSO algorithm and GWO .[2] Maximum power tracking (MPPT) that is mainly concerned on Incremental conductance method with direct control. In this methods microcontroller (dsPIC30F2010) has been used for controlling for maximum power tracking. There are many methods to obtain the optimize power by different techniques i.e Perturb and 0bserve, Incremental Conductance (Inc), fuzzy logic. [4]

In this paper expound the +ve impact effect of the maximum power point tracking methods on the solar Pv system. In this paper expound the theory of operation of different methods. Electronics converters are applied for tracking the maximum power.

This paper is implement different algorithm for obtain optimize power and comparison the result.

III. METHODOLOGY

Methodology of proposed method is described in the flowchart which is mentioned in the figure1.

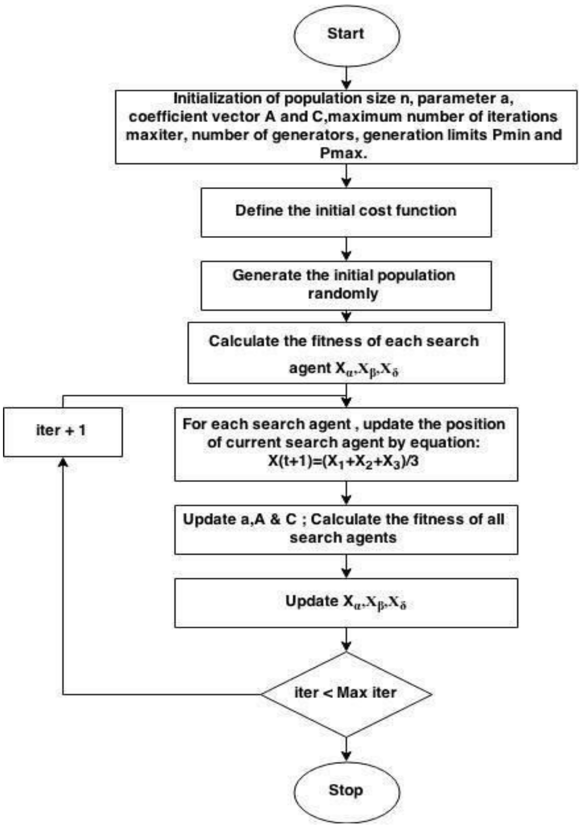

Fig.1 Flowchart of grey wolf optimization algorithm

IV. MATHEMATICAL MODELLING OF SOLARPV SYSTEMS

A mathematical expression involved in current source type PV model which is represented by continually circuit shown in fig. 2.

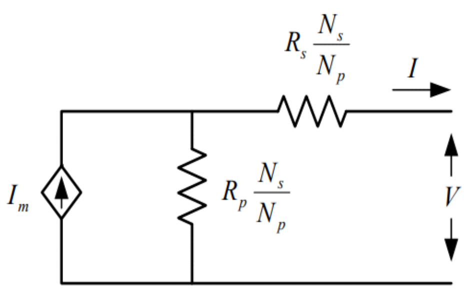

Figure .2 Equivalent Ckt. PV Module

The generalized equation of PV model is given by equation (1) which is given below.

$$I_{pv}N_p - I_oN_p\left[\exp\left(\frac{V+R_s\left(\frac{N_s}{N_p}\right)I}{V_t a N_s}\right)-1\right] \quad (1)$$

Where R_s= series resistance of array
$R_{p=}$ parallel resistance of array
N_s & N_p N_s are the number of series and parallel
I_m is the module current.

The thermal voltage of PV array is given in the equation (2)

$$V_t = \frac{N_{cs}KT}{q} \quad (2)$$

Where,N_{cs}=N0 of series connected cell,
K = Boltzmann's constant
T = Temp. in P-N junction
I_{pv} = Photo-voltaic current
.I_{pv} can be expressed in equation 3

$$I_{pv} = \left(I_{pvn} + K_i\Delta T\right)\frac{G}{G_n} \quad (3)$$

Here , I_o = reverse leakage current and explained in equation 4

$$I_o = \frac{I_{scn}+K_i\Delta T}{\exp\left(\frac{V_{ocn}+K_V\Delta T}{aV_t}\right)-1} \quad (4)$$

Where, I_{pvn} = generated,
G = irradiance at normal condition.
I_{scn} & V_{oc} = short circuit and open Circuit voltage

V. SIMULATION RESULTS

PV module, MPPT Controller and DC to DC converter are cascaded together shown in figure3. PV is shown in left side and yellow box MPPT controller which is part of Matlab Subsystem. Resistive load (green block) where power is extracted from PV module and measured by Scope (Blue block). Duty of IGBT switch is controlled by MPPT controller which can change based upon the load or any change in environmental condition.

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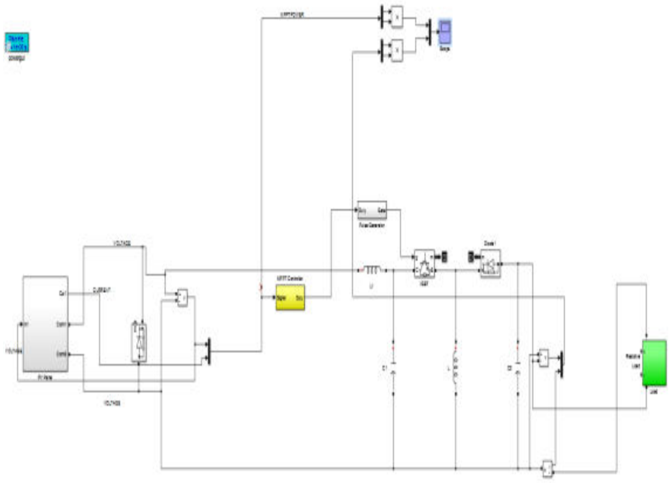

Fig3. Simulink Model

Maximum power which can be extracted by PV module shown in yellow line and pink line shows power dissipated in resistive load. Simulation time was chosen to be 0.2 second. Step size is 1e-6. After 0.14s simulation runs in steady state In Fig we obtain the maximum power from solar panel is 322.2W show in yellow line using optimum operation of solar photovoltaic system using grey wolf optimization method and pink line is resistive load and its value is 281.9W.

TABLE1 COMPARISION RESULT OBTAINED BY P&O,PSO & GWO

	P&O		**PSO**		**GWO**	
	Max Power (watts)	**Power across Load in (W)**	**Max Power (watts)**	**Power across Load in (W)**	**Max Power (watts)**	**Power across Load (Watts)**
	270.1	234	270.3	226.8	270.6	227
	280	242	280.5	237.5	280.7	237.6
	289	251	291.2	248.5	291.6	248.7
	297.5	258	297.7	259.5	301.6	259.8
	305	266	310	270	312.4	271
	313	272.8	322	280	322.2	281.9

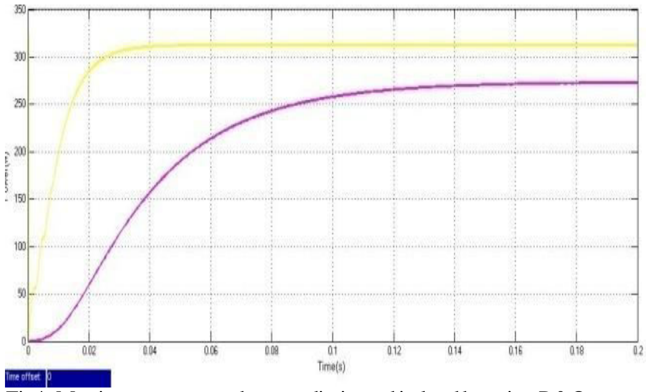

Fig4. Maximum power and power dissipated in load by using P&O

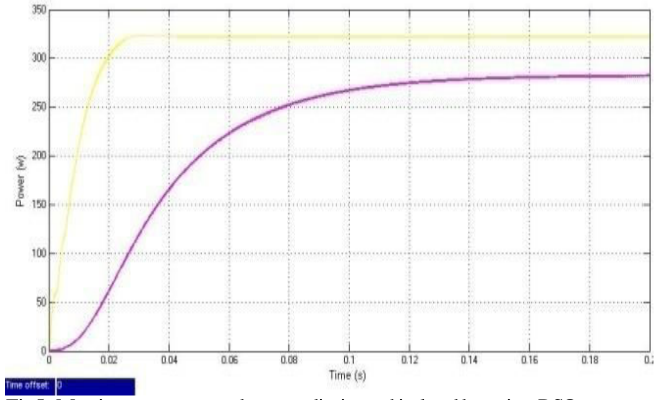

Fig5. Maximum power and power dissipated in load by using PSO

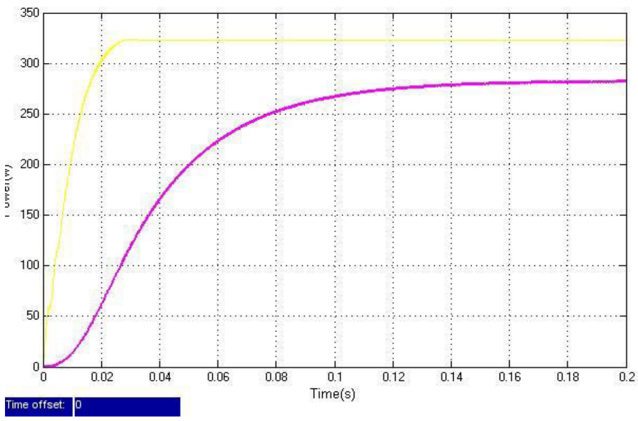

Fig6. Maximum power and power dissipated in load by using GWO

The results of P&O, PSO and GWO have been displayed with respect to the temperature in increasing fashion which is given in the table1.

VI. CONCLUSION

In this paper, the simulation of MPPT of PV panel using Perturb & Observe (P&O), Particle Swarm Optimization (PSO) and Grey Wolf Optimization (GWO) methods has been presented. A comparison of PV panel output corresponding to all three algorithms and its power dependence on temperature has been shown. The results obtained after using GWO technique is best compare to the other two techniques. It has been seen that with increase the temperature, power also increases. So it may be said that maximum power is depend on irradiation temperature. It may be concluded that Grey Wolf Optimization (GWO) technique shows better results and may be used MPPT of PV panel.

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