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BFOA AND ANFIS BASED MPPT CONTROLLER FOR PARTIAL SHADED PV SYSTEMS

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Abstract

This paper proposes ANFISand BFOA(Bacterial foraging optimization algorithm) as search optimization method using SEPIC converter to obtain maximum efficiency under partial shaded condition. SEPIC converter is one which maintains the output voltage constant for the changing solar isolation level. By changing the switching frequency of the converter the maximum power has been achieved. Improved techniques-ANFIS and BFOA is used as MPPT techniques for tracking maximum power.

***Key Words*:**Hydrogel; bioink; cartilage; artifical knee replacement; Biodegradable;

1 INTRODUCTION

Solar energy is highlighted under various renewable energy sources due to its availability and being a clean sourcefor electric power

generation.The energy from sun is converted directly into electric energy by PV modules. Due to their low conversion efficiency tracking of maximum power in a PV system becomes essential. Complexity in tracking of power arises due to the nonlinear nature of PV systems. Non-linearity is because of partial shading condition creating major cause for power loss. There are many maximum power point tracking techniques having their own advantages and disadvantages. The one among them are ANFIS and BFOA. By considering the factors like cost, stableness, cleanliness and their ability to track maximum power these MPPT techniques are chosen for process.

2 PHOTOVOLTAIC ARRAY MODEL

Photovoltaic devices are the one that convert suns energy directly into electrical energy using semiconductors workingunder photovoltaic effect. Photovoltaic panel is made up ofmany solar cells that are arranged in series and shunt patterns.

A PV array circuit is as follows:

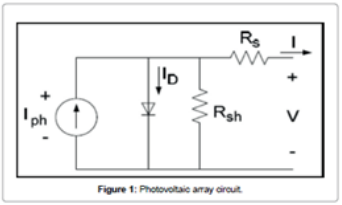

Fig.1 Block diagram

Circuit is modeled by keeping a current source parallel with diode along with shunt and series resistor The output current equations for the PV array circuit is given to be:

$$I = I_{ph} - I_D$$

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Where,
Iph is Photo-current;

A is the Ideality factor;
KB is the Boltzmanns constant;
T is the Cell temperature;
ID is Diode current;
Rsh is Series resistance;
I0 is Saturation current;
q is Electronic charge;
Rsh: Shunt resistance;
Vis Cell voltage;
IisCell current

The I-V curves and P-V curves of a PV module is depicted as follows:

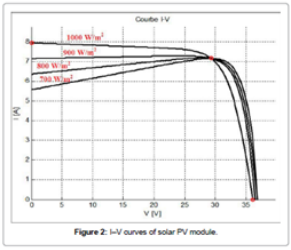


Fig 2- Inkjet Printing in 3D

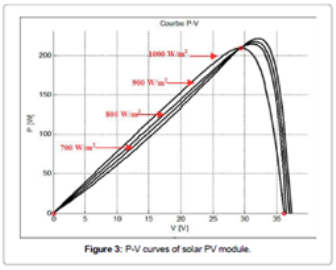


Fig 3-Hydrogel Pattern

3 SEPIC CONVERTER

SEPIC (Single ended Primary Inductor Converter) is a buck boost converter. It is advanced level converter that maintains the output voltage in a constant manner The circuit for SEPIC is shown below:

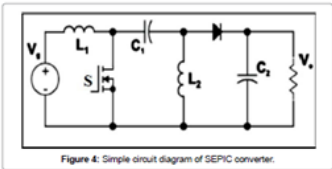


Figure 4: Simple circuit diagram of SEPIC converter.

The above circuit consist of a diode, 2- inductors, 2- capacitors, a load resistor and a switch whose duty cycle is . In the above circuit the input voltage is both stepped up and stepped down and energy supplied at this time is zero.Polarities from current of inductor and voltage of capacitor are also marked in Figure 4.

The control transistor is responsible for controlling the output of SEPIC by adjusting the duty cycle. Having inverted output seems more advantageous.

The parasitic elements in the circuit and duty cycle is responsible for having voltage variations at the output side. The output equation of a SEPIC converter is given to be:

$$V_{OUT} = \frac{D}{1-D} V_{in}$$

4 PARTIAL SHADED CONDITION

Photovoltaic (PV) power generators are used to convert the energy obtained from sundirectly into electrical energy. Most of the time the operation of generators is affected by, irradiances and temperatures of PV cells. PV modules are typicallyprone to electrical losses undernon-uniform operating conditions where some solar modules are shaded and the rest modules are receiving the global solar radiation. The above conditionsare considered to be major cause of energy losses in PV power generators and are called partial shaded conditions.

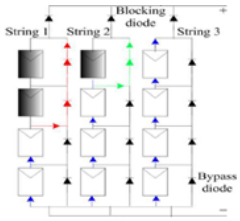


Fig 12: OPERATION OF PV ARRAY PARTIAL SHADING: FOR UNIFORM INSOLATION, THE MODULE HAS SOLAR INSOLATION

4.1 Characteristics of P-V curve under partial shaded condition

A PV array is made of n-No. of PV modules which are in series and parallel connections to get the desired voltage and current. With each PV module Bypass diodes are used in parallelfor preventing modules from hot-spot problems.

Only one MPP exists when solar radiance is uniform and several maximum power points occur for non-uniform solar radiance on the P-V characteristic curve.

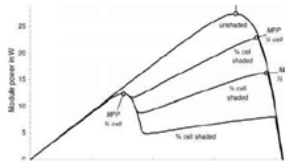
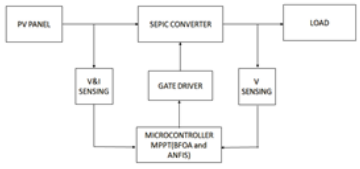


Fig13: POWER-VOLTAGE CURVE FOR VARIOUS SHADED CONDITION.

5 BLOCK DIAGRAM OF PROPOSED SYSTEM



6 BFOA AND ANFIS BASED MPPT CONTROLLER FOR SEPIC CONVERTER

6.1 ANFIS ALGORITHM:

Anadaptive network-based fuzzy inference system (ANFIS) is a artificial neural network that was developed in the early 1990s.It combines both neural networks and fuzzy logic principles thusit holds the benefits of both in a single framework. ANFISis made upof

set of fuzzy IFTHEN rules that has the capability to approximate thenonlinear functions. Hence, ANFIS is a universal estimator. By using the parameters obtained by genetic algorithm, ANFIS can be used in a efficient manner. Here ANFIS algorithm is used as MPPT technique. ANFIS is a rule based technique which uses IF-THEN rules.

6.1.1 ANFIS STRUCTURE

ANFIS is a four-layer neural network that simulates the working of a fuzzy inference system. Input variables are represented by layer one of linguistic node and output variables are represented by layer four of linguistic node Nodes in layers two are membership functions for input variables and are called as term nodes. Every neuron located in the third layer represents one fuzzy rule, where input connections are represented by preconditions of the rule and the output connectionsare represented consequences of the rules. Moreover, all these layers are fully connected initially, representing all possible rules.

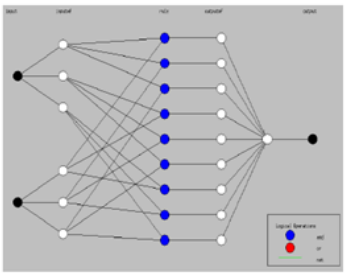


Fig 9:ANFIS STRUCTURE

	NB	NM	NS	Z	PS	PM	PB
B	NB	NM	NS	Z	PS	PS	PM
M	NB	NM	NS	Z	PS	PM	PM
S	NB	NM	Z	Z	Z	PM	PB

Figure 10:ANFIS lookup table.

The above table gives the look up table to execute ANFIS algorithm.

6.2 BACTERIAL FORAGING OPTIMIZATION ALGORITHM (BFOA)

Kevin Passino proposed the algorithm for BFOA. BFOA is a nature inspired optimization algorithm. To obtained the maximum energy per unit time bacteria searches for nutrients.

Sending signals to individual the bacterium communicates withothers.Afterthatbacterium takes a decision by considering the previous two factors. While searching for nutrients it moves by small steps in the process, called chemotaxis.

The BFOA algorithm can be discussed using the below four processes, namely

- ⋆ Chemotaxis
- ⋆ Swarming
- ⋆ Reproduction
- ⋆ Eliminationdispersal.

6.2.1 BFO-algorithm

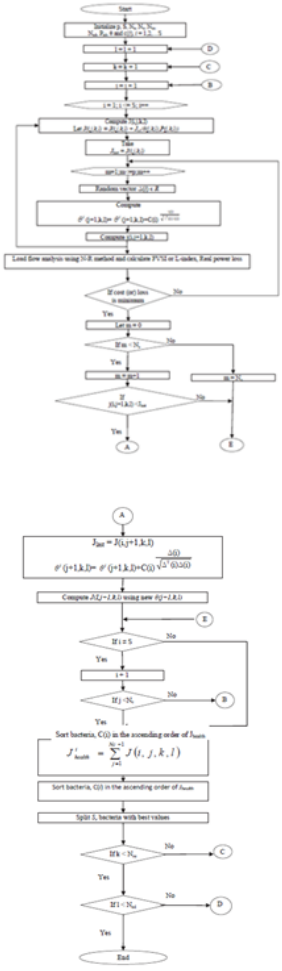
Step 1initialization

- ⋆ Number of parameters (p) to be optimized
- ⋆ Number of bacteria (S) in the population.
- ⋆ Swimming length NSafter which tumbling of bacteria will be undertaken in a chemotactic loop.
- ⋆ Ned- number of elimination and dispersal events.
- ⋆ Ped- probability of the elimination and dispersal bacteria
- ⋆ The location of each bacterium P (i, j, k) which is specified P (i, j, k) = i(j, k, l) for i = 1,2,. . ., S

⋆ The value of C(i) which is assumed to be constant in our case for all the bacteria to simplify the design strategy.

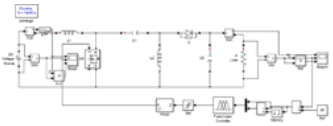
Step 2iterative algorithm for optimization This section represents the bacterial population in the four BFOA process. For the algorithm updating iautomatically results in updating of P.

6.2.2 FLOWCHART

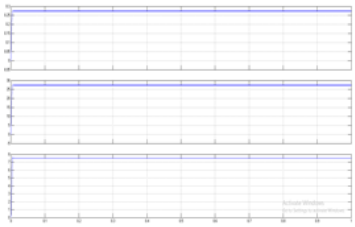


7 SIMULATION:

7.1 The simulation diagram for ANFIS based PV system using SEPIC converter is asfollows:



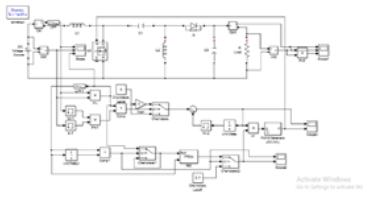
The result of above simulation is shown below:



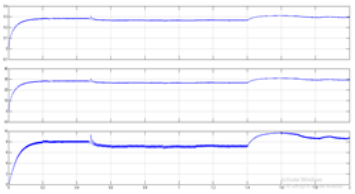
There are totally three graphs in the above diagram. The 1st graph is current vs. time, the 2nd graph is voltage vs. time and the 3rd graph is power vs. time.

The power obtained from using ANFIS Algorithm is nearly 7.5W and the voltage waveform obtained is stable. The efficiency is calculated to be 83%.

7.2 The simulation diagram for BFOA based PV system using SEPIC converter is as follows:



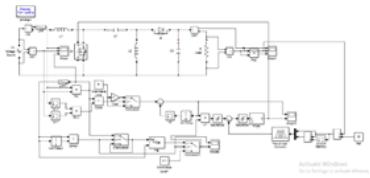
The result of above simulation is shown below:



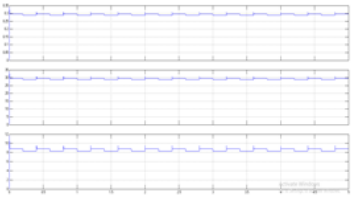
The 1st graph is current vs.time, 2nd is voltage vs.time, and the 3rd is power vs. time.

While simulating using BFOA algorithm it is observed that it is capable of tracking maximum power, but voltage waveform is not stable. The efficiency is also quite low.

7.3 The simulation diagram for ANFIS and BFOA based PV system using SEPIC converter is as follows:



The result of above simulation is shown below:



The above simulation has the current, voltage and power waveforms for the simulation done. The obtained voltage is much stable; power obtained is greater and efficiency is calculated to be 91

8 CONCLUSION:

In this paper SEPIC converter is used which removes the unwanted noise through capacitor and it gives positive output voltage compared to buck boost converter which gives inverted output.

ANFIS&BFOA algorithm is used for MPPT application which eliminates the iterative process of other algorithms. Thus, provides a better efficiency(91%) and accuracy in generation of power under partial shaded condition.

The tabulation below is set for easier understanding of above simulations and has mathematical values too.

Parameters	ANFIS	BFOA	ANFIS AND BFOA
Current	0.27A	0.3A	0.3A
voltage	27V stable	27V Not stable	30V Stable
power	7.5W Efficiency is low	9.5W	8.5W Efficiency is high

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