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Comparative study of MPPT Control by Intelligence Techniques

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***Abstract*: -- MPPT control is an important feature to extract the maximum solar power. It varies depending on the angle of sunlight on the surface of the panel and cell temperature.Maximum power point tracking (MPPT) methods are used to get a maximum output power of PV array. By tracking continuously, to get the maximum power, various intelligent methods have been proposed by various authors has got the most expected results.This paper focused on the work carried out by using different algorithms and flowchart.This study reveals that, among all intelligent methods for MPPT control ,perturb and observe (P & O) method is prominently used because of its simplicity and ease of implementation, though it gives slow response of speed and oscillations in steady state.**

***Keywords*— MPPT-Maximum Power Point Tracking, PV Cell-Photovoltaic cell, intelligence techniques.**

I. INTRODUCTION

Maximum Power Point Tracking, frequently referred to as MPPT, is an electronic system that operates the Photovoltaic (PV) modules in a manner that allows the modules to produce all the power they are capable of. MPPT is not a mechanical tracking system that "physically moves" the modules to make them point more directly at the sun. MPPT is a fully electronic system that varies the electrical operating point of the modules so that the modules are able to deliver maximum available power. Additional power harvested from the modules is then made available as increased battery charge current. MPPT can be used in conjunction with a mechanical tracking system, but the two systems are completely different.

II. MPPT

MPPT or Maximum Power Point Tracking is algorithm that included in charge controllers used for extracting maximum available power from PV module can produce maximum power is called maximum power point (or peak power voltage). Maximum power point (MPP) varies depending on the angle of sunlight on the surface of the panel and cell temperature. Maximum Power Point Tracking, frequently referred to as MPPT, is an electronic system that operates the Photovoltaic (PV) modules in a manner that allows the modules to produce all the power they are capable of. MPPT is not a mechanical tracking system that "physically moves the modules to make them point more directly at the sun. MPPT is a fully electronic system that varies the electrical operating point of the modules so that the modules are able to deliver maximum available power. Additional power harvested from the modules is then made available as increased battery charge current. MPPT can be used in conjunction with a mechanical tracking system, but the two systems are completely different.

III. APPLICATION OF MPPT CONTROL

MPPT is a technique used commonly with photovoltaic (PV) solar system to maximize power extraction under all condition. Although solar power is mainly covered, the principle applies generally to source with variable power ;for example, optical power transmission and thermo photovoltaic. PV solar systems exist in many different configuration with regard to their relationship to inverter system, external grids, battery banks, or other electrical loads. regardless of the ultimate destination of the solar power, through the central problem addressed by MPPT is that the efficiency of power transfer from the solar cell depends on both the amount of sunlight falling on the solar panels and the electrical characteristics of the load . as the amount of sunlight varies , the load characteristics that gives the highest power transfer efficiency changes, so that the efficiency of the system is optimized when the load characteristic changes to keep the power transfer at highest efficiency. This load characteristic is called the maximum power point and MPPT is the process of finding this point and keeping the load characteristic there. Electrical circuit can be designed to present arbitrary load to the photovoltaic cells and then convert the voltage ,current ,or frequency to suit other devices or system ,and MPPT solve the problem of choosing the best load to be presented to the cells in order to get the most usable power out .

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IV. MPPT CONTROL USING INTELLIGENT TECHNIQUES

A. GENETIC ALGORITHM:

GA is a method for moving from one population of "chromosomes" to a new population by using a kind of "natural selection" together with the genetics−inspired operators of crossover, mutation, and inversion. Each chromosome consists of "genes" (e.g., bits), each gene being an instance of a particular "allele" (e.g., 0 or 1). The selection operator chooses those chromosomes in the population that will be allowed to reproduce, and on average the fitter chromosomes produce more offspring than the less fit ones. Crossover exchanges subparts of two chromosomes, roughly mimicking biological recombination between two single−chromosome ("haploid") organisms; mutation randomly changes the allele values of some locations in the chromosome; and inversion reverses the order of a contiguous section of the chromosome, thus rearranging the order in which genes are arrayed. The chromosomes in a GA population typically take the form of bit strings. Each locus in the chromosome has two possible alleles: 0 and 1. Each chromosome can be thought of as a point in the search space of candidate solutions. The GA processes populations of chromosomes, successively replacing one such population with another. The GA most often requires a fitness function that assigns a score (fitness) to each chromosome in the current population. The fitness of a chromosome depends on how well that chromosome solves the problem at hand.

The GAs algorithm can be implemented as follows:

1. Start with a randomly generated population of n−bit chromosomes (candidate solutions to a problem).
2. Calculate the fitness $f(x)$ of each chromosome x in the population.
3. Repeat the following steps until n offspring have been created:

a. Select a pair of parent chromosomes from the current population, the probability of selection being an increasing function of fitness. Selection is done "with replacement". meaning that the same chromosome can be selected more than once to become a parent.

b. With probability pc (the "crossover probability" or "crossover rate"), cross over the pair at a randomly chosen point (chosen with uniform probability) to form two offspring. If no crossover takes place, form two offspring that are exact copies of their respective parents. (Note that here the crossover rate is defined to be the probability that two parents will cross over in a single point. There are also "multi−point crossover" versions of the GA in which the crossover rate for a pair of parents is the number of points at which a crossover takes place.) c. Mutate the two offspring at each locus with probability pm (the mutation probability or mutation rate), and place the resulting chromosomes in the new population. If n is odd, one new population member can be discarded at random.

4. Replace the current population with the new population.

The flow chart of genetic algorithm is shown below:

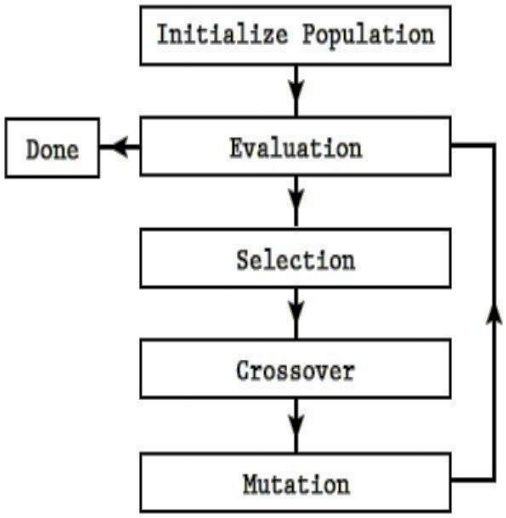

Fig4.1: Genetic Algorithm flow chart

B. PERTURB AND OBSERVE (P&O)

The perturbation and observation method has been widely used because its simple feedback structure and fewer measured parameters which are required. It operate by periodically perturbing (incrementing or decrementing) the array terminal voltage and comparing the PV output power with that of the previous perturbation cycle. If the power is increasing the perturbation will continue in the same direction in the next cycle, otherwise the perturbation direction will be reversed. The flowchart of this method is represented by figure.

The P&O method presents, in some cases, two drawbacks:

- By forcing the operating point to operate near the MPP, oscillations around the MPP appear in steady state as shown in figure . Such a drawback gives rise to the waste of some amount of available energy.
- It can confuse; it moves the operating point far from the MPP instead of close to it under rapidly changing atmospheric conditions.

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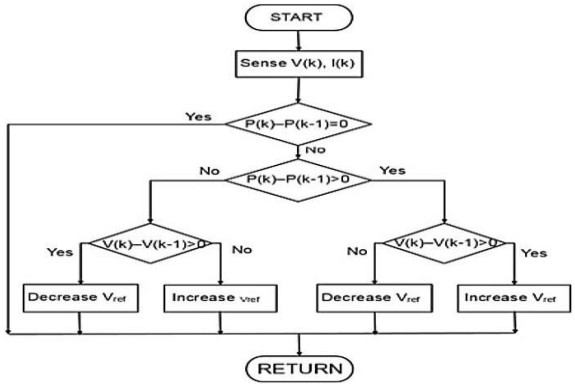

Fig4.2: Flow chart of perturb and observe MPPT algorithm

C. HILL CLIMING

Third method is the most well known and called as hill-climbing algorithm. Here, operating voltage is changed periodically in small steps, and the increase in module power or current is measured. So, increases or the standing start point of decreases is determined and accepted as the instantaneous operating point. If the power or current increases depending on the voltage rising of each step, tracking direction is forward, otherwise it is continued backwards. Maximum power point is determined with this way, and operating point makes an oscillation simply, the working regions is shown in fig. can be taken into account to write the method. If operating point of load is on the left of MPP, in other words if the module works as a current source,

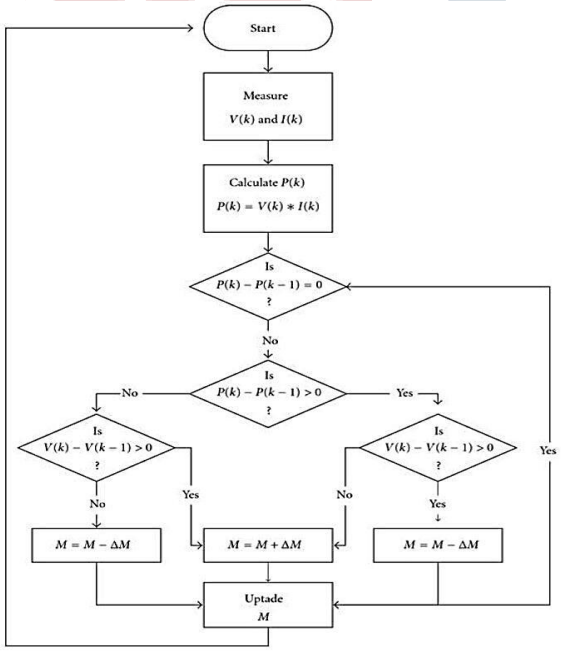

Fig4.3: Flowchart of Hill Climbing MPPT algorithm

D.FUZZY LOGIC

fuzzy logic(FL)is a method of reasoning that resembles human reasoning .the approach of FL imitates the way of decision making in human that involves all intermediate possibilities between digital values YES and NO. The conventional logic block that a computer can understand takes precise input and produce a definite output as TRUE or FALSE, which is equivalent to human's YES or NO.

Fuzzy logic is useful for commercial and practical purpose, it can control machines and consumer products .It may not give accurate reasoning, but acceptable reasoning. Fuzzy logic helps to deal with the uncertainty in engineering.

General diagram of fuzzy logic is shown below:

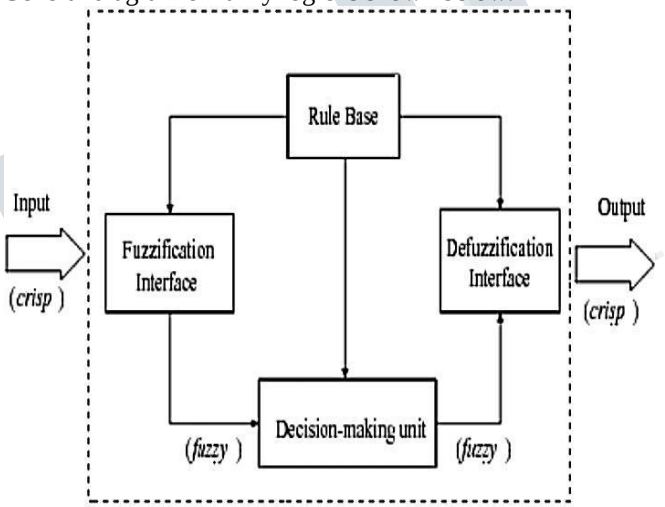

Fig4.4: General diagram of fuzzy logic.

1. Knowledge based: It stores IF-THEN rules provided by experts.
2. Inference engine-It simulates the human reasoning process by making fuzzy inference on the inputs and IF-THEN rules.
3. Defuzzification module: It transforms the fuzzy set obtain by the inference engine into a crisp value.

Advantages of FLS:

1. Mathematical concepts within fuzzy reasoning are very simple.
2. You can modify FLS by just adding or deleting rules due flexibility of fuzzy logic.
3. Fuzzy logic system can take imprecise, distorted, noisy input formation.
4. FLS are easy to construct and understand.

Disadvantages of FLS:

1. Their is no systematic approach to fuzzy system designing.
2. They are understandable only when simple.
3. They are suitable for the problems which do not need high accuracy.

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E.ARTIFICIAL NEURAL NETWORK

Artificial neural network based MPPT techniques. In this technique, a multilayered feedback neural network with back propogation trained network is used. Two stage offline trained artificial neural network base MPPT with two cascaded ANNs estimates temperature and irradiance level from the PV array voltage and current signal. This technique gives the better performance even under rapidly changing environmental conditions for both steady and transient instant with reducing the training set usually a three layer is adopted for implementing the MPPT.

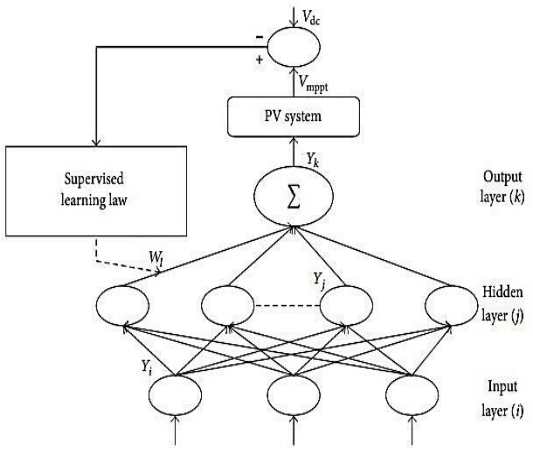

Fig4.5: Artificial Neural Network based MPPT

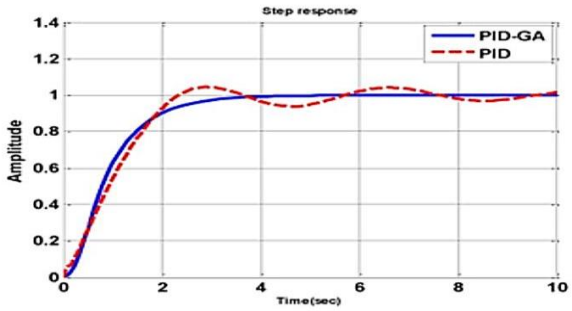

fig5.1

Response of the system fuzzy and P&O controller is shown in fig5.2

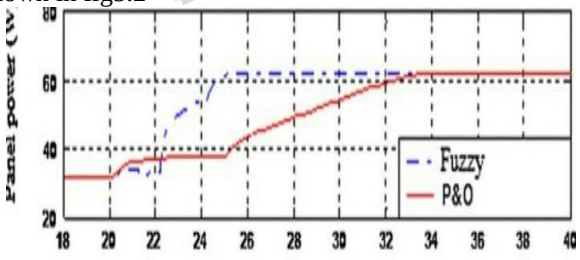

Fig5.2: Response of the system fuzzy and P&O controller.

V. RESPONSE OF THE SYSTEM

The response of the system with GA based PID controller is shown in fig5.1.and it looks stable compared with standard approach. The GA designed PID is much better in terms of rise time and the settling time than the standard methods

VI .CONCLUSION

The PV array output power delivered to the load can be maximised using MPPT control method .in this paper, we compared various artificial intelligence technique from that perturb and observe (P & O) method is prominently used because of its simplicity and ease of implementation, though it gives slow response of speed and oscillations in steady

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