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Various MPPT Techniques for Solar PV System

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Abstract – *Nowadays to satisfy the rise in power demands and to cut back the global warming, renewable energy sources based systems are employed. Out of the varied renewable energy sources, solar energy is that the main various. But, compared to alternative sources, the solar array system converts solely 30–40% of irradiation into electrical energy. So as to induce more output from a PV panel system, an in depth analysis has been afoot for while thus on access the performance of PV system and to research the varied problems associated with the employment of solar PV system effectively. This paper so presents differing types of maximum power point tracking control algorithms that track the maximum power exploitation completely from different algorithms techniques*

Key Words: PV System, MPPT, P&O, INC.

1. INTRODUCTION

Electricity demand is growing with highest rate of all the Energy consumed world-wide. therefore the humanity is facing a colossal challenge of never ending increase in energy demand as a results of overall sociol economic process. The declining fuel resources and tremendous rate of its consumption to battle the prevailing historic period diverges us on the height of consumption of fuel. Incompatibility of standard sources to fulfil this bottom less vale of energy necessities, energy security, and particularly the sky-rocketing hike of fossil fuels costs offers a piece force direction to create compatible possibility. Despite of those unmotivated considerations, the global warming as associate degree ineluctable outcome of carbon emissions by the standard energy sources proves to be a significant driver for renewable energy sources readying. Present accessibility of renewable energies like solar and wind offers a placing answer to follow of these necessities. Continuous efforts of researchers have shown associate degree increased potency in each the conversion and transport of these energy sources..

The electrical phenomenon (PV) power system installation is changing into more and more necessary because the most out there renewable energy supply, since it's clean with very little maintenance and with none noise. Even thought, PV systems have issues, like the conversion with low radiation (in general but 17%), as well as nonlinear characteristic that depends on irradiation and temperature in its operation that amendment the number of electrical power generated. Because of this, potency of PV system get diminished.

The potency of the PV system may be accrued by using power electronic devices together with maximum power point controller. The extraction of most accessible power from a electrical phenomenon module is finished by maximum power point tracking Controller. The potency of the electrical phenomenon system could also be well accrued by using (MPPT). Many algorithms developed to track the utmost maximum power point effectively. Most of the prevailing MPPT algorithms suffer from the disadvantage of being slow tracking. Because of this, the employment potency is reduced. The varied ways of maximum power point technique algorithms like Incremental Conductance (INC) and Perturbation and Observation (P&O) and plenty of a lot of are mentioned during this paper. [6]

2. Photovoltaic System

A photovoltaic (PV) system is solid state semiconductor devices which generates electricity when it is exposed to the light. The building blocks of a solar panel is solar cell. A photovoltaic module is formed by connecting many solar cells in series and parallel. To get maximum output voltage, PV modules are connected in series and for obtaining maximum output current they are connected in parallel.

Solar PV power systems are commercial in several countries because of their deserves like future advantages, maintenance-free and surroundings friendly. The most important challenge that lies in using the PV power generation systems is to tackle the nonlinear characteristics of PV array. The PV characteristics rely on the amount of irradiance and temperature. PV array experiences totally different irradiance levels because of passing clouds, neighbour buildings, or trees. Photovoltic (PV) systems, that convert solar irradiation into electricity, may be used for a good vary of applications, from tiny systems powering masses like sensors or domestic lighting through to giant systems feeding wattage directly into the electricity grid. PV System classified into 2 classes that's a Stand alone [10] PV System and a Grid Connected PV System. [11]

3. Maximum power point tracking (MPPT)

Maximum power point tracking (MPPT) is crucial in photovoltaic (PV) systems that has drawn important endeavor within the past. The operation is to regulate the power interfaces so the operative characteristics of the consumption and also the PV generator match at the perfect level in term of generation [1]. Maximum power point tracking control technique is employed chiefly to extract

most capable power of the PV modules with various solar irradiance and temperature at explicit instant of time by MPPT Controller. Variety of algorithms are developed to track the utmost power point expeditiously. Most of the prevailing MPPT algorithms suffer from the disadvantage of being slow tracking, because of that the employment potency is reduced. There are many kinds of MPPT controller techniques to enhance the solar power potency like Incremental Conductance (INC), Perturbation and Observation (P&O), Artificial Neural Network (ANN) , Fuzzy logic controller. [2].

3.1 Perturb & Observe (P&O)

Perturb and observe algorithmic program is straightforward and doesn't need previous data of the PV generator characteristics or the mensuration of solar intensity and cell temperature and is straightforward to implement with analogue and digital circuits. It perturbs the in operation purpose of the system inflicting the PV array terminal voltage to fluctuate around the MPP voltage even if the solar irradiance and therefore the cell temperature square measure constants. It's been extensively used because of simple implementation as explained within the flow chart in given below Fig. 1 [3]. This is often a nonstop method of observation and perturbation until the operation purpose converges at the MPP. The algorithmic program compares the power and voltages of your time (K) with the sample at a time (K-1) and predicts the time to approach to MPP. A tiny low voltage perturbation changes the ability of the solar panel if the ability alteration is positive, voltage perturbation is sustained within the same track. However if delta power is negative, it indicates that the MPP is much away and therefore the perturbation is remittent to succeed in the MPP. Thus, during this method the total PV curve is checked by little perturbations to seek out the MPP that will increase the latency of the algorithmic program. Conversely, if the perturbation size is enlarged, it generates steady state oscillations concerning the MPP. Several researchers have projected modifications within the P&O algorithmic program to beat the latency drawback and steady state oscillations.[5]

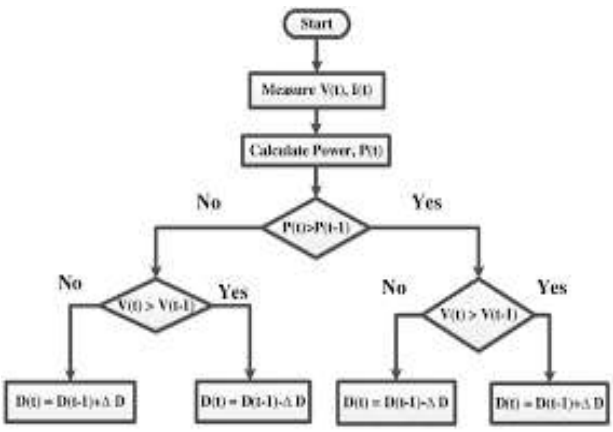

Fig - 1 . Flow chart of Perturb and observe algorithm. [3]

3.2 Incremental Conductance(INC)

The main advantage of the INC algorithmic is that it's ready to track the MPP underneath varied physical conditions, that is that the major downside of perturb and observe algorithmic. If the PV array electrical impedance matches with the effective electrical impedance of the convertor mirrored across the array terminals, then the MPP is tracked . Fig. 2 shows the power–voltage (P-V) curve of the PV array. The slope of the curve is zero at MPP, i.e. dP/dV = 0 as shown in Fig. 2. If the change in IC is greater than the Negative of instantaneous conductance, then this represents the condition of left aspect of the MPP and once the change in IC is less than the negative of instantaneous conductance, then this represents the condition of right aspect of the MPP.

Mathematically, the equations to understand concerning the MPP are reached may be written as: [4]

At MPP, dI/dV = -I/V

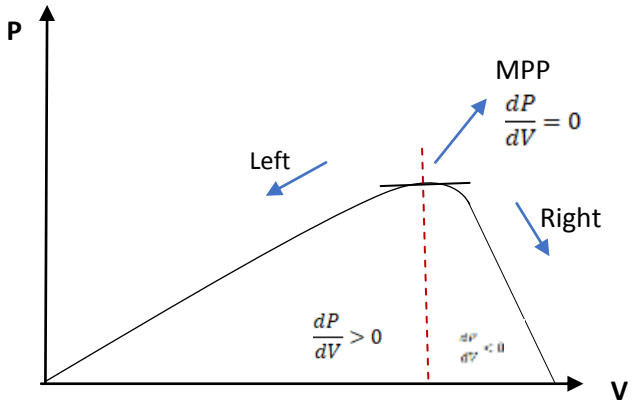

Fig - 2. Graph showing power versus voltage for PV array.

If the operating point is on to the left of MPP, then

dI/dV > -I/V

If the operating point is on the right of the MPP, then

dI/dV < -I/V

The flow chart of the IC algorithm has been shown in Fig 3.

The IC algorithmic further stops perturbing the operation point if the MPPT has reached the MPP. In any case, if the condition isn't consummated, the relation between dP/dV and –I/V tells the direction of the MPPT operating point perturbed.[8]

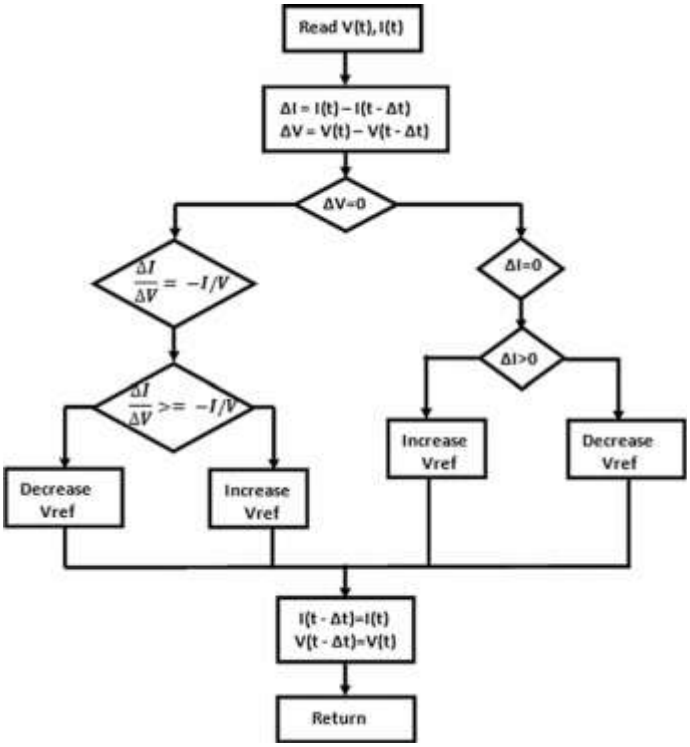

Fig - 3. Flow chart of incremental conductance algorithm.[4]

3.3 Artificial Neural Network (ANN)

The construct of ANN is impressed by the operating of human brains. The functioning of ANN revolves round the process components referred to as neurons interconnected by links and having some adjustable weights appointed to them. The ANN is trained with a group of information and has the flexibility of comprehension. The most important advantage of ANN is its self-learning and self-organized nature. By self-organized it's meant that ANN represents the data that it receives throughout learning time. ANN is employed within the applications that need pattern recognition or data classification. Any artificial neural network primarily consists of 3 layers, i.e. input Layer, hidden layer and output layer that shows within the Fig. [4]. The input layer receives the information or data from some file or directly from the sensors in case of real time application. This information is processed supported the load related to a link between input layer and hidden layer. Similarly, weight is additionally appointed between hidden and therefore the output layer. These weights square measure adjustable and have an effect on the output. Relying upon the quantity of hidden layers used, the structure is known as single layer or multilayer. [9]

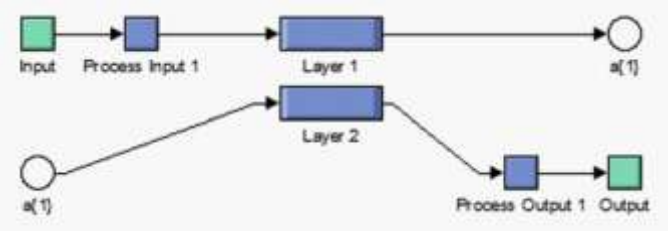

Fig - 4. Multilayer Feed forward network. [4]

3.3 FUZZY LOGIC CONTROLLER

Fuzzy Logic has been used for tracking the Maximum Power Point (MPP) of PV module because it has the advantages of being robust, relatively simple to design and does not require the knowledge of PV exact model. Fuzzy logic control generally consists of three basic components: fuzzification module, fuzzy inference engine, and defuzzification module.

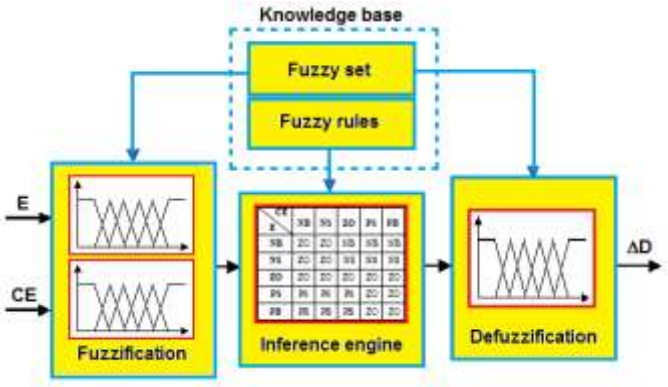

Fig - 5. Structure of fuzzy logic controller. [12]

3.3.1 Fuzzification

During fuzzification, numerical input variables are converted into linguistic variable based on a membership operate. For this MPPT, the particular voltage and current of PV module measured incessantly and also the power are often calculated as P=VxI. The management is set supported satisfaction of two projected input management variable, particularly the error E (which represents the slope of P-V characteristic) and change of error CE at the instant sampling k. The variable E and CE are expressed as follows: [7]

$$E(k) = \frac{P(k)-P(k-1)}{V(k)-V(k-1)}$$

$$CE(k) = E(k) - E(k-1)$$

where P(k) is the power and V(k) is voltage of PV module

3.3.2 Inference Engine

The inference engine applies a rule to the fuzzy input to determine the fuzzy output. Therefore, before the rule can be evaluated, the real input value must be fuzzified to obtain an appropriate linguistic value.

3.3.3 Defuzzification

Since the DC-DC converter require a precise control signal D at its entry, it is necessary to transform the output of fuzzy controller from fuzzy information into deterministic information. This transformation is called defuzzification. In the defuzzification stage, the fuzzy logic controller output is converted from a linguistic variable to a numerical variable. [4]

4. CONCLUSION

Several MPPT techniques taken from the literature are discussed and analyzed herein, with their respective algorithms.. The concluding discussion is that as per demand there are several useful guide in choosing the right MPPT method for specific PV systems.

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