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ARTICLE

MAXIMUM POWER POINT TRACKING- EFFICIENCY AND ITS FUTURE SCOPE

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ABSTRACT

As the fossil fuels are depleting it is desirable to use the renewable energy source. There are different sources of energy available like Sun, Wind, Fuel, but the solar energy is available in abundance. It is desirable to use this energy. This solar radiations change with the course of time in a day. So to maximize the solar output the point of maximum energy has to be calculated. There are different methods for this which is known as MPPT (Maximum Power Point Tracking). The advantages and implications of the Maximum power point technique is compared. The DC-DC converters are used to boost the voltage level obtained from the photovoltaic source. The switching devices of the converters are energized in way to track the maximum power point. The MPPT algorithms are applied to obtain the required switching. The association between the MPPT solar charge controllers ad pulse width modulation solar charge controller is discussed in the paper.

KEY WORDS
MPPT, PWM, P&O method, Incremental conductance technique

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INTRODUCTION

Increasing demand of Electricity in today's world, efficiency of Electricity enhancement and for making eco-friendly environment, necessitates the production of electricity in a very effective manner. MPPT is one of the smart ways of electricity generating with high efficiency. As, MPPT is already associated with the solar power & this technique has the ability to use directly for several purposes such as heating and lighting the facilities, producing electricity, for temperature treatment (heating or cooling), and various other uses related to manufacturing, engineering or money-making [1].

Advantages of Solar Power:

- This energy source is renewable/ regenerative.
- This source has high impact on the reduction of the Electricity bills.
- The maintenance cost of this source is low.

Nowadays, the electricity is mainly generated by non-renewable energy resources such as coal, petroleum, nuclear energy etc. which is limited and also harms the environment badly. Therefore, researchers from all over the world are now working to find out an alternative way to produce the electricity from unlimited resources. Solar electricity is one of them. Unfortunately, the reliability of solar electricity in terms of its efficiency and consistency is not appropriate [2]. To resolve these issues, some innovative techniques are required. MPPT is one of them new techniques, which can be playing an important role for efficient generation of electricity in eco-friendly environment. Solar power is an important resource for generating electricity, because it is cheap and saves environment as well. MPPT is a charge controller, which directs to extract the maximum power from the PV system. Earlier using MPPT is difficult because it can damage the battery due to its fast charging or discharging process. This charge controller enables the facility of generating energy with high efficiency and charges the battery in efficient way. MPPT is designed in such a way that it can extract maximum power from PV panels in a smarter way in order to enhance its reliability, efficiency, reducing cost, and to meet the needs of the future demands of consumers.

MAXIMUM POWER POINT TRACKING (MPPT)

MPPT is a type of charge controllers which extract maximum power from PV system, boosting up the current, by which one can get the maximum power. Generally, it converts high voltage DC from PV panels into low voltage needed for charging the batter in efficiently way as shown in [Fig. 1]. As the recent technologies are much better and efficient as compared to the old ones, therefore, the up gradation plays an important role for producing more energy in low cost. But few challenges are faced in MPPT.

Here are the few challenges where MPPT works:

- Cold weather- At the time of cold temperatures, the timing of sun hour is low, then it needs power for charging the batteries. MPPT works better at low temperatures, but without the use of MPPT we cannot extract maximum power [2].

- Basic working of MPPT- In MPPT technique, at first the ability of the PV module for producing output power is determined then this power is compared with the available voltage if the battery. After the comparison, the amount of power (extract from the PV panel and go to the battery for charging) is fixed in order to provide the optimum voltage for getting maximum current into the

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battery. It can also work as on-grid system, i.e. supply power directly to the DC load bypassing the connection with the battery according to the requirements.

- Low Battery Charge- Sometimes, the battery power is too low and it requires more power to charge. In this condition, the MPPT puts more current into them in order to charge such batteries.

- Long wire runs- If panels are 200 feet away, the voltage drop and losses are more. Although using large wires are expensive. In MPPT, a DC to DC converter is used, which determine the optimum point where the solar array (PV panels), and the battery bank or utility grid are matched in order to reduce the losses.

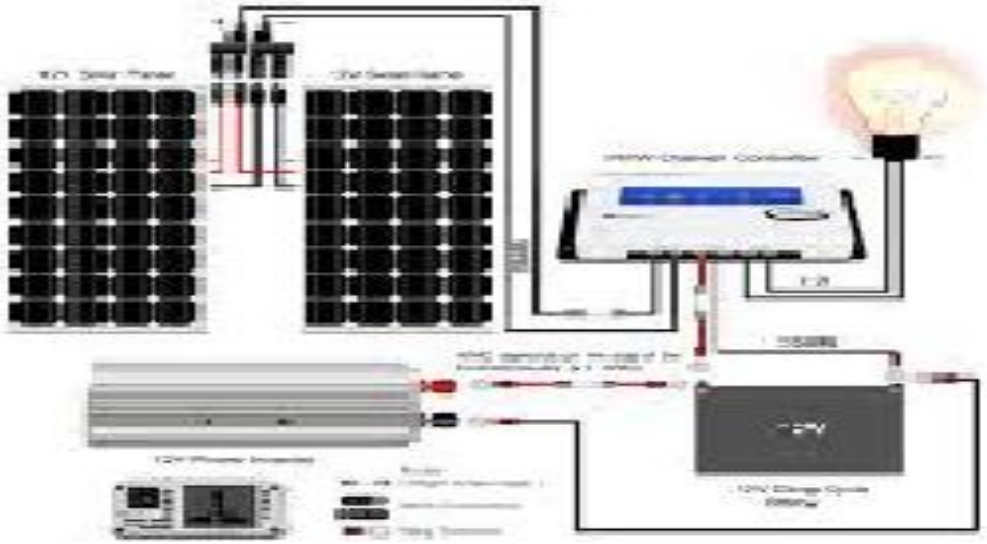

Fig. 1: Set-up for MPPT. [3]

But PV system should be keep at much angle so that it can achieve good sunlight. PV system should be keep at longitudinal degree of that area where the PV system is set-up.

Block diagram of MPPT

The mechanism based on maximum power tracking uses the algorithm and in surplus makes use of the electronic circuitry. The mentioned mechanism works on the principle of impedance matching between load and PV module, which is mandatory for the maximum power transfer as shown in [Fig. 2]. In general scenario, the MPPT termed as an adaptation of direct current (DC) to direct current switching voltage regulator. The impedance matching is executed by varying the duty cycle of the switch.

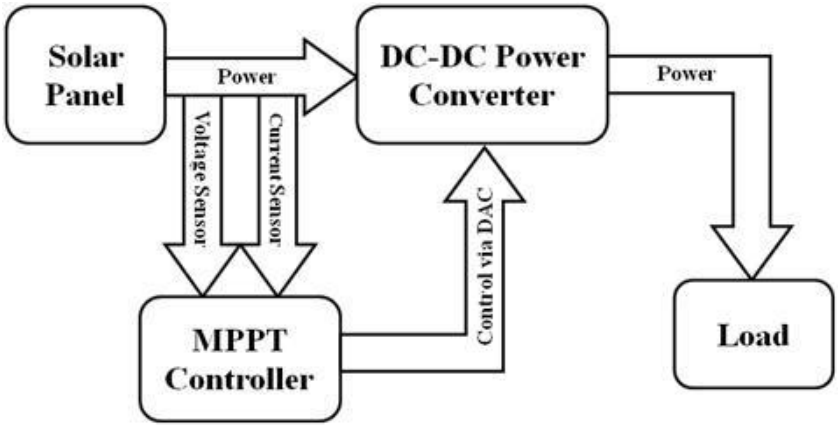

Fig. 2: Block diagram of MPPT [4]

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ADVANTAGES OF MPPT

MPPT have several advantages over the traditional techniques. the comparative study in between MPPT enabled sources and traditional sources in terms of efficiency, cost, power etc. is depicted in [Table 1].

Table 1: Comparative study between MPPT and traditional sources [5]

S. No.	Related terms	Traditional	MPPT
1.	Transmission of electricity	It needs long wire to transmit the power	It does not require long wire.
2.	Efficiency	Less	More than 95%
3.	Cost of energy	High cost	Less cost
4.	Planning time	Planning time is large	Less planning time
5.	Area required	Large	Less
6	Eco-friendly	It is not eco-friendly as it radiates radiations, pollutions etc.	Eco-friendly
7.	Back up	It doesn't provide backup	Provides backup
8.	Quick supply	Since they are installed far away, so doesn't have quick power supply	Not far, so quick supply
9.	Electricity at remote areas	It doesn't provide electricity at remote areas.	It provides electricity everywhere
10.	Reliability	Less reliable	Reliability is high

MPPT V/S PWM

The other technique named as Pulse Width Modulation (PWM) is mainly known for its ability to attain constant voltage throughout the entire session of battery charging by controlling and switching the solar system power devices. When the entire system is following the PWM regulation mode, at first the condition of the battery and its recharging requirements are observed and then according to this the current from the solar array tapers.The comparison is shown in [Table 2].

Table 2: Comparison between MPPT and PWM

S.No.	MPPT solar charge controller	PWM solar charge controller
1	Having ability to extract maximum amount of power from solar panel for charging purpose	Using whatever the power producing from solar panels for charging battery
2	Highly efficient (up to 96%)	Efficiency is low as compared to MPPT technique (up to 70%)

CHARACTERIATICS OF TECHNIQUES OF MPPT

As there are many types of MPPT techniques are available, but three major MPPT techniques are discussed here:-

- P&O method- In perturb and observe (P&O) technique; the photovoltaic output voltage is continuously varying from the minimum to maximum level in order to track the maximum power point (MPP). This is very simple technique and easy to implement. Although, it can't be able to track/retain the MPP, if the variation in irradiance is rapidly fast with time.
- Incremental conductance- This is very interesting property of PV, which is used to optimize the operating current in order to get the output power at maximum level.
- Parasitic Capacitance- As general the parasitic capacitance is defined as the unwanted capacitance present between the various electronic components. It is an unavoidable effect but can be used in MPPT for charge storage purpose.

The [Table 3] represented the comparative analysis between the various characteristics of techniques of MPPT and concluded that the dominance of Parasitic Capacitance technique among the others in terms of output power achieved. Although, it has also getting the maximum ripple amplitude and time responses.

APPLICATIONS

Different users having dissimilar requirement of power. Like Hospitals need premium power because regular use of different types of equipment. Industrial Plants need more electricity because the long

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production hour, and hence seek MPPT applications that give free energy from solar with good efficiency. Indian Railways require more electricity, steady, uninterrupted premium power because running of trains 24 hours. Therefore MPPT plays an important role to achieve these goals with low cost and good efficiency.

Some implementation of solar power and MPPT in different areas and fields are:

1. Electric Rickshaw from Sukam runs by the solar power. Ordinary battery rickshaw uses electricity from conventional form to charge the battery (takes 2-3 hours), but Solar rickshaw runs by the Sun. It gives 20km more average than an ordinary rickshaw [7]. Using MPPT technique, at first the MPPT Controllers converts the achieved voltage into regular voltage of need, and then the remaining excess/extra amount of voltage in converted into Amp. Due to this, the level of charged voltage in the battery is kept at an optimal point, which helps to reduce the required time for charging.

2. Envision Solar, California, has been awarded contract in California to provide portable EV (electric Vehicle) chargers. They made the PV panels in upper side of parking area where the Vehicles can be charged and provides 150miles of range in a day. [8] MPPT used in electric vehicles for fast charging as compared to others.

Table 3: Comparison between various characteristics of techniques of MPPT [6]

Related terms	P & O Method	Incremental Conductance	Parasitic Capacitance
Benefits	Very simple and easy to implement.	Power of the entire system can be controlled by varying voltage value	This system is able to store the charge with in solar cell itself by adding the capacitance with the lighted diode equation.
Drawbacks	It fails under rapidly changing environment condition.	Time response, average power is low.	No such drawbacks.
Time response	1.758	0.55792	2.558
Average power	279.7	280.7	283.7
Ripple Amplitude	88.23	88.73	89.17

FUTURE VISION

It is well known that various types of methods is used for generating the electricity like Thermal Power plants (Nuclear, Coal, petroleum etc.), Hydro (water) power plants, but it is non-renewable resources and also harmful for humans as well as environment. [9]

As many types of other charge controllers like PWM etc. also available, but due to low efficiency it cannot be used completely by the consumers. Hence there is need to develop more other cheap and effective MPPT algorithms [10], so that almost 100% efficiency can be achieved.
Here are the some that can be future research papers:

1. MPPT operating APP: An application of operating MPPT by the help of smartphones can so be made operate from whenever via the Internet.
2. DC-DC running loads: DC from MPPT can be taken directly and DC load can be run. DC loads helps to consume low electricity. [1]
3. Energy Management: There is need to manage energy when these algorithm are developed. [11]

CONCLUSION

By seeing the world population and demand of electricity, it is necessary to use solar power and extract more power from it, MPPT is one of the technique to done efficiently. As it is discussed that parasitic capacitance technique is good from both P&O and Increment conduction method by power output. So as the population is increasing, there is need to use the renewable energy source. Therefore, solar energy is gaining the popularity. To extract maximum power, it is desirable to use MPPT algorithm, therefore to develop different types of algorithms of MPPT, so that maximum power can be extracted from solar energy with good efficiency. Comparative analysis on the basis of the advantages & disadvantages, voltage ripple,average power obtained, time response is done. The case study of the applying the MMT techniques on the Electric Rickshaw has been depicted in this paper

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CONFLICT OF INTEREST

There is no conflict of interest.

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FINANCIAL DISCLOSURE

None.

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