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# Literature Review on Maximum Powerc Tracking System

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***Abstract:*** *The need for renewable energy sources is on the rise because of the acute energy crisis in the world today. India plans to produce 20 Giga watts Solar power by the year 2020, whereas we have only realized less than half a Giga watt of our potential as of March 2010. Solar energy is a vital untapped resource in a tropical country like ours. The main hindrance for the penetration and reach of solar PV systems is their low efficiency and high capital cost. In this thesis, we examine a schematic to extract maximum obtainable solar power from a PV module and use the energy for a DC application. This project investigates in detail the concept of Maximum Power Point Tracking (MPPT) which significantly increases the efficiency of the solar photovoltaic system.*

***Keywords****— Maximum power point tracking (MPPT), photovoltaic (PV) system. boost converter*

## I INTRODUCTION

Maximum Power Point Tracking (MPPT) is widely used control to regulate the output power using buck-boost converter technique to extract maximum power available from the photovoltaic (PV) module. Since the solar cells have non-linear I-V characteristics, the energy conversion efficiency of PV module is very low and at particular instant power output depends on solar isolation level and ambient temperature, the maximization of power output with greater efficiency is of special interest. Moreover there is a substantial amount of power loss due to mismatch of source and load. So, to extract maximum power from solar panel a MPPT is needed to be designed. The objective of the paper is to present a novel constant voltage based perturb and observe algorithm for fast and efficient MPPT detection of a photovoltaic panel at any kinds of rapidly changing environmental conditions. The proposed controller scheme utilizes PWM techniques to reduce cable conductor size as well as the transmission losses and simultaneously controls the charging process of battery. For the feasibility study, parameter extraction, model evaluation and analysis of converter system design, a MATLAB/Simulink model developed and simulated for a typical 60W solar panel. Finally, the proposed MPPT technique is compared with the conventional techniques at different solar isolation level. The resulting system has high-efficiency, very fast tracking speed and can be easily modified for introducing additional control function for further development there are an assortment of renewable Resources which are used for electric power generation, such as solar energy, wind energy, geothermal etc. Solar Energy is a good preference for electric power generation, while the solar energy is openly converted into electrical energy by solar photovoltaic modules. These Modules are completed up of silicon cells. When many such cells are connected in series we get a solar PV module. The current rating of the modules increases when the area of the personality cells is increased, and vice versa. When many PV modules are connected in series and parallel combinations we obtain a solar PV array, which is appropriate For obtaining advanced power output. The Applications of solar energy are increasing and many researches are done to improve the equipment and methods used to harness this power source. Main factors that affect the efficiency of the collection process are solar cell competence intensity of source radiation and storage techniques. The efficiency of a solar cell is limited by materials used in solar cell manufacturing. It is particularly difficult to make considerable improvements in the performance of the cell, and hence restricts the efficiency of the overall collection process.

## II SOLAR CELL

Operating principle Solar cells are the basic components of photovoltaic panels. Most are made from silicon even though other materials are also used. Solar cells take advantage of the photoelectric effect the ability of some semiconductors to convert electromagnetic radiation directly into electrical current. The charged particles generated by the incident radiation are separated conveniently to create an electrical current by an appropriate design of the structure of the solar cell, as will be explained in brief below. For further details, the reader can consult references [4] and [1]. A solar cell is basically a p-n junction which is made from two different layers of silicon doped with a small quantity of impurity atoms: in the case of the n-layer, atoms with one more valence electron, called donors, and in the case of the p-layer, with one less valence electron, known as acceptors. When the two layers are joined together, near the Interface the free electrons of the n-layer are diffused in the p-side, leaving behind an area positively charged by the donors. Similarly, the free holes in the p-layer are diffused in the n-side, leaving behind a region negatively charged by the acceptors. This creates an electrical field between the two sides that is a pass through the cell without potential barrier to further flow. The equilibrium is reached in the junction when the electrons and holes cannot surpass that potential barrier and consequently they cannot move. This electric field pulls the electrons and holes in opposite directions so the current can flow in one way only: electrons can move from the p-side to the n-side and the holes in the opposite direction. A diagram of the p-n junction showing the effect of the mentioned electric field is illustrated in Figure 1 Metallic contacts are added at both sides to collect the electrons and holes so the current can flow. In the case of the n-layer, which is facing the solar irradiance, the contacts are several metallic strips, as they must allow the light to pass to the solar cell, called fingers. The structure of the solar cell has been described so far and the operating principle is next. The photons of the solar radiation shine on the cell. Three different cases can happen: some of the photons are reflected from the top surface of the cell and metal fingers. Those that are not reflected penetrate in the substrate. Some of them, usually the ones with less energy, causing any effect . Only those with energy level above the band gap of the silicon can create an electron-hole pair

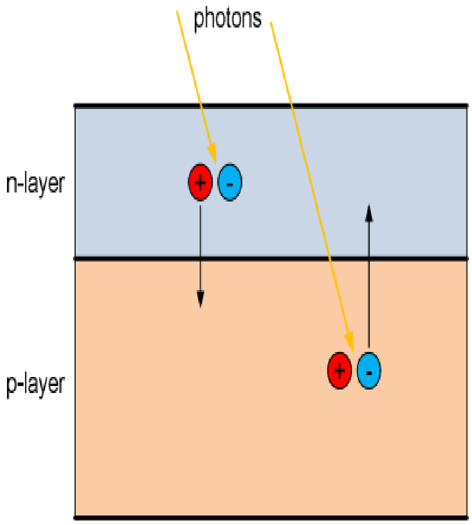


Figure 1 solar cell

. These pairs are generated at both sides of the p-n junction. The minority charges (electrons in the p-side, holes in the n-side) are diffused to the junction and swept away in opposite directions (electrons towards the n-side, holes towards the p-side) by the electric field, generating a current in the cell, which is collected by the metal contacts at both sides. This can be seen in the figure above, Figure 1. This is the light-generated current which depends directly on the irradiation: if it is higher, then it contains more photons with enough energy to create more electron-hole pairs and consequently more current is generated by the solar cell. Attainable method of improving the performance of solar power there are two major approaches for maximizing power extraction in solar systems. They are sun tracking, maximum power point (MPP) tracking or both. Later on in this thesis, two MPP tracking techniques are studied and compared. The first technique is based on artificial neural networks and the second one is based on the P&O method. Also a complete grid connected scheme is proposed along with a DC-AC inverter control technique based on hysteresis current control.

## III LITERATURE REVIEW

The MPPT system can be classified based on the algorithms used power converter in the system and application of the system

**Classification based on algorithms many methods to track Maximum Power Point (MPP) for PV arrays** have been discussed by Trishan Esram et al [1]. It comprises of all the techniques implied in this field. It was shown that at least 19 distinct methods have been already introduced. A high-frequency photovoltaic pulse charger (PV-PC) for lead-acid battery (LAB) guided by a power-increment-aided incremental-conductance maximum power point tracking (PIINCMPPT) was proposed by **Hung-I Hsieh et al** The PV-PC implemented by a boost current converter (BCC) is to eliminate sulphating crystallization on the electrode plates of the LAB and to prolong the battery life. The BCC associated with the PV module is modelled to maximize the energy charging to battery under maximum power transfer. A duty-control guided by the PI-INC MPPT is designed to drive the BCC operating at MPP against the random insulation. A design example of a PV-PC system for a four-in-series LAB battery (48 VDC) was examined. The charging behaviour of the PVPC system in comparison with that of CC-CV charger was studied. Four scenarios of solar insulation changes to describe tracking behaviour of PI-INC MPPT in PV-BC system were investigated, which is also compared with that of INC MPPT. **K.H. Hussein et al** have developed a new Maximum Power Tracking (MPT) algorithm to track Maximum Power Operating Point (MPOP) by comparing the incremental and instantaneous conductance of the PV array. The drawbacks of Perturb and Observe method were analyzed and it showed that the Incremental Conductance algorithm has successfully tracked the MPOP even when atmospheric conditions changes rapidly. The work was carried out by both simulation and graphs. A new method for MPPT named CVT (Constant Voltage Tracking) is proposed by **Zheng Shicheng et al** with the analysis of characteristic curve and operation theory of PV array [4]. A lower power photovoltaic (PV) system with simple structure has been designed. This method has been verified by PV charging system and it showed that MPP of PV array can be tracked well by applying the charger controller. An adjustable Self-Organizing Fuzzy Logic Controller (SOFLC) for a Solar powered Traffic Light Equipment (SPTLE) with an integrated MPPT system on a low-cost microcontroller has been presented by **Noppadol Khaehintung et al [5].** It comprises of boost converter for high performance SPTLE. Variation of duty ratio for DC-DC boost converter is implemented on PIC16F876A RISC-microcontroller. A fuzzy based perturb and observe (P&O) MPPT in solar panel was presented by **C. S. Chin** et al [6]. The solar system is modeled and analyzed in MATLAB/SIMULINK. Simulation results showed that fuzzy based (P&O) MPPT has better performance and more power is produced from solar panel. Panom Petchjatuporn et al introduced a maximum power point tracking algorithm using an artificial neural network for a solar power system [7]. By applying a three.**S. Yuvarajan et al** proposed a fast and accurate maximum power point tracking (MPPT) algorithm for a photovoltaic (PV) panel that uses the open circuit voltage and the short circuit current of the PV panel [8]. The mathematical equations describing the nonlinear V-I characteristics of the PV panel were used in developing the algorithm. The MPPT algorithm is valid under different insulation, temperature, and level of degradation. The algorithm is verified using MATLAB and it is found that the results obtained using the algorithm were very close to the theoretical values over a wide range of temperature and illumination levels. The maximum deviation in the maximum power was less than 1.5% for the illumination levels and temperatures normally encountered by a commercial PV panel. The complete derivation of this MPPT algorithm was presented. It is seen that the algorithm is faster than other MPPT algorithms like perturbation and observation (P&O) and more accurate than approximate methods that use the linearity between voltage (current) at maximum power point and open-circuit voltage (short-circuit current). **Prof. Dr. IlhamiColak, et al.** have modeled three separate solar farms that provide 15 kW power for each farm using Mat lab Simulink real-time analysis software [9]. Energy conversion was performed with maximum power point tracking (MPPT) algorithms in each converter using Perturb and Observe (P&O) structure. These were collected in DC bus bar with parallel connection of converters over inter-phase transformers (IPT). The voltage was applied to a full bridge inverter to generate 3- phase AC voltages at the output of inverter which was controlled with sinusoidal pulse width modulation (SPWM) scheme. **S. G. Tesfahunegn et al**. designed a new solar/battery charge controller that combines both MPPT and over-voltage controls as single control function [10]. A small-signal model of lead acid battery was derived in detail to design the employed dual-loop control configuration. Case studies were then conducted, in SIMULINK/SIMPOWER, to evaluate the performance of the designed controller in terms of transient response and voltage overshoot. The designed controller was demonstrated to have good transient response with only small voltage overshoot**Yuncong Jiang et.al.** Present an analogue Maximum Power Point Tracking (MPPT) controller for a Photovoltaic (PV) solar system that utilizes the load current to achieve maximum output power from the solar panel [10]. Comparing to the existing MPPT controller circuitry which requires multiplication of the sensed PV panel voltage and current to yield panel power, the cost and size of the proposed circuit.

## IV CLASSIFICATION BASED ON APPLICATION

The control strategies in photovoltaic charge control including Maximum Power Point Trackers were presented by V. Salas et al [3]. It has been integrated on a Photovoltaic stand-alone system and has been simulated. Roger Gules et al presented the analysis, design, and implementation of a parallel connected maximum power point tracking (MPPT) system for stand-alone photovoltaic power generation [3]. The parallel connection of the MPPT system reduces the negative influence of power converter losses in the overall efficiency because only a part of the generated power was processed by the MPPT system. Furthermore, all control algorithms used in the classical series-connected MPPT can be applied to the parallel system. A simple bidirectional dc–dc power converter was proposed for the MPPT implementation and presents the functions of battery charger and step-up converter. The operation characteristics of the proposed circuit were analysed with the implementation of a prototype in a practical

## V CLASSIFICATION BASED ON CONVERTER

**Eftichios Koutroulis et al** introduced a new MPPT system that uses Buck-type DC/DC converter which is controlled by a microcontroller [9]. In this method the output power of PV array is directly used to control the DC/DC converter. This method has high efficiency, lower cost and can be easily modified to handle more energy sources. A new MPPT system has been developed by EftichiosKoutroulis et al consisting of a Buck-type dc/dc converter, which was controlled by a microcontrollerbased unit. The main difference between the method used in the proposed MPPT system and other techniques used in the past was that the PV array output power was used to directly control the dc/dc converter, thus reducing the complexity of the system. The resulting system has high-efficiency, lower-cost and can be easily modified to handle more energy sources (e.g., wind-generators). The experimental results show that the use of the proposed MPPT control increases the PV output power by as much as 15% compared to the case where the dc/dc converter duty cycle was set such that the PV array produces the maximum power at 1 kW/m2 and 25 C. A system with an alternative source of energy supply from photovoltaic energy system which operates in case of utility power failure has been discussed by **C.Thulasiyammal** [1]. The proposed PV system is composed of conventional novel single axis tracking system and PV system with DC-DC boost converter and PWM voltage source inverter. The PV panel voltage is taken as input parameter to maximize the output power PWM techniques to regulate the output power of boost converter at its maximum possible value and simultaneously control the charging process of battery was proposed by **D.V.N. Ananth [2].** Analysis of boost converter was demonstrated using MATLAB/Simulink model. Chamnan Ratsame presented an intelligent control method for the maximum power point tracking(MPPT) of a photovoltaic powered water pump system for long tailed boat in Thailand by using DC-DC boost converter as switching charger. This system consisted of a solar array, a switching battery charger based on boost DC-DC converter, a battery and small water pump [3]. The solar array had a specification as 75 watts of output power, 14-18 volts of output DC voltage, and 3A of output DC current. The output power of solar array was the input power for boost DC-DC converters the switching charger. To control the boost converter, the pulse width modulation (PWM) was applied. The water pump was controlled by a microcontroller PIC 186627. When the water amount reaches the specified level, a sensor will send the signal to the microcontroller for controlling a relay to drive a motor in the water pump. To verify the proposed pump system, the prototype of water pump for small boat was built to experiment. From the results, to stabilize the output voltage of the boost DCDC charger at 25.6 volts, the duty ratio was controlled at 35-50% with 100 kHz of switching frequency. The battery having rated voltage as 24 volts and rated current as 7 amps per hour was used in the system.

**VI PARALLELED MULTIPLE-INPUT SOURCES WITH BOOST CONVERTERS.**

Since the current ripple of the battery charging current can be minimized without the restrictions of source voltages, c urrents and duty cycles, the Maximum Power Point Tracking (MPPT) algorithm was also able to be implemented with the proposed technique for integrating renewable into the smart grid. The proposed technique was validated through detailed numerical analysis, simulation and experiment results. The modelling and control design of the PV charger system using Buck-Boost converter was presented by **B. SreeManju et al** The controller was designed to balance the power flow from PV module to the battery and the load such that PV power was utilized effectively and the battery was charged in three charging steps. The latest development of inverters for photovoltaic AC-modules is focused by **Soeren Baekhoej Kjaer et al.** The past technology was based on Centralized Inverters, present on String Inverters and future on AC-Modules and AC-Cells. **Yun-Pam Lee et al** focused on a DC to AC Inverter; power switching system; ability to generate the drive voltage and switching the power supply between the city electrical system and the solar power system [30]. The main aim is to construct a stabled, completed and low cost of solar energy conversion systems. Novel photovoltaic converter system was proposed by **J. H. R. Enslinan,** implementing a new maximum power point tracking technique [31]. The three functions, battery regulation, inverting and maximum-power-point tracking, needed for photovoltaic systems with battery back-up, were integrated in a single cost effective converter. This converter charges the battery, operates close to the maximum power point of the photovoltaic array and forms a dc to ac inverter for a complex power load. The step down charger allows the combination of high-voltage PV arrays with low voltage batteries. A full description of the circuit and practical measured results with efficiencies were presented.

## VII CONCLUSION

It is noted that perturb and observe and incremental conductance is superior to all other MPPT algorithms. Though fuzzy and neural networks are developing in the present days, the efficiency remains high in perturb and observe and Incremental conductance methods. The converters such as buck, boost, buck-boost, buck converters are being used in MPPT systems. PWM inverters are used for grid interconnection and standalone AC loads. The selection of converters is based on the load connected to the system. The ripples in dc voltage and current also influence the selection of converters. With the above mentioned converters and MPPT algorithms, solar panels can be configured to feed any kind of load. The vast development in improving efficiency of MPPT algorithms can encourage domestic generation of power using solar panels.

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