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Power Maximization of a Photovoltaic System using Automatic Solar Panel Tracking along with Boost Converter and Charge Controller with Software Control

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Abstract: Photovoltaic (PV) cell converts part of the solar energy into electrical energy. The remainder part is converted into heat. This heat inversely affects the efficiency of the solar cell. The estimated lifetime of cells used as solar converters is about 25 years. It looks at the performance of photovoltaic modules in non ideal conditions and proposes topologies to minimize the degradation of performance caused by these conditions. Photovoltaic cells are the key component in most photovoltaic power systems, but their performance is still subpar, so future work is needed to improve their performance and optimize the interactions between the cells and other components. The applications in which photovoltaic systems are used are increasing as the cost of photovoltaic module decreases.
Keywords: Photovoltaic (PV) cell, Topologies, Efficiency.

I. INTRODUCTION

Solar energy is a valuable form of energy, which has the potential to meet a significant proportion of world energy needs. The major applications of solar energy include solar thermal and solar photovoltaic systems. Solar collectors are designed IO generate thermal energy, however, photovoltaic cell produces electricity directly from solar energy. During photovoltaic energy conversion, thermal energy is also generated which results increase in cell temperature. This is well known fact that the efficiency of PV cells drops as the temperature of cell increases. In several PV panels the heat is removed by heat sinks and is dissipated to the surrounding atmosphere. Another approach to solve this problem is to cool the PV cells by means of water or anther fluid, thus keeping certain operating temperatures within limits to achieve higher cell efficiency. Many regions of the world suffer from severe shortages of rain and surface water such as the area of Hail in Saudi Arabia. It depends on underground aquifers for their daily supply. Traditional pumping and irrigation systems, employing diesel engines and electric grid
powered motors, represent a partial solution for some water delivery needs. But the cost of fuel and electricity, spare parts and / or the equivalent in time and labor of hand pumping systems make water pumping techniques prohibitively expensive for many rural towns and villages. Clean, silent, maintenance-free solar electric power is a technology made for the water pumping requirements of the developed and enveloping world. The applications in which photovoltaic systems are used are increasing as the cost of photovoltaic module decreases. Photovoltaic water pumping systems for irrigation and drinking water supply, in remote rural areas located far from the public grid, is one of the important applications of photovoltaic.

II. RELATED WORK

The paper [1] presents the terminal voltage of the PV cells decreases as the temperature of the cells increases. The solar efficiency of PV cells generally increases with illumination intensity. Most of components in the cost of a PV system are proportional to the area of the system and the solar cell recessing cost represents a small portion of the overall system cost. Therefore, the cell efficiency a large impact on the cost of energy produced by photovoltaic. Not only the use of high-efficiency solar cells allows reducing the PV system area, but also higher efficiency cells have a lower efficiency temperature coefficient and make PV modules with higher efficiency. A concentration technique is very important rule for increasing the performance of the PV system and decreasing the area of PV cells. A cooling mechanism is an important component in any concentrating PV system, due to the substantial reduction in performance with cell temperature. The evaporative cooling method has been successfully applied with PV system. More reliable thermal performance can be obtained and temperature of PV cells decreased. and thus performance is increased. Combination between the solar photovoltaic and thermal collector (PVT) by cooling in pipe under the cells is very efficient because of the increase of electrical power due to cooling, and also the fraction of heated water. By using a concentrator PV system based on reflective parabolic dish and cooling the PV system by heat pipe (evaporative cooling) technique or circulating cold water method the performance of the overall PV system is increased Also, the efficiency has been increased and PV system cost is decreased. This paper gives the information on Photovoltaic (PV) cell converts part of the solar energy into elect cal energy. The remainder part is inverted into heat. This heat inversely affects the efficiency of the solar cell. In this paper, the effect of the actual cell temperature on the performance of a photovoltaic cell is investigated. The effect *of* concentrator direction and maximum number of reflectors on the performance of a PV cells is resented. Two methods of cooling the PV cells are used. The first method is direct water-cooling. The second method is cooling PV cells by using, hcat pipe technique. From the obtained results, the terminal voltage of the photovoltaic decreases as the temperature of the cells increases. Use of parabolic concentrating collectors (dish) in order to maximize cell output with minimizes cell area. PV cells have high output power at lower operating temperatures. Heat pipe cooling technique is the best cooling method for a PV cells. The average cell operating temperature are necessary rather low in order to maintain a reasonable conversion efficiency.

The paper [3] presents the results from field measurements in a 20 kWp PV plant connected in the distribution network. The harmonic behavior regarding the solar radiation and the output current is being xamined. A model of the PV plant was developed in the PSIM© and Harmoniques© software packages and the impact of the PV plant in the distortion of the current and voltage waveform is then been investigated. Penetration scenarios were then examined by connecting in parallel similar PV plants at two points of the LV network. Simulation results showed violation in the voltage harmonic limits posed by international standards and overvoltage. Finally, the behavior of the harmonic components, including the amplitude and the phase, is examined for various settings of the PV inverters' parameters. A further study will include a combination of the above settings in order to attenuate the harmonic impact of PV plants connected in parallel. This paper broadly gives the idea about the operation of Photovoltaic (PV) units connected to the system is characterized by several uncertainties due to the number of running units, the points where these units are sited, the exported power and the injection of harmonic currents. The objective of this paper is to investigate the penetration level of PV units in the low voltage (LV) network. Starting from field measurements a model has been created for the computation of harmonics and voltages in the grid. The PV unit is modeled as a dc voltage source connected to the network via electronic switches, representing the PV inverter. Simulations were performed in the simulator packages PSIM© and Harmoniques©. Results from the simulated model agree with the results obtained by the measurement campaign. Following this the acceptable penetration level of PV systems in the LV distribution network is investigated for several scenarios, referring the number, the locations and the operation of the units.

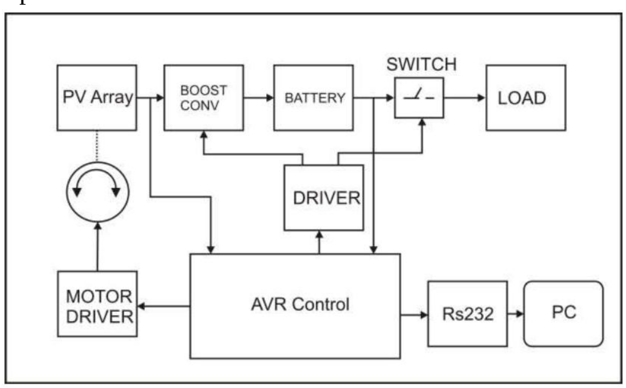
The paper [4] presented an in-depth analysis and modeling to discover the intrinsic characteristics of a photovoltaic power generation system. It also presented the use of Youla parameterization to design a control system for regulating the photovoltaic voltage. In the bench system, both the photovoltaic modules and switching-mode converters present nonlinear and time-variant characteristics. It is important to approximate the nonlinear feature by a linear model since the techniques of linear control are better established and simpler than the case of nonlinear control. To ease the analysis, the operating range was divided into four regions, namely: 1) the current-source region; 2) power region I; 3) power region II; and 4) the voltage-source region according to relative output characteristics. The method of successive linearization simplifies the nonlinear problem back to the linear case. The system also shows the time-variant characteristics because both the mathematical models and experimental results show that the frequency response is different from one region to another. The major variation lies in the damping factor caused by the variation of dynamic resistance. The change of insolation and temperature also affect the values of dynamic resistance. Based on these characteristics, a controller is designed through Youla parameterization. However, the computational lag that is introduced by the digital control reduces the system phase margin significantly. Therefore, further tuning is also presented to guarantee system stability and robustness. Finally, experimental and simulation results demonstrate the effectiveness of the presented analysis, design, and implementation.

The paper [5] presents the purpose of the MPPT is to adjust the solar operating voltage close *to* the MPP under changing atmospheric conditions. In this paper, different MPPT techniques and dc dc converters were investigated and compared. A simple method which combines a discrete time control and a PI compensator is used to track the MPP's of the solar array. The proposed converter system based on a DSP was constructed and the experimental tests were carried out, the tracking efficiency was confirmed by simulations and experimental results. This paper also gives different
type dc/dc converters were designed to evaluate the converter performance. A simple method which combines a discrete time control and a PI compensator is used to track the maximum power points (MPP's) of the solar array. The implementation of the proposed converter system was based on a digital signal processor (DSP) and the experimental results are presented.

The paper [6] has discussed the topologies used for photovoltaic power systems to optimize the operation of MPPT. First, it illustrated that non ideal conditions considerably downgrade the performance of MPPT, especially when photovoltaic modules are connected in series. To solve this problem, this paper proposed an individual power interface for each photovoltaic module and recommended a structure suitable for the photovoltaic features and MPPT to minimize the performance reduction caused by nonideal conditions. For high-efficiency conversion, most grid-connected power systems ignore dc/dc modules and convert dc photovoltaic energy directly to ac grid power. Fig. 16 illustrates a different photovoltaic power configuration, which consists of dc/ac MPPT modules, an ac voltage bus, and an anti-islanding device, where the bus voltage is equal to the grid voltage. The dc/ac MPPT module is the power interface between the photovoltaic module and the ac voltage bus. This is controlled by the algorithm of MPPT to generate the maximum possible solar power. The energy is eventually transferred to the grid via the ac bus and anti-islanding device. As shown in Figs. 5 and 16, both mechanisms ensure that any defective photovoltaic module will not influence the overall array so that each individual module is able to work at its optimal operating point. The control variable that represents the MPP can be either the photovoltaic voltage or the photovoltaic current. An analysis shows that regulating the photovoltaic voltage has advantages to improve the performance of MPPT. Finally, this paper provides a comparative study to choose the right converter topology for the applications of dc/dc MPPT modules. The boost topology shows some advantages over the buck converter for this application. The features include cheaper implementations and better dynamic response when compared to the buck converter.

III. PROPOSED WORK

This Project proposes a microcontroller based single axis automatic solar panel tracking control method for keeping the solar panel approximately at right angle with the incident photon for the better performance and maximize the output power of the solar panel. The charge controller with the DC-DC boost converter is used along the automatic tracking system for further enhancing output power under variable isolation conditions and protecting the battery from being overcharged and over discharged condition. The Boost converter is used to overcome the lower output voltage of solar panel for not fulfilling the minimum charging voltage requirement of the battery thus more power extraction is possible from the solar panel to battery. The system includes a photovoltaic array, one LDR sensor, a PWM controlled Boost converter, charge controller and sensor circuits. This paper discusses the low cost implementation of the whole system in the 8-bit microcontroller using the tools and techniques to generate optimized real time code in C for PIC controller which will demonstrate how maximization of power output is visible and efficient solution for increasing the efficiency of a solar system based on experimental results rather than on mathematical models.



A. *Advantages*

1) By implementing this project, battery continuously receive the charge as it required**.**
2) We can also control it manually**.**
3) Data can be recorded continuously in PC/Laptop.

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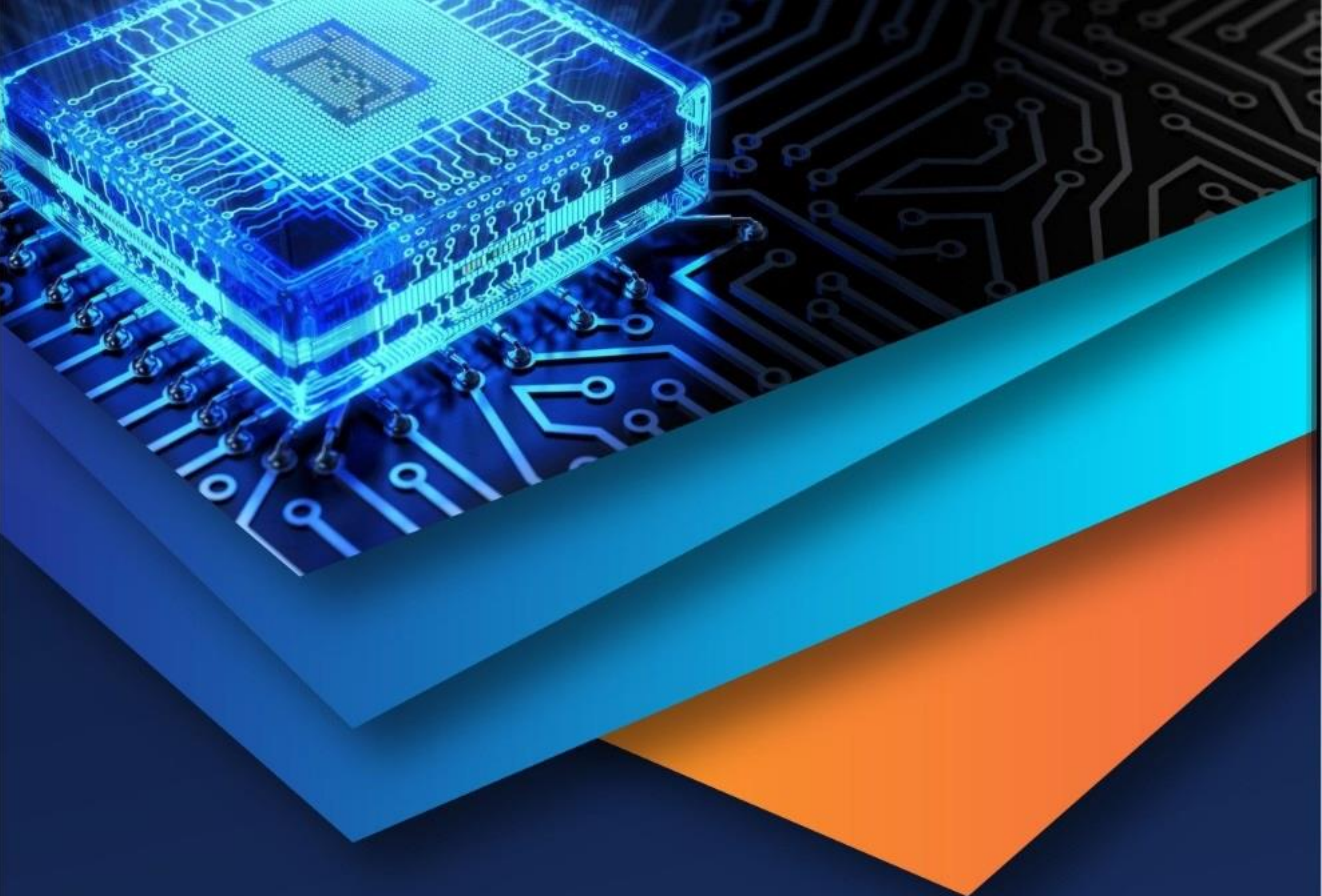

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