Automatic Solar Tracking System with SFFB Converter

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Abstract

In the proposed system, the solar panel is fixed adjacent to a street light. The panel is tilted according to the suns position and the energy is saved in the battery producing maximum output for solar powered applications. Solar tracker is designed with LDR's and permanent magnet dc motor. The stored energy is used for street lights. A high step up dc-dc converter which has series connected forward-fly back converter using transformer technology to increase the performance with an advantage of high power conversion efficiency and high system reliability. The system is automated and the process is done by the microcontroller with help of LDR.

Keywords--*Photovoltaic panel, Light Dependent Resistor, SFFB converter, Maximum Power Point Tracker, Battery Microcontroller.*

I. INTRODUCTION

For large number of purposes energy is required. Some traditional energy used from coal, oil, natural gas, nuclear energy is exhaustible and polluting. So an alternating source that is renewable solar energy is used as it is a good option and the electricity produced is clean, reduced cost and long lasting. The growth of solar in the past years have been expanded the importance of photo voltaic panels. the power conversion fundamental is represented by a PV panel unit of a PV generator system.

The solar isolation of a PV module is responsible for the output characteristics since it has some linear characteristics. It is necessary to design and model for the applications which require it. To obtain the maximum power from the solar panel an algorithm used is maximum power point tracking technique. The voltage output from the solar panel is regulated from a boost converter.

II. RESEARCH METHOD

A. *Photovoltaic Model*:

A photo voltaic cell is a device which generates electric power using solar cells to convert energy from the sun into a flow of electrons. A PV Module refers to a number of cells connected in series in a photo voltaic array; modules are connected both in series and parallel. Environmental problems such as green house and polluting emissions to the atmosphere are reduced by large use of photovoltaic (PV) cells. voltage-current(V-I) curves, voltage-power (V-P) curves, maximum power point values, current in short-circuit and voltage in open-circuit across a area of irradiation levels and cell temperatures are accurately predicted.The linear curve depending on irradiation and temperature. Both V-I and V-P curves have a maximum mount which is often called as Maximum Power Point (MPP).

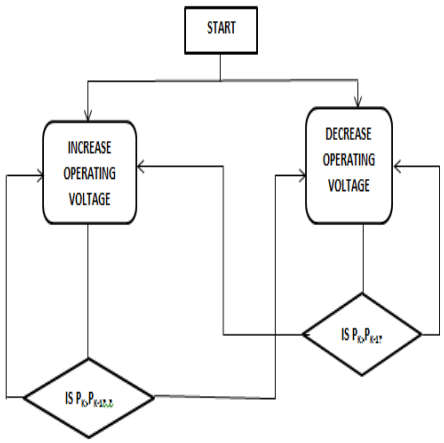

Fig. 1 Flowchart of PV Model

$P_{K=}$ current power value
$P_{K-1=}$ previously acquired power value

The output voltage of a PV Cell is basically a function of the photon current which is determined by load current mainly depending on solar irradiation level during the operation. The P-V and I-V characteristics of a solar panel are given below:

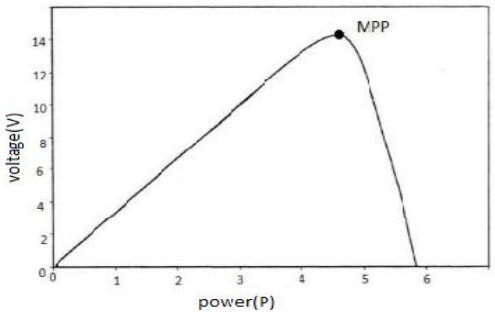

Fig 2 (a) V-P characteristics

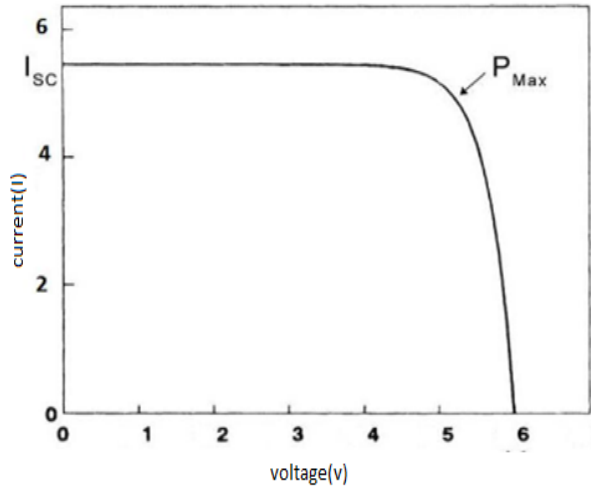

Fig 2 (b) V-I characteristics

B. Maximum Power Point Tracking Technique:

An essential part of a PV array in a PV system is to track its maximum power point. With the variation of the solar irradiance and temperature the PV module changes its power output. From the figure 2 it is clear that there exists a maximum power which corresponds to the current and voltage. it is desirable to operate the module at its maximum power since the solar cell has 8-15% of its efficiency. so maximum power can be transmitted to the load with varying temperature and irradiance levels MPPT is an electronic algorithm which enables the PV system to store the maximum power in any conditions[2].various MPPT algorithms are present among them perturb & observe method is the most popular one. The peturb&observe algorithm is discussed.

1) Ability of an Algorithm To Detect Multiple Local Maxima:

The irradiance levels at different points on a solar panel's surface are so common to vary. This leads to multiple local maxima in one system. The true maximum power point or a local maximum power point is calculated by the efficiency and complexity of an algorithm determined. In the latter case, by tilting the panel according to the movement of the sun the maximum electrical power is extracted from the solar panel.

2) Convergence Speed

The time taken to converge to the required operating voltage or current should be low For a high-performance MPPT system. Determined by how fast you need to do this and your tracking system requirements, the system has to accordingly maintain the load at the highest power point. different types of algorithms passed down , among them P&O algorithm is used to modify the voltage and current characteristics to obtain maximum power.

C. Perturb &Observe Method:

The approach behind the "perturb and observe" method is to modify the photovoltaic panel operating voltage or current until you obtain maximum power from it. For ex, if a voltage is increasing to a cell increases the power output of a cell, the operating voltage is increased by the system until the power output begins to decrease. Once this happens, the voltage decreases to get back to the highest power output value. This process remains until the maximum power point is attained. Thus, the output power value oscillates around a maximum power value until it stabilizes. Perturb and observe is mostly used among MPPT method due to its ease of implementation.

3) MPPT Boost Converter:

Fig 3 .MPPT Boost converter

D. Series Connected Forward Fly back Converter:

The DC/DC forward converter uses a transformer to increase or decrease the voltage output depending on the transformer ratio and provides galvanic isolation for the load. it is possible with multiple output windings to provide both higher and lower voltage outputs continuously. Many lighting systems with distributed photovoltaic micro generation have been proposed as a suitable solution for some specific cases. A fly back converter is used for the conversion of DC-DC with dynamic isolation between inputs and any outputs. A common transformer is used to merge fly back converter and a forward converter. The fly back converter operates only when the input voltage becomes lower than the reflected output voltage. Both the converters are operated in the case to share the output power in the rest region. The traditional forward converter consists of dead zones which exists in the ac input current are eliminated and a high power factor can be achieved in it.

III STREET LIGHT INTEGRATED SYSTEM

The main objective of this paper is to develop an automatic street light system, with increased efficiency and long lifetime using alternative energy sources. In autonomous street light system, the solution is by using solar energy to reduce nonrenewable resources affecting the environment. By using solar energy the system can increase its efficiency and it can be easily installed even in urban areas. A converter is placed between the PV panel and the dc link which is used to track the maximum power point. The SFFB converter which is a combination of fly back and forward converter with a transformer is used both in distributed generation and street light system. The proposed system comprises two types of sensor. The light sensor which is used to detect darkness to activate the ON/OFF switch, the photoelectric sensor turns on and activates the street light when it detects the movement. LDR is used to measure the intensity of light which also varies the amount of light falling on the surface gives an inductions for whether it is a day time or night time, the photoelectric sensors are placed on the road sides, The battery rating will be of 12V, 75 Ah (at C/10 discharge rate).75 % of the rated capacity of the battery should be fully charged and in load cut off conditions. The entire system can be controlled by a microcontroller.

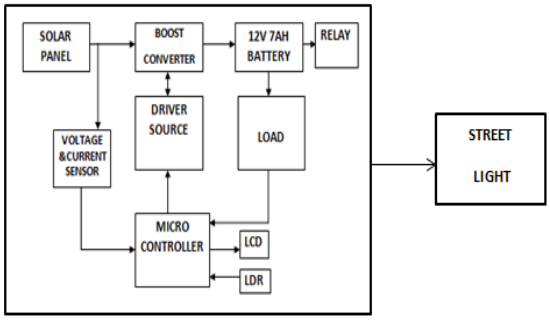

Fig 4 Block diagram of street light integrated system

IV HARDWAREIMPLEMENTATION

The main challenge in designing a hardware part is to design the parameters to meet its requirements and to increase the maximum system efficiency. The PV panel is connected to the boost converter and the MPPT controller. The converter used is DC-DC boost converter which shares the transformer to increase the utilization factor and to boost the energy produced. The produced voltage is isolated and controlled DC voltage. The maximum power point tracking method with the P&O algorithm integrated with the open circuit voltage is connected with the PV panel to speed up the tracking speed. Battery used with the nominal voltage of 12V and capacity 7AH for long service life. The converted power is given to the load placed at the end of the circuit.

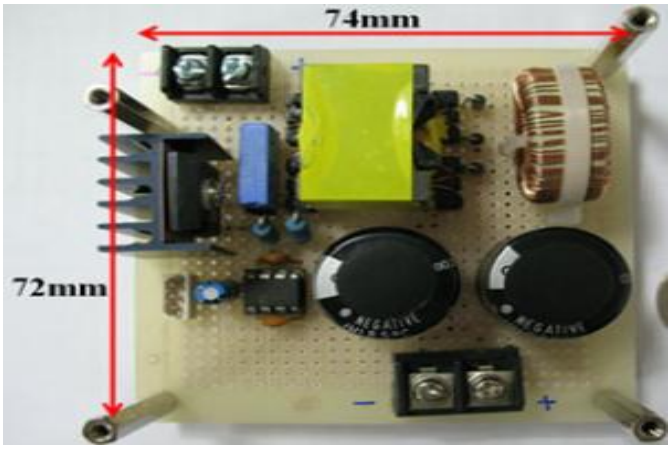

Fig 5 Proposed SFFB Converter

V RESULTS AND ANALYSIS

The overall system consists of Maximum Power Point Tracking circuit and a SFFB converter circuit. The overall system control is realized by a microcontroller. From the experiment two modules consisting of Maximum power point tracking circuit of the solar cell is implemented. To build a solar power system two modules are combined with the battery. One bidirectional charge/discharge controller and a battery used. By using the SFFB converter the output power is increased according to the input given in the circuit. By using P&O algorithm the system efficiency achieved is comparatively higher than the existing system

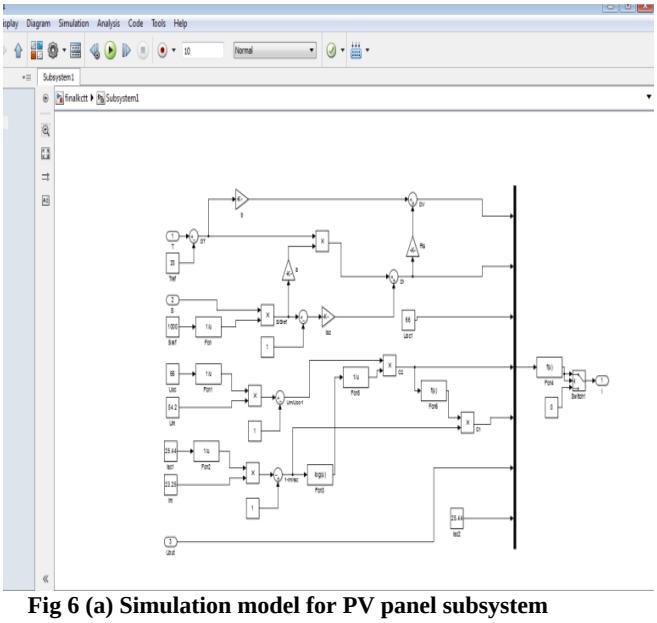

Fig 6 (a) Simulation model for PV panel subsystem

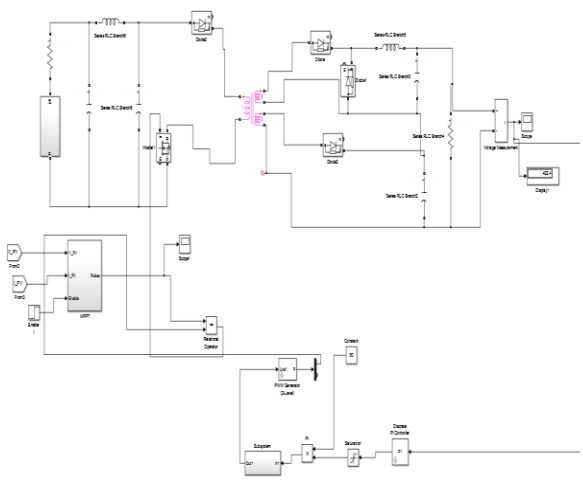

Fig 6 (b) proposed simulation model

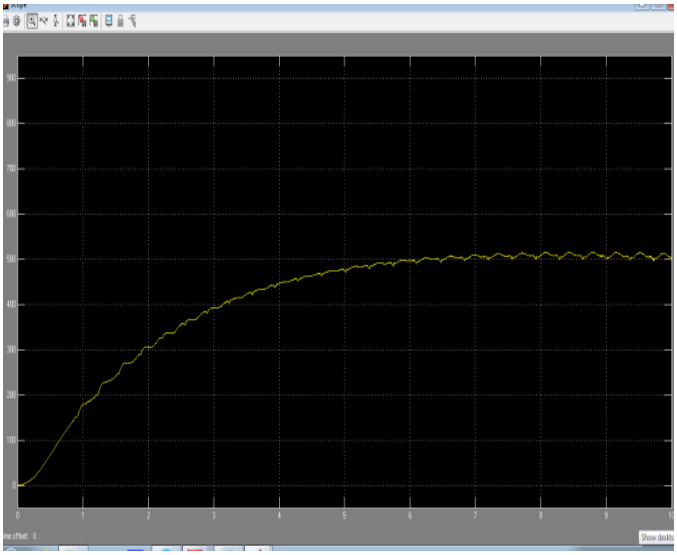

Fig 6 (c) waveform 1 for PV cell

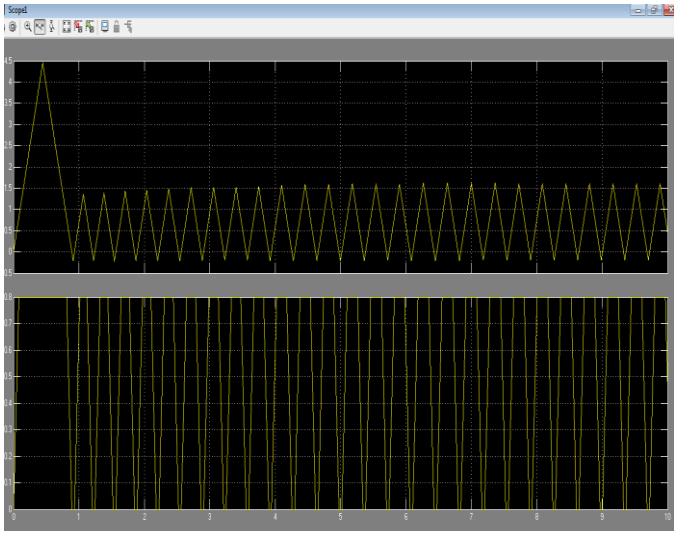

Fig 7 (a) Output Waveform for MPPT

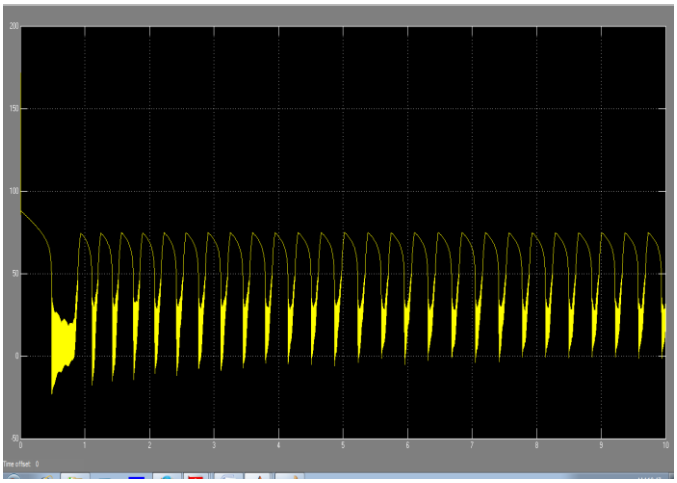

Fig 6 (d) waveform 2 for PV cell

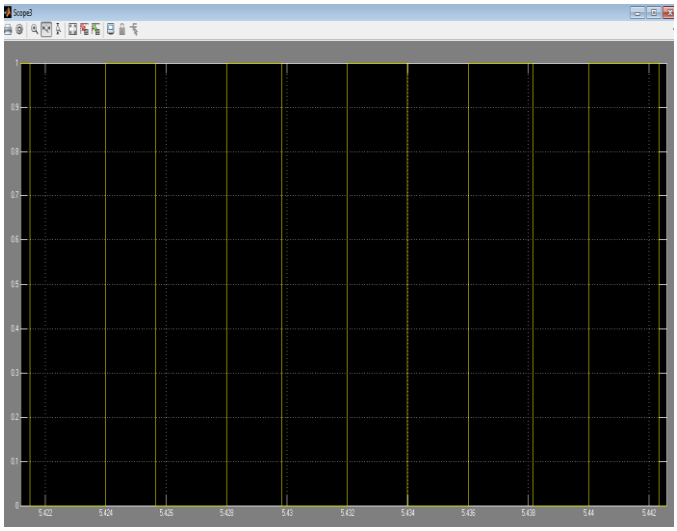

Fig 7 (b) Output Waveform for MPPT

VI CONCLUSION

Perturb & Observe algorithm used in the MPPT method is used to attain maximum energy efficiency. the implementation of a Microcontroller based solar tracking system gives a design that using 32-bit microprocessor chip as a controller, the automatic sun tracking is done by tilting the panel according to the movement of the sun. Thus the LED driver circuit produces maximum efficiency of 94.7% as compared to the previous methods in the litreture. hence 98% efficiency can be obtained in the future .PV module design and simulation is done using MATLAB/Simulink. Thus the low power LED solar street light system can be installed even in urban areas.

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