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Improved Performance of Photovoltaic by MPPT Using Fuzzy Logic with Battery Switching Technique

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ABSTRACT: Interest in PV power generation system has increased over the past decade as a clean and infinite energy. However, the output power induced in the PV modules is influenced by an intensity of solar cell radiation, temperature of the solar cells and so on. With the advancement in power electronics technology, the solar PV energy has been recognized as an important renewable energy resource. The intelligent controller can extract the maximum power from a PV panel under steady state power oscillations and dynamic problems. This proposed system uses a fuzzy logic for MPP tracking which provides better convergence speed and improved tracking performance than the conventional methods. The algorithm controls the duty ratio of the DC-DC converter in standalone system using change in slope of P-V curve as input and change in voltage as output. This calculates the operating point at which the two batteries are capable of producing maximum power to drive the required load by automatic switching. In addition, the fuzzy controller maintains the dc link voltage within the limit for injecting the power into the system. Further Light dependent resistor (LDR) is used to track the solar panel towards maximum intensity of the sunlight in such a way that to trap maximum solar energy. The simulation results validate the performance of grid interactive PV system for active power injection to mitigate the power quality issues which increases the utilization factor of the system.

KEYWORDS: MPPT, Solar Power, Photo voltaic effect, Battery, Relaying

I. INTRODUCTION

Solar energy based energy conversion is the predominant ongoing research and trending in the society of electrical and electronics engineering. There are many proposals based on the proficiency of solar energy to give output equivalent to the coal non-renewable energy based conversion. Previously, it is noted that efficiency from the output of solar energy is high but the technique used to track the light from the sun and also the conversion techniques is tedious, while the process of converting energy lot of electronic devices has to be used. To avoid such problems fuzzy logic based MPPT algorithm and LDR tracking system is used in this project. For example, if we take Maximum Power Point Tracking (MPPT) in which the sensing units are made to follow the sun light. Recognizing the movement of the sun tracker redirects the panel to make sun rays to fall directly to gain maximum output.

Photovoltaic cells are used in the solar panel, as it is the usual device embed in each and every panel. Overall the manufacturing process of creating solar photovoltaics is simple in that it does not require the culmination of many complex or moving parts. Because of the solid structure nature of PV systems, they are reliable and have much more life to get in field, may be 10 to 30 years. In order to increase electrical output of a PV based proposals the manufacturer must simply add more photovoltaic components for efficient output.

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Solar energy mainly developed for the stand alone system because of the DC supply and imperfect conversion techniques of DC – AC. Limited to the frequency matching and relaying techniques, it may not be connected to grid. Instead of facing such critical problems, it can be used as stand-alone system promoting the use of grid less transmission system. Instead of transmitting the AC power over a long distance, the solar power can be used as a distributed energy to reduce the transmission line loss.

Storage of solar power involves the usage of vast exposure of batteries. Batteries plays a vital role in protection and considered as heart of the power system. In the proposal concept batteries are the whole body of the system, as it involves the continuity of supply and also stores it and supplies based on the circuit connection. Most commonly used batteries are Nickel-Cadmium batteries which are most reliable and effective in closing the circuits with supply.

The most important tool used in the proposal system is Fuzzy logic, simple and automatic computing system based on any real number between 0 to 1 employed to handle the concept of partial truth. However, it is automated based on the real time equipment inputs and readings from the load. The action required should be completed within a limited time, as the Fuzzy logic favors such a requirement.

Overall it is proposed that Stand-alone solar power energy conversion based grid less generation and transmission system is possible, serving clean energy supply to remote areas.

II. LITERATURE SURVEY

[1] MattiaRicco proposed a filtering system from efficient solar power tracking, obviously with the MPPT based tracker. Simple logic used here is to filter the signals of input to the LDR in phase of light.

[2] Shameemahmad recorded the solar irradiation by the MPPT based tracking showing the results of direction and monitoring the irradiation based on the intensity programmed in the tracking system. Clearing the light intensity radiations and concentrating on visualizing the solar irradiation.

[3-5] Non-Automated stand-alone system with MPPT based solar tracking have been presented. In fact, this proposal has the maximum percentage stated 85% regarding lossless tied up components including the Panel arrangements.

[6-14] Proposed a controlling system in MPPT, even with the tracking there is no options for high intensity tracking system, however Simplified method is adopted by embedded based circuits. Using the controlling mechanism, we can also manually control the whole tracking system according to the needs.

[15-16] Practically achieved a solar tracking by system movement using MPPT. Again it is proven the increased efficiency using tracking avoiding the shaded portions involving the removal of shades and intimation low power from a single panel. Neglecting the shades proposal proceeded with the high end tracking system.

[17] MPPT based solar power tracking applied in solar car, basic difference in the system is tracking is done for two different reasons, one is for panel movement and other one is for vehicle movement based on the tracking. Single tracking system is good enough for PV solar power conversion technique for the maximum power trapping from the sun energy.

From the literature survey it is concluded that one of the most useful combination is Fuzzy logic based MPPT and LDR solar tracking system which is proposed in this paper. The proposed work is simulated using MATLAB software.

The results shows the improvements in harvesting solar energy using proposed method.

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III. HARDWARE USED

I. MICROCONTROLLER

The Atmel AT89C52 is an 8051-based on Fully Static 24MHz CMOS controller with 32 I/O Lines, 3 Timers/Counters modified, 8 Interrupts/2 Priority Levels for high interrupt enable, UART, Three-Level Program Memory Lock for efficient programming and addressing, 8K Bytes Flash Memory, 128 Bytes On-chip RAM. Clock signals are provided for the ultra-fast operation of controlling and relaying.

P1.0	1	40	VCC
P1.1	2	39	P0.0 (AD0)
P1.2	3	38	P0.1 (AD1)
P1.3	4	37	P0.2 (AD2)
P1.4	5	36	P0.3 (AD3)
P1.5	6	35	P0.4 (AD4)
P1.6	7	34	P0.5 (AD5)
P1.7	8	33	P0.6 (AD6)
RST	9	32	P0.7 (AD7)
(RXD)	P3.0	10	31 EA/VPP
(TXD)	P3.1	11	30 ALE/PROG
(INT0)	P3.2	12	29 PSEN
(INT1)	P3.3	13	28 P2.7 (A15)
(T0)	P3.4	14	27 P2.6 (A14)
(T1)	P3.5	15	26 P2.5 (A13)
(WR)	P3.6	16	25 P2.4 (A12)
(RD)	P3.7	17	24 P2.3 (A11)
XTAL2		18	23 P2.2 (A10)
XTAL1		19	22 P2.1 (A9)
GND	20	21	P2.0 (A8)

Figure 1. Pin diagram.

On chip memory lets the controller to be capable of finding the platform on real time applications.

II. SOLAR PANEL

All solar modules usually possess an electrical capacity that can be measured in amps and volts. The basic unit of power, the watt, equals volts multiplied by amps, or $P = V \times I$. ("I" stands for current intensity). Each module contains several dozens of solar cells that transform sunlight into watts. The more cells a manufacturer can pack into a module which may be solar panel, the denser and heavier it is, and the higher the total wattage depending upon the load. This is measured in square meters (w/m^2). Besides picking a module with a low or no negative power tolerance, and a low temperature coefficient, you should consider implementing some forms such as heat mitigation when designing the array. The array should be of closely packed and maintained in a instructed space and should be categorized. Still better performance can be achieved by implementing the mounted arrays on the insulated panels. Directing towards the radiation about to be dense.

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III. PHOTOVOLTAIC CELL

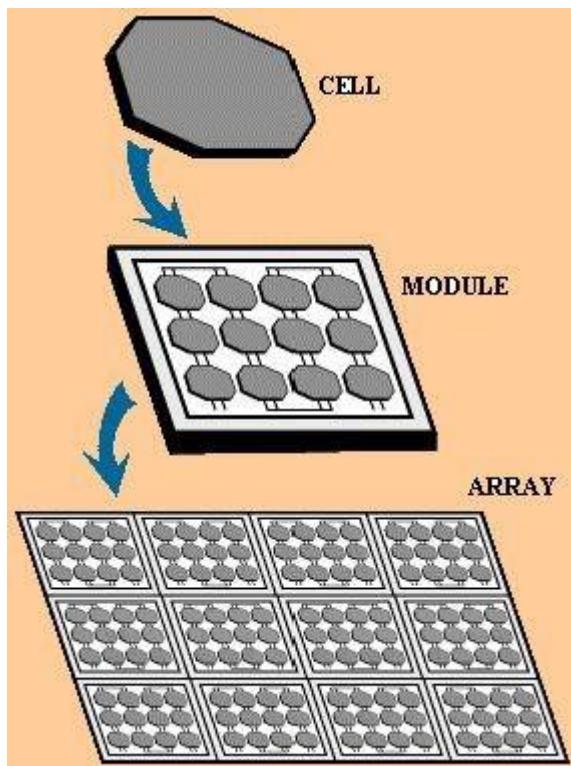


Figure 2. Solar panel

IV. MPPT

Maximum Power Point Tracking (MPPT) is the interface between the solar panels and the battery for avoiding the deterioration of battery life because of noises and variations in the output of the panel. The working of MPPT is nothing but, When the output is obtained fed to the diode build with in the device to recover major variations in magnitude of output voltage then the DC charge capacitance is provided to suck the medium level unwanted electrical impulses in the supply. Then to IGBT switch to regulate the voltage specified for battery, again to inductor to obtain smooth DC straight line voltage with high magnitude than normally derived from panels.

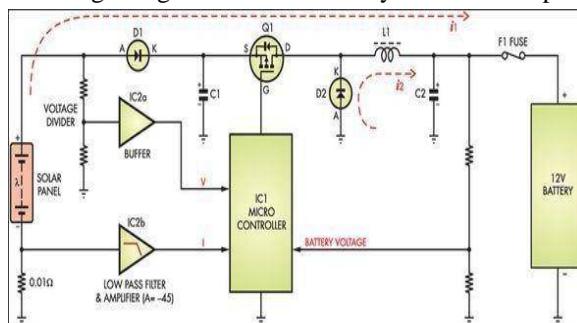


Figure 3. Maximum Power Point Tracking

Photovoltaic cell works based on the principle that when the light falls on the two junctions of n-type and p-type due to the light energy, there occurs the breakdown letting the electron to move giving out electricity.

A photovoltaic cell generates electricity when irradiated by sunlight.

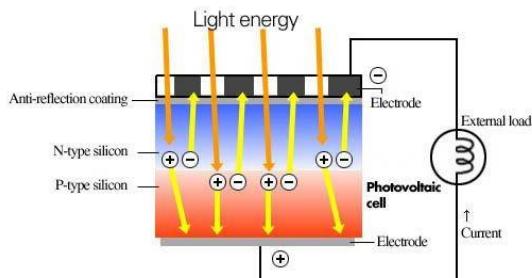


Figure 4. PV Cell

4. LDR

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Light dependent resistor is only responsible for the input based on the intensity of the light. Based on this input the tracker is directed by the drive and projected to trap solar energy.

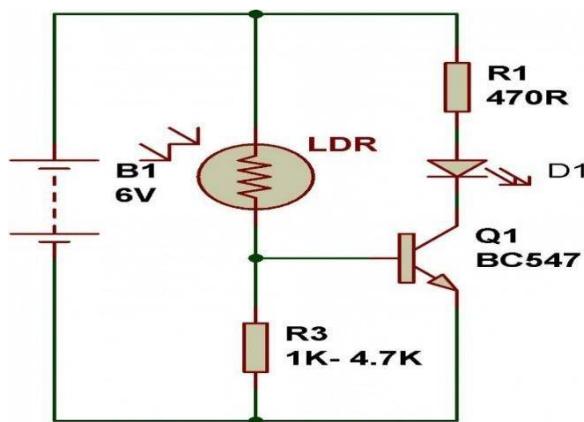


Figure 5. Light Dependent Resistor Circuit

V. CUK CONVERTER

It is nothing but the DC-DC converter where it is employed in the solar panel to battery system to regulate the DC obtained from the panels. Unlike Boost, buck, Buck boost converters it has either high or low output than the input based on the requirements. It operates in two modes

- Continuous Mode
- Discontinuous Mode

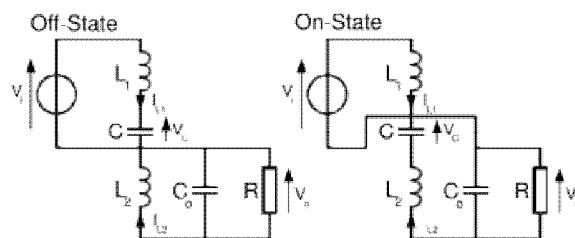


Figure 6. CUK Converter

In steady state, the energy stored in the inductors (effect of inductance) has to remain the same at the beginning and at the end of a commutation (periodic) cycle. The energy in an inductor is given by:

$$E = \frac{1}{2}L \cdot I^2$$

This implies that the current through the inductors has to be the same at the beginning (starting) and the end of the commutation cycle. As the evolution of the current through an inductor is related to the voltage across it:

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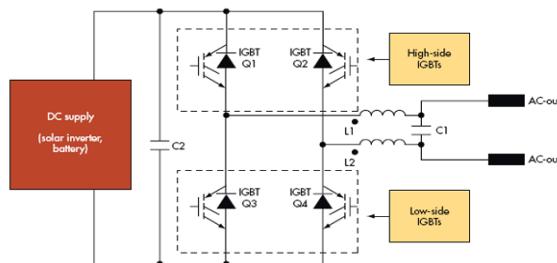
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$$V_L = L \frac{dI}{dt}$$

it can be seen from the equation that the average value of the inductor voltages (V_L) over a commutation period have to be zero to satisfy the steady-state requirements.

VI. SOLAR INVERTER

Inverter or of many types, which is categorized based on pulses for buffering the supply and conversion techniques used, by the technique familiar with the real time applications are Pulse Width Modulation technique. It is basically converts the high end DC from the storage batteries to load or may be grid. The AC output obtained should have synchronized frequency and magnitude of voltage in case of grid.



I. The solar-power inverter taps high-voltage IGBTs in a full-bridge topology.

Figure 7. Solar Inverter

VII. RELAY

Relay used here for the switching of load and also to switch between the batteries which will alternately charges and discharges the standby and supplying batteries respectively. For switching Fuzzy logic is implemented and the control is provided for the logic based on the inputs.

VIII. BATTERY

Batteries are the second important component in the proposal, as the solar panel output cannot be given directly to the load. And also the DC is the output, likely the load is optimised to operate on AC. Storage depends on the specifications. If there are series of 12V batteries say 20 then the output from the series connection will be 240V.

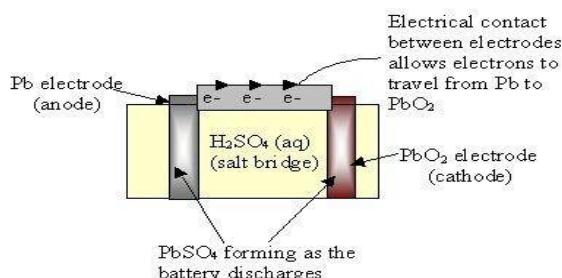


Figure 8. Lead Acid Accumulator

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IV. WORKING OF PROPOSED SYSTEM.

Starting from the solar panel, it traps the solar energy by the PV cells arranged as an array, that is by the photovoltaic principle. Then the whole electrons outlet is collectively accumulated and directed to reach the series of batteries ahead. The main aim of proposal system is introducing the doubly series connection batter sets. One is to live the load and one is to charge and make it standby until other one completely discharges. In between the output from the solar panel is fed via DC-DC (CUK) converter to regulate and filter the output to make the battery reliable. MPPT is the main reason for the efficient power tracking from all the panels without loss.

BATTERY 1	BATTERY 2	FUZZY LOGIC OPERATION (OUTPUT)	OPERATION
0	0	0	DISCONNECTS THE LOAD
0	1	1	SWITCHES BATTERY 2 TO THE LOAD
1	0	1	SWITCHES BATTERY 1 TO THE LOAD
1	1	1	DISCONNECTS MPPT FROM THE BATTERY

Figure 9. Fuzzy Logic working table

Fuzzy logic is introduced to give switching command to MPPT to stop or start and for the connection/disconnection of load through relays. It is also provided to switch between the batteries also.

From the fig.9 in battery 1 and 2 the 0 implies the completely discharged status and 1 implies the completely charged status and in the column of Fuzzy logic operation 0 implies no supply from any of the battery sets and 1 implies the supply from any one of the battery sets.

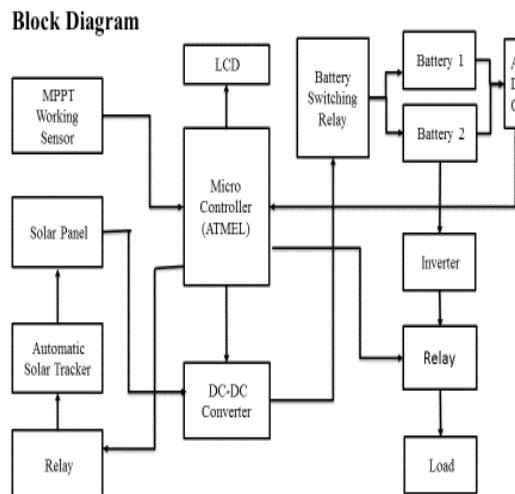


Figure 10. Block diagram of proposed system.

Automatic solar tracker is nothing but the motor drive placed for the rotation of the panel. LCD display is provided to

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display which battery set is at charge or discharge and how much % of battery is used and gets charged and time elapsed to bring it to supply. ADC is to convert battery level and condition analog data to digital data and it is sent to Microcontroller. Microcontroller based on the inputs and outputs it performs the required action.

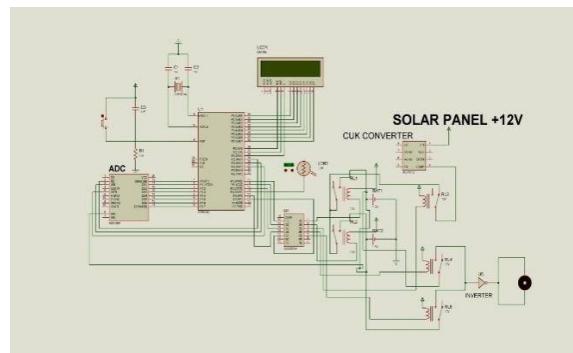


Figure 11. Circuit Diagram

V. SIMULATIONS AND EXPERIMENTAL RESULTS

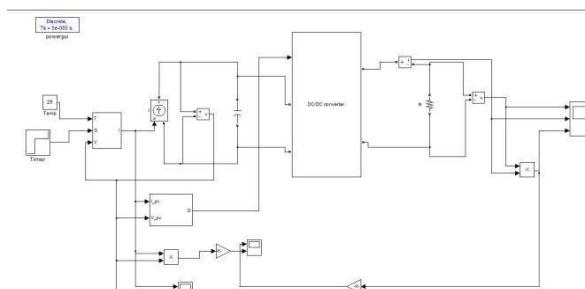


Figure 12. MATLAB Parametric Analysis of CUK Converter

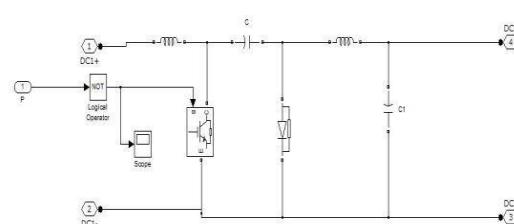


Figure 13. MATLAB Parametric Analysis of CUK Converter

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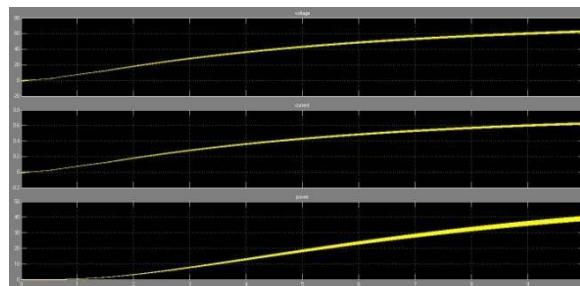


Figure 14. Output Waveform of CUK converter

VI. CONCLUSION

Hoping the proposal system definitely will be of great demand with the improved performance by the addition of some more features. Overcoming the disadvantages of power tracking and discontinuous power supply from grid as well as standalone system. Logical wise Fuzzy logic and system wise MPPT and practical wise standby feature together will be the great system providing the long time and continuous supply of load even in the remote areas. Standalone system makes the big deal with solar energy based power systems..

VII. ACKNOWLEDGEMENT

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