Maximum Power Point Tracking For Solar PV Array

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ABSTRACT

Maximum Power number of solar panel needed to obtain desired output power. Several different MPPT method have been proposed, but there has been no comprehensive experimental comparisons between all different algorithm and their overall Maximum Power Point (MPP) tracking efficiencies under varying condition (i.e. illumination, temperature, and load). This task performed by tracker of the Maximum Power Point (MPPT): it maximize power output of the PV system for assigned conditions of radiation & temperature, thus optimizing efficiency. The core of the MPPT is represented by implemented algorithm devoted Point Tracking (MPPT) is very important in the solar power systems because it reduces solar plant cost by decreasing to find & maintain the operation near to Maximum Power Point (MPP).

Result are obtained using microcontroller. The main aim will be the to track the maximum power point of photovoltaic module so that maximum possible power can be extracted from the photovoltaic cell. The algorithm utilized for the MPPT are generalized algorithm & are easy to model or use as a code. To achieve Voltage characteristics with respect to the time of solar panels & battery as well as when the battery will be start charging. Also showing battery charging status still the charging of Battery is in the process. In present paper, starting from set of the whole system of PV module, an innovative procedure to identify & reach MPP is presented & experimentally verified.

Keywords: *MPPT, Battery, photovoltaic (PV) cells.*

1. Introduction

Solar power is renewable source of energy, which has become increasingly popular in the modern time. It has the obvious advantage over the non-renewable energy sources, such as the coal, oil & nuclear energy. It is the non-polluting, reliable & it can produce the energy anywhere that there is sun shining, so that it resource are not going to run out anytime soon. It even has advantages over the other renewable energy sources, including wind & water power. Solar power is generated using the solar panel, which do not require the any major mechanical part, such as the wind turbines. These mechanical part can break down & cause maintenance issues & can also be quite noisy. Both of these issues are virtually non-existent with solar panel. Also, the solar cells, that connected together make up the solar panel, can last up to several decades without the replacement.

However, there is a drawback in solar power – energy can only be produce when sun is shining. To overcome this problem, usually solar panel are coupled with back up rechargeable batteries, which can be store excess power generated during the day & use it to provide energy to system when there is no sun shining. In this way a solar power can be use to power house & other large scale system. In these system the DC-AC conversion is needed. This is because of the solar panel produce an output that DC (Direct Current) & the power supply in home usually runs off AC (Alternating Current), so conversion is required. For this project, however, the load to be connected only requires a DC input, so that DC-AC conversion is not needed. Instead, DC-DC conversion would be used to provide the correct power to system from the power generated by the solar panel. Using this information, a number of design solution were determined & considered.

The behavior of a PV module is defined by a family of voltage characteristic with respect to time. MPP is the point on the curve where the PV module operates with maximum efficiency and produces the maximum power output: every curve has single MPP. One significant problem in PV systems is the probable mismatch between the operating characteristic of load & the PV array. The plot of typical curve for a PV panel and Charged Battery, with the X-axis representing time and the Y-axis representing voltage. It can be calculated using a model of the PV array and measurement of the irradiance and array temperature, but making such measurements is usually too expensive for this application, & often the required parameters for the PV array model are not known adequately. Thus, the MPPT must continuously search the MPP. Several MPPT search algorithm have been proposed that the make use of different characteristics of the solar panels & the location of the MPP. Unfortunately, it is difficult to compare the effectiveness of these method because no comprehensive experimental comparison has been performed. Several papers have been written comparing different algorithm to the perturb & observe algorithm "P&O" but they have either been experimental comparisons between one algorithm & P&O, or they have been simulation using an un optimized form P&O. This problem is solved by using a Incremental Conductance (IC) algorithm, but in present paper, the resent most popular algorithm Voltage Based Peak Power Tracking is used. Which has the main advantages that it Covers wide range of angle, having a Reliable algorithm, Simplicity and Less time consuming.

2. MAXIMUM POWER POINT TRACKING ALGORITHM

Our system aims is the power generated by solar cell.This is done by using Maximum Power Point Tracking (MPPT) algorithm. There are different MPPT algorithms are used like perturb and observe, Incremental conductance methods are used. These methods required constant voltage supply. Instead of these two methods the most popular MPPT algorithm Voltage Based Peak Power Tracking is used. Voltage Based Peak Power Tracking Algorithm (VPPT) algorithm is a robust method to track the position of maximum Solar voltage. In this algorithm we first bring the solar panel to Morning position (1^{st} Position) and then gradually read the solar panel voltage in few steps. At the end the solar panel is at the Evening position (last position). Once the µC has all the values of Solar panel voltage it will apply the voltage based peak power algorithm to find which position gives the highest voltage.

The µC will then move the panel to the position where the voltage is maximum. In this way we are implementing the MPPT algorithm to get the maximum amount of power at any given time of day.

Below shows the Algorithms to track the Maximum Power Point i.e. Voltage Based Peak Power Tracking. The algorithm steps and flow chart are summarized as follows.

2.1 Voltage Based Peak Power Tracking Algorithm Steps and Flow Chart:-

Algorithm Steps:

1. Start
2. Initialize Solar panel to 1^{st} position
3. “B”
4. Take Voltage reading
5. Move Panel to next position
6. Is position =10? N→ “B” ” (1 to 10 pos. loopwise)
7. Y→ Calculate the Max voltage of all the readings
8. Position the Solar panel on the maximum Position
9. “C” ”(checking battery voltage)
10. Is time = 5 minutes? Y→”B”
11. N→”C”

3. DESIGN OF SOLAR PANEL USING MPPT ALGORITHM

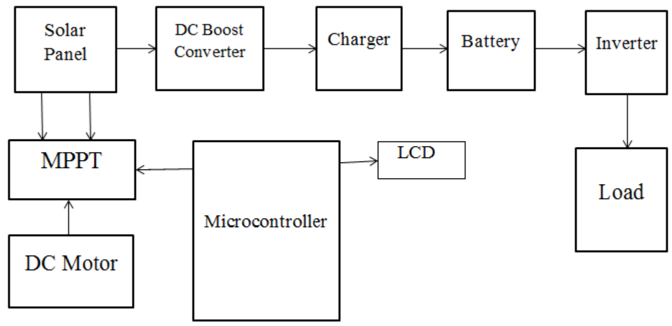


Fig. 1 - Block diagram

3.1 SOLAR PANEL:

Solar panel convert the sun energy into usable form. Solar panel can be certain kind of device that attract sun to use the sun to power machinery that can be transfer the heat from sun into whatever they need. We could use solar panel to convert the heat from sun into energy we need to power things that run.

3.2 BOOST CONVERTER:

It is a DC-to-DC power converter with an output voltage greater than its input voltage. The maximum power point tracking is basically load matching problem. In order to change input resistance of panel to match the load resistances (by varying the duty cycle), DC to DC converter is required. Power for the boost converter can come from the any suitable DC sources, such as battery, solar panels.

3.3 INVERTER:

A solar inverter and PV inverter or solar converter, convert the variable direct current DC output of the PV solar panel into utility frequency alternating current AC that can fed into a commercial electrical grid or used by local electrical network. It is critical component in PV system ,allowing use of ordinary AC powered equipment. Solar inverter have special functions adapted for the use with PV arrays ,including MPPT.

3.4 CHARGER:

A charger controller may used to power DC equipment with the solar panels. The charge controller provides a regulated DC output & stores the excess energy in a battery as well as monitoring battery voltage to prevent under or over the charging. More expensive units will also perform the MPPT. An inverter can be connected to output of the charge controller to drive AC load.

3.5 DC MOTERS:

This DC motors are used to physically drive application as per requirement provided in the software. The dc motor works on 12v. To drive dc motor, we need a dc motor driver is called L293D. This dc motor driver is capable of driving two dc motors at a time. In order to protect dc motor from a back EMF generated by dc motor while changing the direction of the rotation, the dc motor driver have an internal protection suit. We can also provide back EMF protection suit by connecting the 4 diode configurations across each of dc motor.

3.6 BATTERY:

This is a rechargeable battery that integrate a solar cell with battery power storage which have been developed specifically for the use in photovoltaic systems. In system 6V Lead Acid Battery is used for purpose of to store charge from the solar panel & also for giving a Input supply to the solar panel. Battery charger circuit is used to charge battery for providing required voltage when it will get discharge.

3.7 AT8C51 MICROCONTROLLER:

A microcontroller is the general purpose device, but that is meant to be read the data, perform limited calculations on that data & control its environment based on those calculation. The prime use of microcontroller is to control operation of the machine using a fixed program that can stored in ROM & that does not change over the lifetime of system.

The microcontroller that design uses much more limited set of the single & double byte instructions that are used to move the data & code from internal memory to the ALU. The microcontroller is concerned with getting data & to its own pins and the architecture & instruction set are optimized to handle the data in bit & byte size.

The AT89C51 is low-power, high-performances CMOS 8-bit microcontroller with the 4k bytes of Flash Programmable & erasable read only memory (EROM). A device is the manufactured by using Atmel's high-density non-volatile memory technology & is functionally compatible with industry-standard 80C51 microcontroller instruction set & pin out.

FEATURES:

- 89C51 based architecture
- 8-Kbytes of on-chip Reprogrammable Flash Memories
- 128 x 8 RAM
- Two 16-bit Timer/Counter
- Full duplex serial channel
- Boolean processor
- Four 8-bit I/O port, 32 I/O line
- Memory addressing capability
  - 64K ROM and 64K RAM
- Power save modes:
  - Idle & power-down
- Six interrupt source
- Most instruction execute in the 0.3 us
- CMOS and TTL compatible
- Maximum speed is: 40 MHz @ Vcc = 5V
- Industrial temperature is available
- Packages available:
  - 40-pin DIP
  - 44-pin PLCC
  - 44-pin PQFP

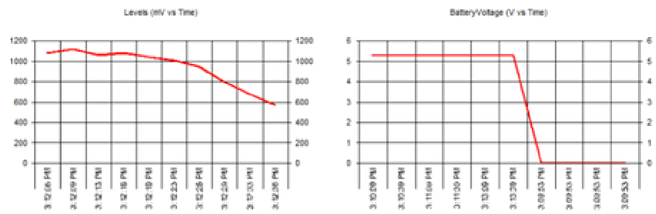
4. PROTOTYPE MODEL DEVELOPMENT

Fig 2- Prototype model of microcontroller based solar pannel using MPPT algorithm

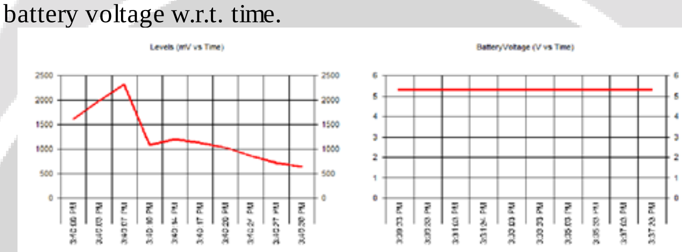
Here we are use the PV array, microcontroller, DC boost converter, Inverter, Charger and Load. Microcontroller controls the PV solar Array by using MPPT algorithm in the direction of maximum intensity of sun. PV array rotates in 15 degree per hour in east to west. Also 5 degree south to north hemisphere.

This assembly uses the positional shaft and DC motor to rotate the PV solar array in the direction of maximum intensity of sun light.

5. RESULT



The parameters were obtained for the generalized solar cell. The plot is similar to the theoretically known plot of the solar cell voltage and battery voltage w.r.t. time.



The first graph shows the Solar voltage levels at 10 different angles taken at 10 second interval. The 2nd part shows the characteristics of battery voltage Vs Time taken at every 30 seconds.

Clearly we can observe that there is a rise in battery voltage which is also shown in the Battery voltage Vs time graph.

The second graph shows the reading of conventional method vs the Max reading obtained after applying the MPPT algorithm. Here we can observe that there is an increase of 10% after using the MPPT algorithm.

6. CONCLUSION

MPPT algorithms appear to be very attractive for MICs. Unlike a string of modules, in a single panel, it can be assumed that all the cells have the same temperature and are exposed to the same solar radiation. In this case, the PV panel can be easily modeled and its MPP voltage can be predicted from the measurement of solar radiation and cell temperature. The advantage of MB MPPTs in terms of dynamic response in rapidly changing conditions is well known, but until now they have been rarely employed because of the high cost. Dramatically reduces the cost and increases its robustness, thus making the method competitive with respect to the others techniques.

In this system, tracking of solar energy is facilitated also the voltage across panel. It gives real time update of the voltage across the panel. It gives the real time Voltage characteristics of solar panel and battery with respect to time. In this system, I have done implementation of MPPT algorithm for electricity generation using energy of the sun. I have measured the voltage across the solar panel and plotted graph for the same time on x-axis and voltage on y-axis. Also, battery charging is done. Thus purpose of Maximum Power Point Tracking algorithm is achieved successfully.

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