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Designing of a New MPPT Technique: A Conceptual Review

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Abstract

Each day sun illuminates the whole earth by rising in east and setting in the west. The parallel rays of the sun irradiating directly gives the best output and hence the panel must directly face the sun throughout the day for maximum efficiency. The designed tracker will be made without the use of sensors and will be controlled using controllers and electric drivers. The system can be programmed to rotate at various step angles as per need and also the sensitivity of the system can also be altered giving much greater flexibility and advantages over traditional systems. The system has been designed for single axis tracking but the algorithm can be extended to be used for dual axis tracking as well.

Keywords: controllers, electric drivers, MPPT, sensor less tracker

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INTRODUCTION

Renewable energy is the source of energy which can be reused, replenished, and recycled again and again. It is non-exhaustible sources of energy. The most common available source of energy is sun. Sun has been an indispensable part of mankind since its existent. It is the prime sources of energy. Energy obtained by sun is known as solar energy. It comes from the light of sun, which makes it as a renewable source of energy which is pollution free. The most basic unit which is used to harness this energy is called solar cell that convert the sunlight into electrical energy. Although the solar radiation is relatively constant outside the earth atmosphere but its local climate influence which leads to wide variation of solar irradiance value from place to place on earth surface. Due to the relative motion of sun with respect to earth surfaces at different orientation permit these surfaces to catch different amount of solar irradiance. The three basic parameters which determine any solar energy conversion system are amount, quality and the timing of available solar irradiance at that site. With the constant depletion of conventional sources of energy, the use of solar energy has become a foremost requirement.

To make solar energy more viable, the efficiency of solar array systems must be maximized. A feasible approach to maximizing the efficiency of solar array systems is sun tracking. Currently a lot of maximum power point tracking (MPPT) techniques based on current and real time analysis are being used to harness maximum amount of solar energy but these current MPPT techniques have some serious disadvantages associated with them like abnormal behavior of the algorithm due to rapid change of solar irradiance, shadowing of panel which would cause the additional task of reframing the algorithm, simultaneously these[1] methods vary in complexity, sensors required, convergence speed, cost, range of effectiveness, implementation

hardware, popularity, and in other respects. This paper deals with new MPPT technique that controls the movement of a solar array so that it is constantly aligned towards the direction of the sun.

The parallel rays of the sun irradiating directly gives the best output and hence the panel must directly face the sun throughout the day for maximum efficiency. The proposed MPPT technique will avoid the use of sensors and will be controlled using controllers and actuators. The system can be programmed to rotate at various step angles as per need and also the sensitivity of the system can also be altered giving much greater flexibility over traditional systems. The system has been designed for single axis tracking but the algorithm can be extended to be used for dual axis tracking as well. The MPPT technique proposed in this paper offers a reliable and affordable method of aligning a solar array with the sun in order to maximize its energy output. With the feature of sensor less, it also cuts down the overall cost of tracking system. The main objective of the system is to be able to dynamically follow the movement of the sun across the sky without the use of any sensors. The cost of the system should also be competitive and its response fast, precise and accurate.[2–8]

CURRENT CONCEPTS OF MPPT

MPPT stands for maximum power point tracker are techniques used to harness maximum solar energy from sun through solar panels. There are several MPPT technique available which are currently being on run in order to make and optimize the solar energy. The basic concept of MPPTs involves the use of electric controllers integrated to MPPTs which transfer the solar energy obtained from collector panels to inverter for the further use. Special designed inverter converts this nonlinear energy to linear energy to make it usable. The aim of MPPT is to sample the output of the solar panel, to get a calculate resistance in order to obtain maximum power for any given geographical condition. Different types of MPPT concepts are:

1. Direct methods

(i) Perturb and observe: This algorithm tracks MPP according to increase and decrease of power curve of the solar array by comparing it with last power curve value if the power curve is increasing then it moves the solar array in that direction and if the power curve is decreasing, it moves the solar array in opposite direction in order to achieve MPP. This algorithm is easy and mostly solar array are based on this technique.[1,3,4]

(ii) Incremental conductance: As the name shows this algorithm formulate the conductance of solar array by determining the incremental change of panel current and voltage in order to compute the sign of power with respect to voltage. This algorithm takes instantaneous conductance as reference value and compares it with MPP conductance of the panel and moves it accordingly.[1,4,5]

2. Indirect methods

(i) Fixed voltage method: In this method MPP voltage is adjusted constant by periodic and continuous estimation of MPP according to season for same irradiance value. As it is assumed that MPP at winter is higher that of summer. So, the tracker orientation is adjusted accordingly. Basically it is not tracking technique in precise words.[1,4]

(ii) Fractional open circuit voltage: Under this algorithm open circuit voltage of the PV module is calculated continuously in order to obtain the maximum power point voltage to achieve the required orientation of the PV module. Thus this technique only allows the tracker to move around the MPP, which means it supports less accuracy.[1,4]

(MPP voltage)Vm=k × Voc (Open circuit voltage)

3. Current sweep: This algorithm uses the timely updated in fixed interval I/V curve which is obtained from the sweep waveform current and using this curve, it computes MPP voltage during that interval.[1,4]
4.]Fuzzy logic: In this method current and voltage and current data of the panel are collected and according to this obtained data fuzzy logic control inputs are generated and then using fuzzy controller, movement of tracker takes place.[1,4]

Like this there are several other methods like voltage based MPPT[9] and, etc. on which currently ongoing study is going on before they will put into practice.

DRAWBACKS OF CURRENT MPPTs

(1) Technique like fixed voltage is less accurate because they work on fixed operating voltage and irradiance values. So they are useful at places where there is no variation in climatic conditions.

(2) The major drawback with open circuit voltage method is that every time load has to be removed from the circuit in order to measure the open source voltage because of which PV power loss occur. Although this situation has been overhauled using[1] pilot cell but still the dependency of MMP voltage on "k" value makes it less accurate as it gives the value of voltage fluctuation around MPP voltage region.

(3) P&O algorithm is also associated with some of drawbacks. This method fails under rapidly changing atmospheric conditions. So the system keeps oscillating about MPP, because of the change of irradiance value cause power curve shifting within one sampling period due to which MPP keeps changing and making it impossible for this algorithm to track MPP. Although several modifications like[6,7,] have been made to improve this technique but it has caused the burden of complexity.

(4) Although IC algorithm provide better results as compared to P&O method to overcome its drawback. But still this suffers oscillations issues on rapidly changing atmospheric conditions. If the computational period is increased in order to annihilate oscillation, then it would slow down the sampling frequency and increase the complexity of this algorithm.[1,4,6]

(5) Although Fuzzy logic method provides better algorithm to track MPP but still this method is expensive to exploit in the field of solar energy.[1,4]

PROPOSED METHOD

The goal of this MPPT technique is to make the solar panel follow the movement of the sun across the sky throughout the day without the use of any external sensor or pre-programmed movement as per time and date. The output of the proposed method should also be able to produce stable and usable power. In order to do this it should be able to sense the position of the sun and move accordingly. It should also be able to take into consideration the clouds, shadow cover, etc. so that the voltage comparison occurs accordingly and control is set as required.

The solar panel is divided into two regions (i.e. top and bottom) and the voltage across the two parts are interfaced to the microcontroller ADC for comparison to check which part of the panel is getting higher amount of irradiation. The controller can be programmed to give the precise angles varying from 15° to 90°.

Control Algorithm for the tracker:

(1) Compare the voltage inputs.

(2) If value 1 > value 2 then move panel one step clockwise.
(3) If value 2 > value 1 then move panel one step anticlockwise.
(4) Provide sufficient delay between two comparisons.

Exception handling algorithm:
(1) In case both the regions are under cloud cover or shadow: Both parts of the panel will not be receiving proper amount of sunlight and hence both will give less output leading to no movement.
(2) If the tracker has moved by mistake and the sun is in a different direction altogether : The panel can be moved at larger step angles on either side if the ADC voltage is below a certain threshold value to check whether the sun is shining in any other different direction or not.
(3) During night time: The microcontroller can be interfaced with a flash memory and made to turn off at night time of its own.

ADVANTAGES

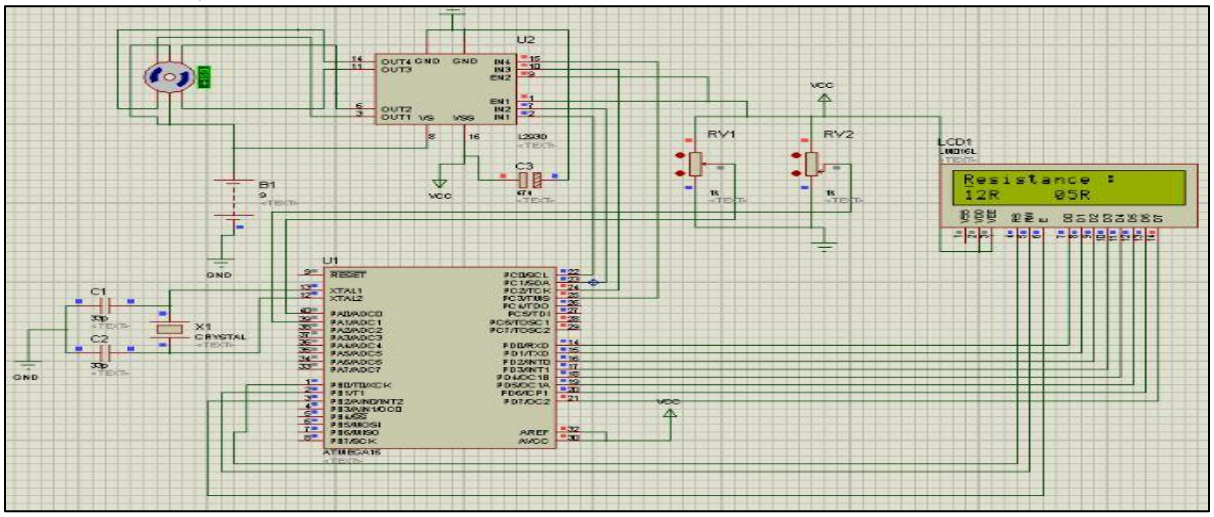
(1) The prototype will work with greater efficiency and have dynamic response depending on the environment around it.
(2) The prototype will be sensor less and easily reprogrammable.
(3) During rapidly changing environment this algorithm adjusts itself to MPP within one sampling period.
(4) If the tracker has moved by mistake and the sun is in a different direction altogether the panel can be moved at larger step angles on either side if the ADC voltage is below a certain threshold value to check whether the sun is shining in any other different direction or not.
(5) By using RTC of ATmega16 the tracker can be made to turn off at night time of its own.
(6) In case of cloud cover both the panel will be receiving less amount of sunlight and hence less output leading to no movement.
(7) If any shadow comes by any obstacle then after sampling time this algorithm moves the tracker at certain angle clockwise and anticlockwise to find the position of sun and then MPP.

SIMULATION AND RESULTS

The model design and simulation is carried out in AVR studio and proteus. The ADC port of ATmega16 is used for voltage comparator circuit. The input voltage used in the ADC circuit is 5 V. Solar plate used here are of 5 W and 12 V.

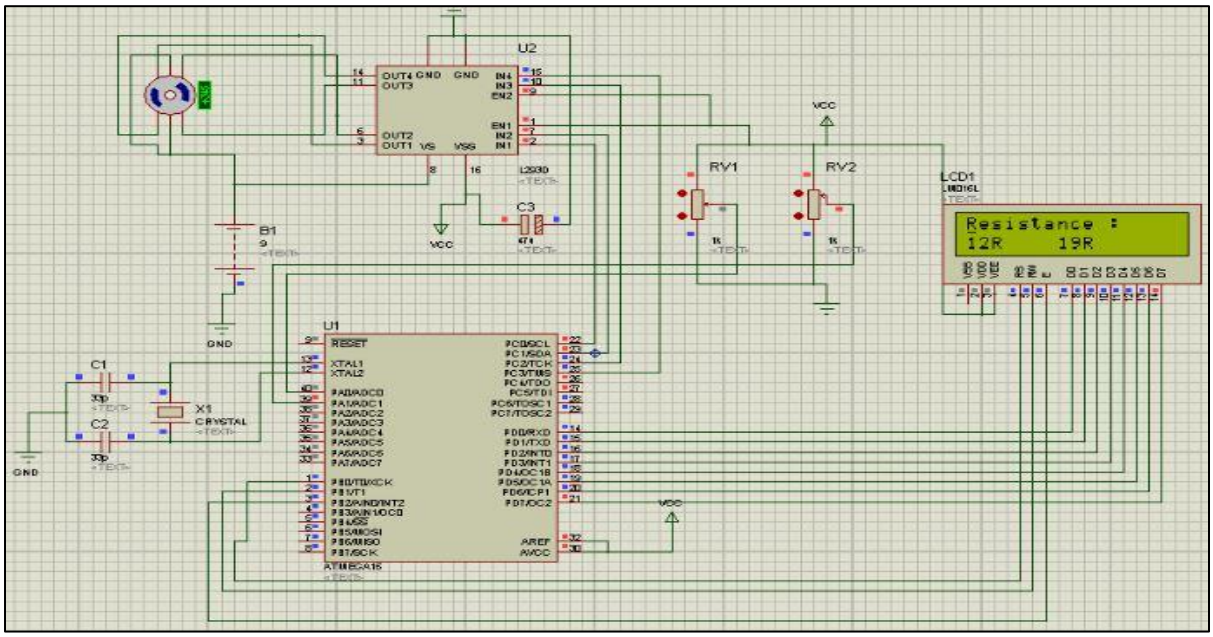
Case 1

When V1 > V2, Motor moves +15°



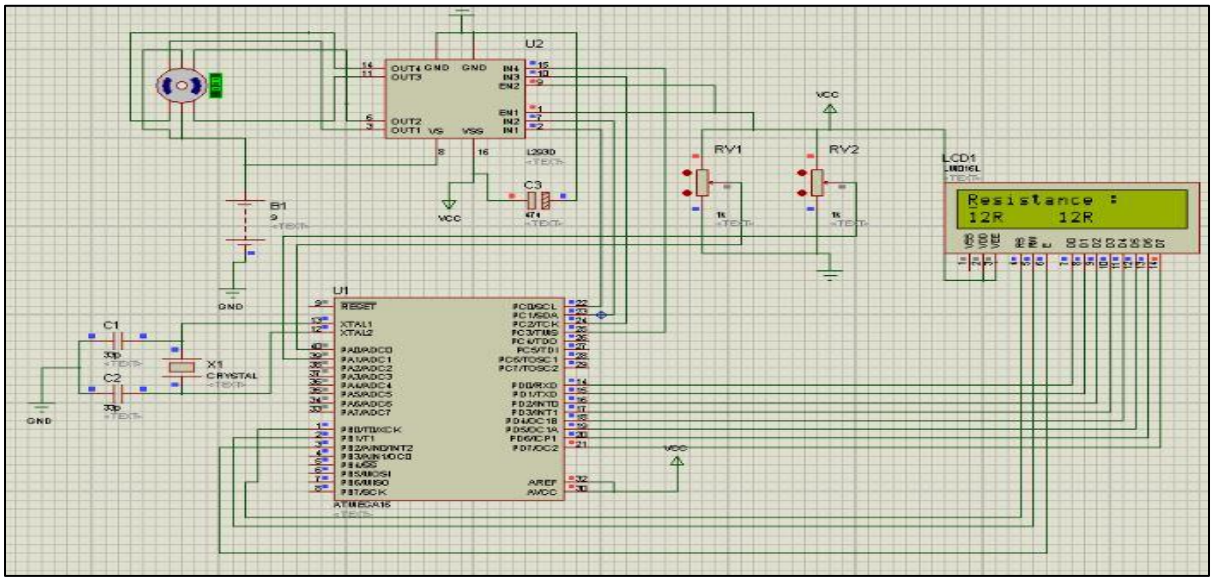
Case 2

When V2 > V1, Motor moves –15°



Case 3

When V1 = V2, Motor moves 0°



CONCLUSION

The designed algorithm is a highly flexible solar tracker mechanism using voltage comparator mechanism. Efforts are being made during the formulation of the algorithm in order to increase the accuracy of ADC inputs and reduce the step angle of the system as far as possible in order to closely follow the sun throughout the day. In case of shadow or cloud this proposed algorithm provides an effective respond with increased efficiency in real world scenarios. The simulation results show that this proposed algorithm provides several advantages and overcomes the drawbacks of other available MPPT technique.

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