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Control Strategy of Maximum Output of Solar Array

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Abstract. This paper first describes the working principle of solar cells, solar cell work to analyze the equivalent circuit and simulation model. Secondly, the two traditional maximum power point tracking control algorithms are analyzed and compared, and their respective advantages and disadvantages are proposed. Incremental Conductance and P&O.

1. Introduction

Nowadays, solar cells are also becoming more and more commonplace in production and life. However, the widespread use of solar cells must take into account many problems: the maximum power output of solar cells with temperature and light intensity changes. All solar power generation systems want the solar array to generate as much energy as possible at the same temperature, which is why we have theoretically proposed the maximum point tracking of the solar array output power.

Therefore, this thesis focuses on the theoretical analysis of the maximum output power point tracking control technology of solar array in order to achieve tracking control of maximum output power of solar array and improve the efficiency of solar power generation system.Research on Solar Cell Operating Characteristics.

2. Research on Solar Cell Operating Characteristics

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2.1. The working principle of solar cells

Figure 1 is the basic principle of solar cell work shows that the nature of solar cells is the incident photon energy into electrical energy process.

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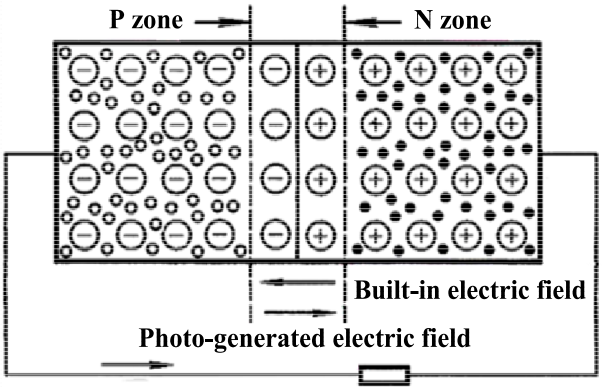

Figure 1. Solar cell working principle diagram

2.2. Equivalent circuit of solar cells

The figure below is the P-N homogeneous junction solar cell equivalent circuit.

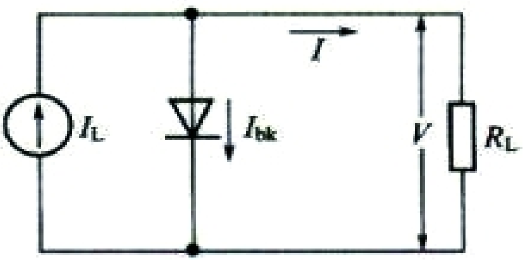

Figure 2. Not consider the series resistance

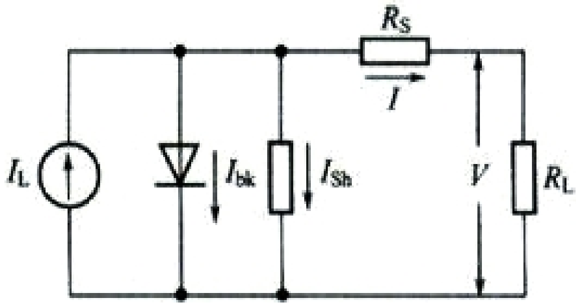

Figure 3. Considers the series resistance

3. Solar Cell Simulation

In this paper, Qingdao Tai Energy Co., Ltd. TD100-36 solar panels as the research object, the following table is the solar panel parameters.

Table 1.

Electrical Characteristics	Specification
Maximum Power	100W
Working Current	5.7A
Operating Voltage	17.5V
System Voltage	1000V
Open Circuit Voltage	21.5V
Short Circuit Current	6.02A
The Number of Batteries	72

The output characteristic equation of this solar cell array:

$$I=ISC\ [1-C1\ (expel\ (V1/\ (C2VOC))-1)] \quad (1)$$

Solar cell simulation diagram:

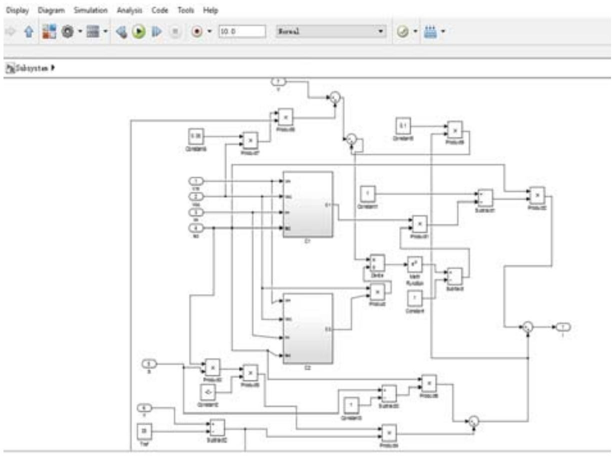

Figure 4. Solar cell simulation diagram

Figure 5 is a model of a solar cell module. Using V, T, S as input, I, P as output.

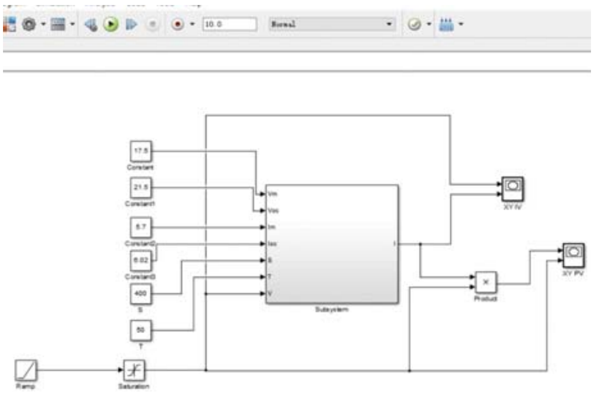

Figure 5. Solar cell module modeling

Get I-V, P-V relationship as shown below:

T = 25 ℃ under different sunshine intensity, the photovoltaic module on the amount of change in the characteristics of the curve:

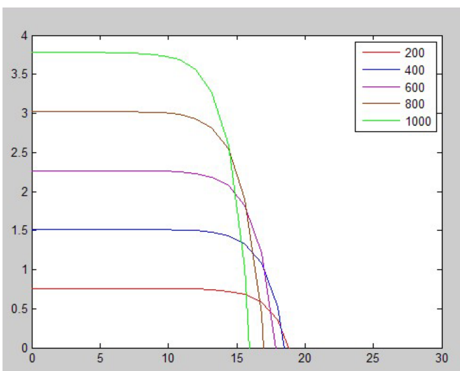

Figure 6. I-V relationship

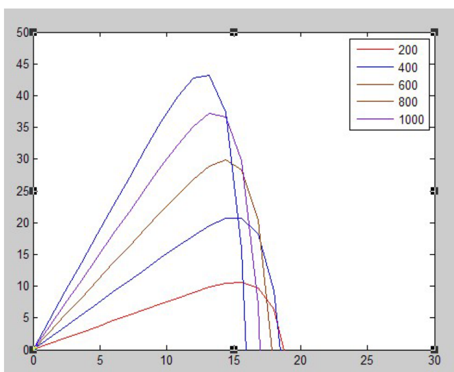

Figure 7. P-V relationship

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S = 750w/㎡, under different atmospheric temperatures, the characteristics of the photovoltaic module temperature curve:

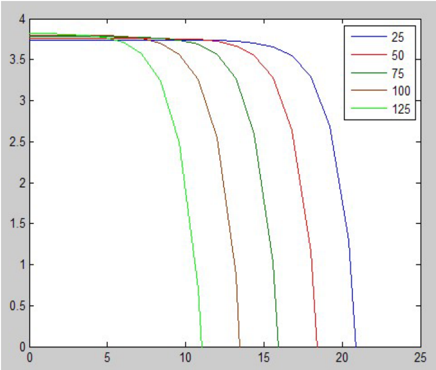


Figure 8. I-V relationship

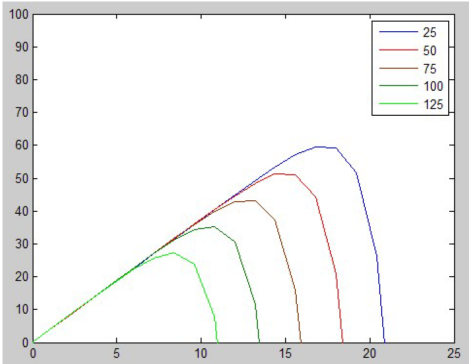


Figure 9. P-V relationship

In order to maximize the use of solar energy, we must ensure that a certain degree of conversion efficiency, to overcome the external factors that change the internal system of the various effects, so we use the maximum power point tracking method to minimize energy waste, the following two Method to study, in order to achieve the maximum power point tracking basic research.

4. Research on Maximum Power Point Tracking Algorithm

4.1. Disturbance Observation Method

*4.1.1. Disturbance observation method works.*The solar cell is initially set to operate at a reference voltage Verve, assuming a changing direction and a smaller step for the reference voltage, and then changing the output voltage in a hypothetical manner. There are two cases when the maximum power point is not reached on the left side of the maximum power point: Assuming that the reference voltage is determined to be shifted to the right, ΔP at this time is positive, approaching the maximum power point, and the reference voltage should continue to be shifted rightward; b. If the reference voltage is determined to be shifted to the left, then ΔP is negative and away from the maximum power point, the reference voltage should move in the reverse direction to further approach the maximum power point. Similarly, on the right side of the maximum power point, we can also analyze two cases, similar to the left side. By continuously detecting the change of the output power of the solar cell at this moment, the change direction of the output voltage at the next moment is determined. The following figure is the flow chart of the method:

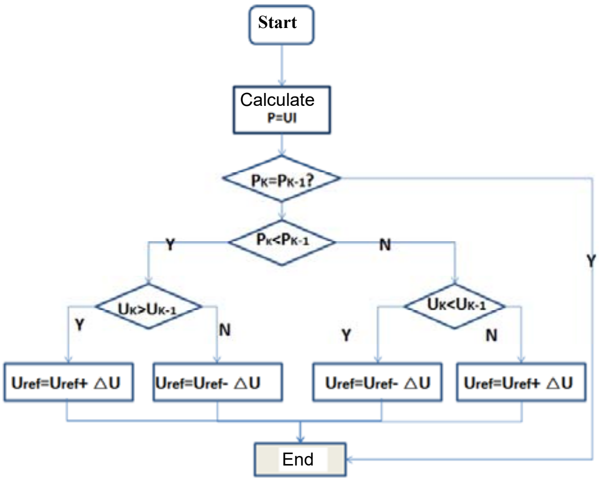
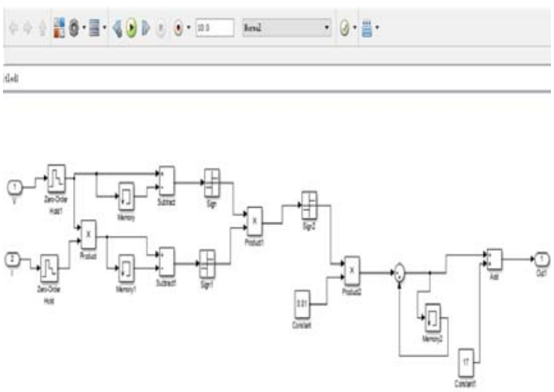


Figure 10. (P&O)flow chart

4.1.2. Simulation Model and Simulation Result of Disturbance Observation Method



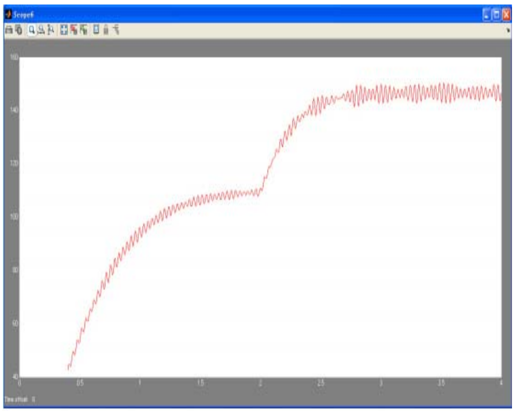


Figure 11. Simulation model **Figure 12.** Simulation results

4.2. Incremental Conductance

4.2.1. Incremental Conductance method. The figure below is the P-V graph of the solar array:

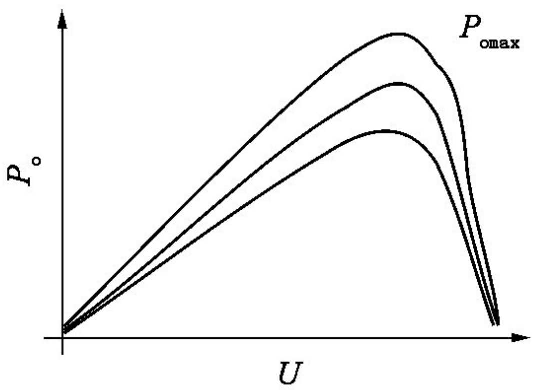


Figure 13. The P-V graph of the solar array

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From the P-V curve analysis of the array, dP / dV = 0 at the maximum power point, dP / dV> 0 to the left of the maximum power point and dP / dV <0 to the right of the maximum power point. Incremental method to determine the relationship between the battery array output voltage and power: For the output power are: P = IV, V on both sides of the derivative and I as a function of V, can be:

$$\frac{dP}{dV} = I + V\frac{dI}{dV} = 0 \tag{2}$$

It can be seen from the P-V curve analysis that dP / dV = 0 when V = Vm and dP / dV <0 when V> Vm and dP / dV <0 when V> Vm.

$$dI/dV>-I/V(V<Vmax) \tag{3}$$

$$dI/dV<-I/V(V<Vmax) \tag{4}$$

$$dI/dV=-I/V(V=Vmax) \tag{5}$$

In this way, according to the relationship between dI / dV and -IV to adjust the operating point voltage to achieve the purpose of MPPT. Here, the introduction of the reference voltage ref, the following figure is the reference voltage flow chart:

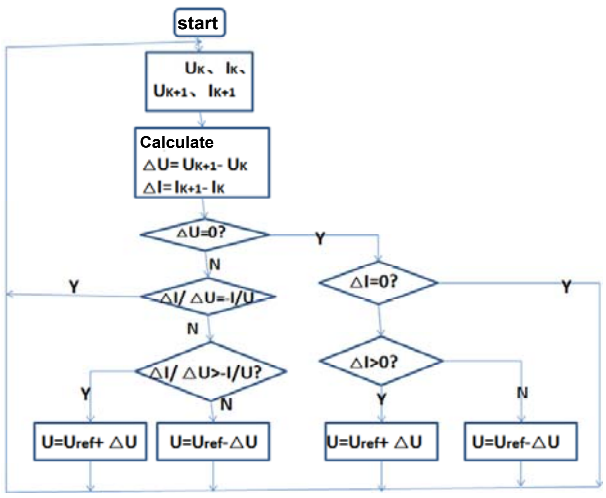
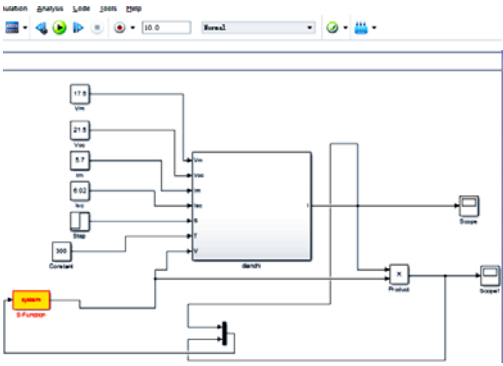


Figure 14. Incremental Conductance method flow chart

4.2.2. Simulation Model and Simulation Result of Incremental Conductance



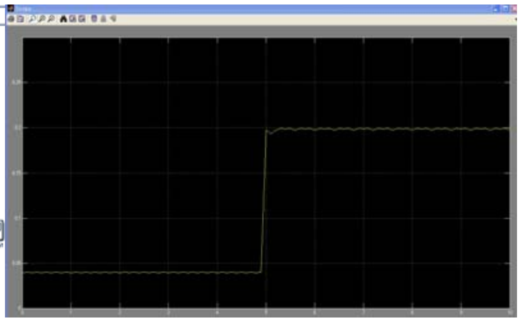


Figure 15. Simulation model **Figure 16.** Simulation results

5. Two kinds of MPPT algorithm analysis and comparison

The disturbance observing method has less parameters to be measured, the control system is simple, the control algorithm is relatively easy to implement, and the precision of the sensor is less demanding. It can realize the dynamic tracking of the maximum power point and improve the dynamic utilization of the system. However, the goal is relatively blind. Due to the constant disturbance, the operating point of the photovoltaic cell always changes constantly around the maximum power point, and cannot work stably at the maximum power point, resulting in a certain power loss. Because the disturbance observing method uses the power and time as a function to track the extremum of the power time curve, it can only improve the tracking effect by increasing the disturbance frequency and reducing the disturbance step, so as to reduce the range of misjudging the blind area.

Incremental method is fast, the effect is good, to adapt to rapid changes in atmospheric conditions, occasions, the control of high stability, when the external environmental parameters of the system changes can be smoothly tracked, and the solar module has nothing to do with the characteristics and parameters.However, the cost is high, and the initialization voltage of the control voltage has a great influence on the tracking performance during the startup of the system, and if set improperly, a large power loss may occur. The derivative can be calculated by adopting the three-point calculation formula of numerical differentiation to improve the calculation precision of derivative and improve the A / D sampling precision so as to improve the tracking accuracy of the system.

6. Conclusion

This article focuses on the analysis of two control strategies of maximum power point tracking for solar cells and puts forward some strategies to improve the tracking efficiency. From the above analysis, the following conclusions can also be drawn: In the case of photovoltaic systems that require stable long-term operation and the external environment of the system When the parameters change more slowly, it is more suitable to use the above two methods, that is, the disturbance observation method and the fixed-step long-admittance incremental method.

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