

Automatic Solar Tracking System Controlled by HW PLD

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Abstract

In order to make better use of solar energy, automatic tracking system is more and more used in solar energy industry. The solar panel automatic tracking system based on programmable logic controller (PLD) includes hardware and software, in which the hardware includes PLD input and output port, signal processing unit and driving part; The software includes PLD control and monitoring program. The solar panel automatic tracking system enables the photovoltaic panel to track the solar care in real time, so as to obtain solar energy to the greatest extent, effectively improve the utilization rate of solar energy and the efficiency of photovoltaic power generation system, and reduce the cost of photovoltaic grid connected power generation. It has theoretical research significance and application promotion value.

Keywords

PLD; Solar energy; Automatic tracking system.

1. Introduction

The development of new energy and renewable resources is a common topic facing the world. Among new energy sources, solar power generation has become the fastest developing technology in the world. As a clean and pollution-free energy, solar energy has a broad development prospect. However, due to the gap of the sun and the continuous change of light intensity with time, higher requirements are put forward for the collection and utilization of solar energy. At present, many solar panel arrays are basically fixed, which can not make full use of solar energy resources and low power generation efficiency. According to the test, in the solar panel array, under the same conditions, the power generation capacity of power generation equipment using automatic tracking system is about 35% higher than that of fixed power generation equipment.

The so-called solar tracking system is a power device that can make the solar panel face the sun at any time and let the sunlight shine vertically on the solar panel at any time, which can significantly improve the power generation efficiency of solar photovoltaic modules. At present, the tracking system used in the market is divided into single axis solar automatic tracking system and double axis solar automatic tracking system according to the driving device. The so-called single axis means that the sun can only be tracked horizontally, and the height is artificially adjusted and fixed according to the changes of geography and season, which not only increases the workload, but also the tracking accuracy is not high enough. Dual axis tracking can track the sun's trajectory in both horizontal and altitude directions. Obviously, dual axis tracking is better than single axis tracking.

In terms of control means, the system can be divided into sensor tracking and apparent solar trajectory tracking (program tracking). Sensor tracking uses photoelectric sensor to detect whether the sun light deviates from the normal of the battery board. When the sun light deviates from the normal of the battery board, the sensor sends a deviation signal, and controls the actuator after amplification and operation to make the tracking device align with the sun again. This tracking device has high sensitivity, but it will affect the operation in case of dark clouds covering the sun for a long time. The apparent solar motion track tracking is to adjust

the tracking device according to the actual running track of the sun and the predetermined program. This tracking method can track all-weather real-time, and its accuracy is not very high, but it conforms to the operation situation and is widely used.

From the type of main control unit, it can be divided into PLD control and single chip microcomputer control. The single chip microcomputer control program is written and developed by professionals when leaving the factory. It is not easy for general equipment manufacturers to develop and set parameters again. It is easy to learn to use PLD. Through the training of PLD manufacturer's technicians, the technicians of equipment manufacturers can easily learn simple debugging and writing, and PLD can provide a variety of communication interfaces, and the communication networking is also convenient and simple.

2. System Hardware Design

The system is a dual axis automatic tracking system based on the apparent solar trajectory control (program control) of the PLD main control unit. The apparent solar trajectory tracking is to calculate the real-time position of the sun: solar azimuth and solar altitude by using the corresponding formulas and algorithms of the PLD control unit, and then send instructions to the actuator to drive the solar tracking device, In order to achieve the purpose of real-time tracking of the sun.

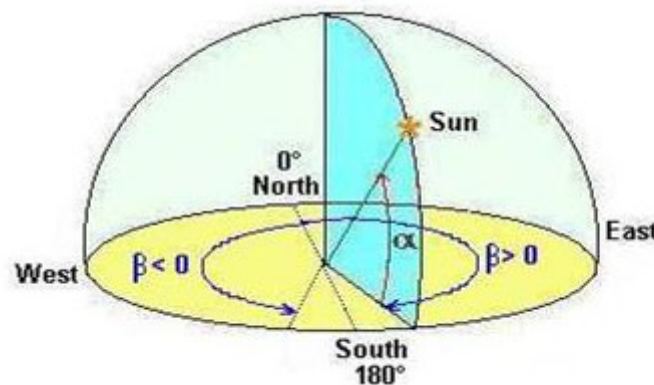


Figure 1. Schematic diagram of azimuth and altitude angle: α - Height angle β - azimuth

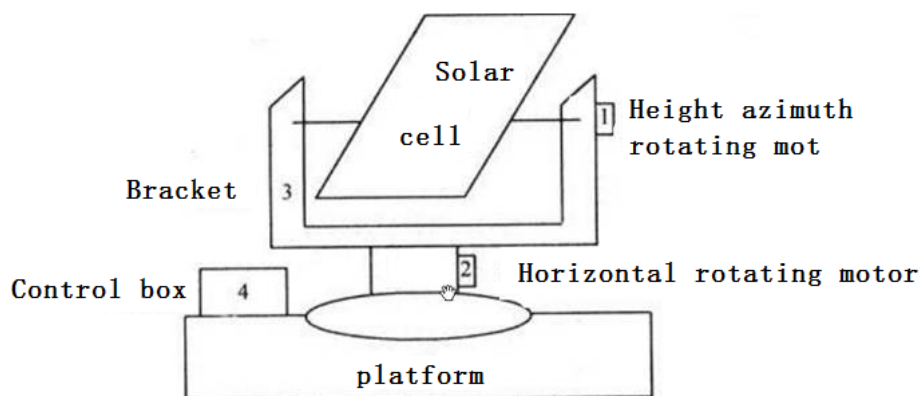
The position of the sun in the sky can be determined by the solar altitude angle and solar azimuth angle. Solar altitude angle, also known as solar altitude and solar pitch angle, refers to the angle between the sun's light and the surface level. The azimuth of the sun, that is, the azimuth of the sun, refers to the included angle between the projection of the sun's light on the ground plane and the local meridian, which can be approximately regarded as the included angle between the shadow of the straight line on the ground under the sun and the due south direction. The real-time values of solar azimuth and altitude can be calculated by using formulas through geographical longitude, latitude and time zone parameters.

The main control unit is the core component of the solar tracking system, and the system is compact. Xilianfa HW PLD with flexible configuration and rich instructions. The selected configurations include HW 3108cpu module and HW 3310 expansion module. Hw3108 is integrated into digital quantity 24di and 16Do, which can meet the requirements. The communication is integrated with two communication interfaces: RS232 and RS485. RS232 is used to communicate with the upper text display, and RS485 can be used for networking. HW 3310 is a four-way AI module, which can be used to collect protection data such as wind speed. Used with xilianfa hd2400l text display, it can monitor the operation status and change parameter settings to achieve the purpose of control.

Table 1. System signal table

Serial number	Signal type	Signal description
1	DI	Height angle origin limit
2	DI	Upper limit of height angle
3	DI	Lower limit of altitude angle
4	DI	Azimuth origin limit
5	DI	Height angle East limit
6	DI	Height angle West limit
7	AI	Wind speed sensor
8	DO*2	Height angle forward / reverse
9	DO*2	Azimuth forward / reverse

The structure of the tracking adjustment device designed in this paper is shown in the figure below: it is mainly composed of base, vertical shaft, horizontal shaft, two rotating motors, transmission gears, etc. The rotating motor 1 drives the horizontal axis, supports the solar panel to move around the horizontal axis and tracks the height angle. Rotating motor 2 drives the horizontal axis to track azimuth changes.

**Figure 2.** Mechanical structure diagram of tracking system

In the whole process of a day, the tracker can obtain the optimal altitude angle and azimuth angle, and the battery panel can receive the maximum daily solar radiation. The system uses a set of formulas to calculate the altitude and azimuth of the sun at the actual time from PLD, and calculates the tracking operation time of the actuator according to the difference between the real-time solar altitude and azimuth and the actual altitude and azimuth of the tracking device, as well as the operation speed of the driving device. Finally, the program is executed to drive the motor to reach the required position to realize the tracking of altitude angle and azimuth angle.

3. System Software Design

The judgment process of tracking mode is completely realized by software with high flexibility. It can be adjusted according to different regions and different climates, so as to improve the power generation efficiency of photovoltaic power station. Multi sensor devices such as light intensity sensor and wind sensor can also be added as needed to improve safety and higher control requirements.

Through program control, it can automatically judge whether the operation conditions are met, so as to achieve the control of automatically starting the operation device, automatically stopping and returning to the initial state. The wind sensor is added to protect the system. When the wind force is greater than a certain value, the system stops working and resets to the origin. When the wind speed meets the working conditions, the system starts working automatically. The solar panel has two degrees of freedom, and the control mechanism adjusts the height angle and azimuth. When the battery board turns to the end, because the tracking device is equipped with a limit sensor, the output is automatically cut off when it reaches the limit contact, and the motor stops working.

4. Conclusion

This paper introduces a double axis solar energy automatic tracking system based on xilianfa HW PLD control. The system is designed by using the apparent solar motion trajectory tracking method to automatically detect the operating conditions and achieve the effect of real-time tracking the sun. Taking xilianfa PLD as the main control unit, the angle difference between the real-time position of the sun and the system position is calculated by the PLD program through the algorithm, and then the running time is calculated by the running speed of the rotating motor. Through the logic control relationship of PLD program, the motor is driven to rotate to achieve the function of automatically tracking the sun position. Therefore, the automatic tracking system has high accuracy and strong reliability. Even in the case of complex weather changes, the system can work normally and improve the utilization efficiency of solar energy. Because PLD has strong programmability, customers can modify and write control programs according to their own requirements to achieve the best control effect. For the control of series and parallel large-scale photovoltaic solar array system, the communication network can be formed through the communication of HW PLD for centralized control. It can be seen that the solar automatic tracking system developed based on xilianfa HW PLD has the characteristics of high precision, real-time tracking of solar changes, convenient communication networking and so on, and can meet the needs of customers.

Acknowledgments

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