

Research Of Control System Based On Solar Panel Cleaning Mechanism

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Abstract:- The solar panels are the core of the solar power generation system, and the dust particles will influence the efficiency of their power generation. However, the cleaning process of the solar panels usually encounters the problems, such as difficult to operate, poor efficiency, time-consuming, laborious and high cost. The solar panels cleaning robot to solve the problems developed by our research team is introduced briefly in this paper, and a kind of automatic control system used to control the robot is also proposed and studied. According to the function of the need, the components of the control system are designed, including the drive units, the sensor units, the information process units, the controller, and so on. The application of the control system can be helpful for the efficient completion of the cleaning work of various types of solar panels.

Keyword:- solar panel; cleaning mechanism; control system; positioning monitoring

I. INTRODUCTION: PROJECT RESEARCH BACKGROUND AND SIGNIFICANCE

Under the impetus of the new national energy policy, China's solar photovoltaic products have met a large development period, whose production and productivity keep rising. From the perspective of the supply situation of photovoltaic modules, since 2007, China has become the world's largest producer of photovoltaic modules. In 2013, the production of polysilicon in China is 84000 tons, up 18.3%, the import of polysilicon is 80000 tons; the production of battery components is about 26GW, which accounts for 15 percent of global share. It is up 13 percent from a year earlier. Its export is 16GW and its value of exports is about 12.7 billion dollars.

The solar panels is the core part of the solar power system and the most expensive part of the solar power system, as the Fig.1. Its function is to convert solar energy into electric energy or to send the energy to the battery to store them or to promote the load to work^[1]. Quality and cost of solar panels will directly determine the quality and cost of the whole system. If you want to lift the Solar photovoltaic panels' power generation efficiency by 1-2 percentage points, it will spend a lot of research and development funds; Due to the dust which blocks the sun, the photoelectric effect of the silicon photovoltaic panels will be influenced a lot, which will make the power generation efficiency 35-40% lower.

Nowadays there are more than one hundred companies engaged in, as shown in Fig.1 equipment research and development production in our country, which is mainly in the field of silicon wafer processing, cell manufacturing, components and auxiliary equipment manufacturing production. The factories are most located in the east, north and south of China. The distribution of the silicon wafer cleaning equipment market in China also presents a certain region, which is concerned with the main object of this service and cleaning equipment manufacturers and the distribution of silicon cell component enterprises^[2]. Yangtze River delta region of east China consume alone accounts for half of the country's demand, the second is south China, north China, northwest, northeast and other regions. These companies mainly use the expensive self-cleaning materials, as well as the danger manual cleaning methods, as shown in Fig.2. There are also a small amount of companies that use the automatic cleaning device, but it is only aimed at the single piece of the solar photovoltaic panels. It is difficult to meet the need of the cleaning fact of the great number of the solar photovoltaic panels groups and the low degree of the automation can't supervise the cleaning degree the panels' sets and the running state of the cleaning equipment^[3].

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Fig.1. Photovoltaic power station



Fig.2. Manual cleaning of photovoltaic cells

Solar silicon wafer cleaning technical problem is that in the cleaning process it will produce a lot of sticky dust, which will have residue slurry residue, cleaning fluids, cleaning fluid and reactants of silicon, silicon oxide, etc. To clean these solar wafers with sticky dust, we must unload them and use the solar cleaning machine to clean it. Although the cleaning effect is considerable, it is time-consuming and will increase labor cost. So we starve for a kind of intelligent cleaning robot that have the function of intelligent control, online monitoring, visual control and so on.

II. THE CONTENT OF RESEARCH

This project is based on the previous study of cleaning robot of panels and the method to develop a set of solar panels set of cleaning robot automatic control system. Mechanical system is mainly composed of cleaning device, water supply equipment, and walk across device and adjustable bracket. What has been completed is showed in Fig.3

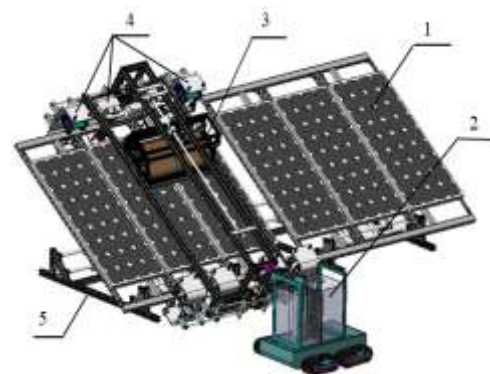


Fig.3. Cleaning robots' 3D models researching mechanical system

1--Solar panels; 2--water supply equipment; 3--cleaning device; 4--walk across device; 5--adjustable bracket

The control system of this project we developed needs to realize automatic exhaust cleaning change, real-time network control and monitor equipment operation status and fit all kinds of photovoltaic panels group by machine vision adaptive contour analysis and geometric matching in the cleaning^[4-5]. This project belongs to the electromechanical integration control field.

III. RESEARCH ON CONTROL SYSTEM

3.1 Control System Hardware

According to the actual application to the output and the number of input ports, we choose the PLC model for the S7-200 226CN, which has two high speed pulse control is controlled for 7 motors. One of the high speed pulse control controls two sets of motors; another high speed pulse control controls 3 motors^[6].

Selection principle of fuse:

Total load current of 1.5 ~ 2.5 times, if no motor can be 1.5 times the choice. Impact of current general situation refers to the equipment start-up current, such as motor starting current is 4-7 times the rated current, or even higher, in equipment fault or short circuit it will also produce impulse current. This is under the standard sine, generally in the serious harmonic system, crest factor can reach 2.53, so it choose fuse, at least to choose the total load current of 2.5 times. Its multiple is the most fundamental factor in the system of wave crest factor.

Selection principle of circuit breaker:

1. Circuit breaker rated voltage greater than or equal to Line rated voltage;
2. Circuit breaker rated current greater than or equal to line calculated load current;
3. Breaker rated current greater than or equal to load current circuit calculation;
4. Circuit breaker limit breaking capacity greater than or equal to the maximum short-circuit current in the line;
5. Automatic switch instantaneous line terminal single phase short-circuit current is not less than 1.25 times (or short delay) tripping current setting;

3.2 Function Of Control System

The automatic control system of the solar panel cleaning robot is developed on the basis of previous research in this paper. The system's design of photovoltaic battery plate washing system is based on tracked mobile water supply platform, which can work in harsh environments, like large-scale photovoltaic power station is located in the desert, Gobi and wilderness. For the ability of walking, spanning technical rail mobile cleaning robot can complete the cleaning mask between each block of photovoltaic solar panels^[7]. Therefore, it can realize the automation and industrialization of cleaning process. The whole cleaning system of the machine is composed of a self - cleaning device, an adjustable multifunctional bracket, a solar cell board, a walking across the device and a water supply device. The overall scheme is shown in the Fig.4.

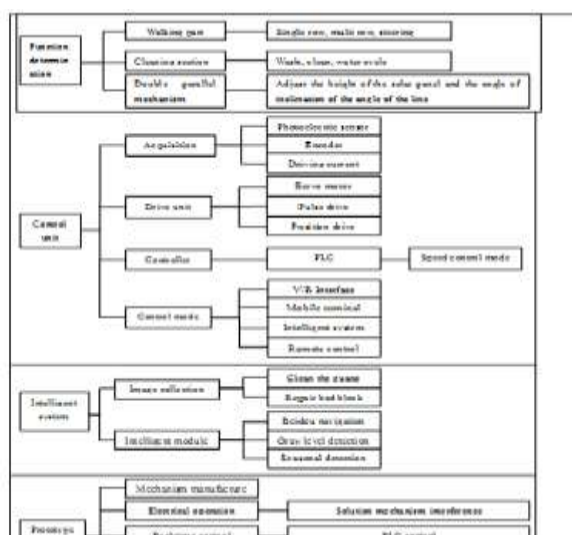


Fig.4. Block diagram of intelligent detection and cleaning robot for array photovoltaic cells

3.3 Components of control system

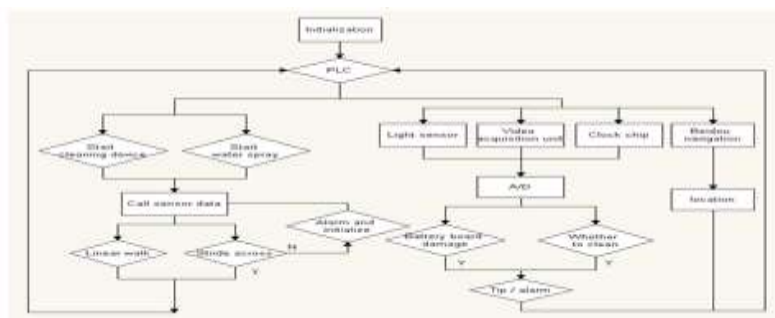


Fig.5. Components of control system

PLC control of the cleaning equipment has the following characteristics. First, high reliability, thanks to a series of measures to the reliability of PLC, PLC MTBF can be generally up to 3 ~ 50000 hours. And PLC environment adaptability is strong, it can work reliably in industrial environment; Secondly, simple programming, PLC ladder diagram language is the most commonly used programming languages. This kind of programming language visual image is easy to grasp, do not need special knowledge of computers and is easy to master by the vast field of engineering technical personnel. When work process needs to change, it can change procedures. It is convenient and flexible. Thirdly, it has small volume, compact structure, easy installation,

maintenance. By the PLC's self diagnosis, fault alarm and fault display function, it can be more easy to change the module plug-in and troubleshoot quickly.

Because solar panels set clear institutions are often under high temperature continuous work, which is needed to control the temperature of the system, especially the controller has strong stability and seismic capacity, through a combination of the control system, the advantages and disadvantages in this topic of practical control system will be chosen based on the PLC as the controller of control system (see the Fig.5). The system has strong anti-interference ability, good reliability, low external connection, the average failure rate less advantage.

3.4 The electrical schematic diagram

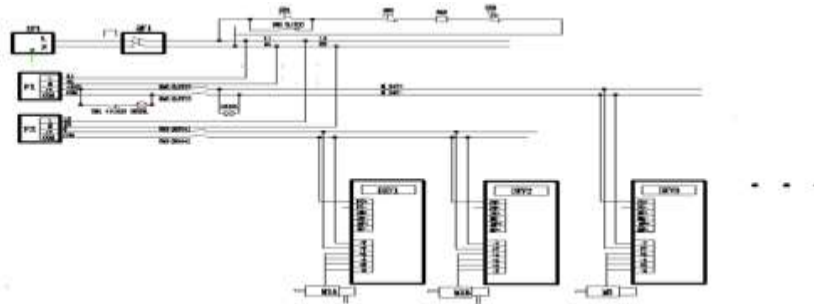


Fig.6. Electrical schematic diagram

3.5 The ladder diagram program

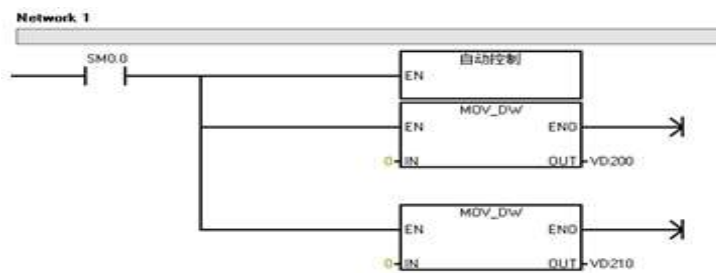


Fig.7. Parts of PLC ladder diagram program

IV. ROBOT PROGRAM DEBUGGING

4.1 Program debugging steps of control system

- 1) For the more complex control system, the system flow chart is needed to make clear the sequence and condition of the action.
- 2) Design ladder diagram. This is a key step in the design of the program, but also a difficult step. To design a ladder diagram, the first to do is very familiar with the control requirements, but also have a certain electrical design experience.
- 3) The program input to the PLC user memory, and ensure that the program is correct.
- 4) Debugging and modification of the program, until meet the requirements.

4.2 The Matters To Be Noted In The Process Of Debugging

- 1) Data line and computer interface must be set to maintain a matching with the port of the software, otherwise the operation will produce a communication error.
- 2) Connect the PLC, it is necessary to clear how much is the PLC's power supply voltage is , if the actual voltage is less than the power supply voltage, it will not run, PLC power lamp would not light; if the actual voltage is greater than the power supply voltage, PLC will be burned out.
- 3) Port connection must be strong.
- 4) Be sure to pay attention to the safety of power.

V. CONCLUSION

- 1) The control system of the solar panel cleaning robot is designed, and can realize the functions of automatic cleaning, network real-time control, monitoring of the equipment operation status and so on. And it can adapt all types of solar panels cleaning;
- 2) The control system based on PLC for the controller has the advantages of strong anti-interference ability, good reliability, low external connection, and low failure rate and so on;
- 3) The control system can guarantee to work continuously at high temperature and can be used for earthquake proof and seismic resistance;
- 4) The application of the control system can help to realize the automation and industrialization of the cleaning process of the solar panel.

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