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Study of Architectural Shading System Based on BIPV

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ABSTRACT

(Pv) Power combined with Building (Building Integrated Photovoltaic, hereinafter referred to BIPV) is the one of the form in the practical application of Photovoltaic technology, its main combining ways have Photovoltaic roof, curtain wall of pv Building, pv Building sunshade, etc. This paper introduces a design that can be used for engineering photovoltaic an intelligent sun-shading system, which contain intelligent sunshade function and have (pv) power ability.

Keywords: BIPV, Photovoltaic shading, Automatic control.

1. INTRODUCTION

To solve the energy crisis and environmental pollution, we should also pay attention to save energy except the development and utilization of new and renewable energy. The building energy consumption accounts for about 30% in the total energy consumption from society, so the energy conservation of the building is very important. Solar generation of photovoltaic power and building intelligence sunshade integration in the research and design shows that the design of effective building sunshade is very significant in hot summer to reduce energy consumption.

Shading can effectively weaken heat of sun radiate into indoor and reduce the load of air conditioning; it Can improve lighting evenness and avoid to produce glare; it can reduce light pollution in glass curtain wall and also can reflex and isolated from the noise of world profile outside. Building sun-shading system which is used in the manufacturing technology of modern industrial, its unique form and structure, light and shade variations can add the building more artistic aesthetic feeling in addition to the physical function.

Sun-shading system can be divided into fixed and adjustable form according to the controllability. Adjustable form can be divided into manual adjustable, electric adjustable and intelligent control which can be adjusted. The so-called intelligent sun-shading system, intelligent control system is adjustable, which is accompanied by a variety of sensors, such as smoke sensors, wind speed and direction sensors, photosensitive sensor, the snow and rain sensor etc, it can automatically adjust the shade (leaf)perspective according to the actual circumstances in order to the optimum shading effect.

2. OVERALL PLAN

2.1 System overview

This paper designs both a shading of photovoltaic system and the intelligent shading and photovoltaic energy function, it is arrived as shown in figure 3-1. It mainly includes the following four parts: it designs supporting structure and designing shade (leaf), electric machine and transmission mechanism, control system, Photovoltaic power system in order to combine with engineering practice and design within the building in 1600 mm wide and 800 mm high outside surface. Photovoltaic blinds components connect and control by the form of array. Every piece of leaf is breadth of 100 mm and length of 800 mm, about 20 mm distance; all parts add up to 16 pieces. 16 blades run by the control a motor and single-chip controls electric machine.

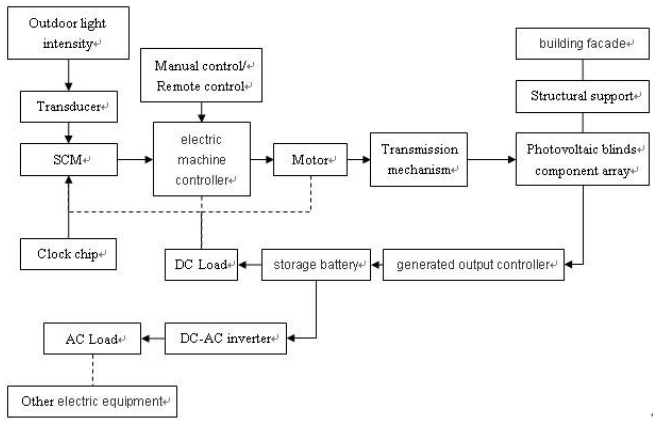

Figure 1. System block diagram

2.2 Working principle

Photovoltaic blinds are not only as the building component of shadow to undertake the mission of sunshade but also bearing and integrating the photovoltaic cells to output power. The blade Angle changes by the control of single-chip microcomputer. At the same time its photovoltaic battery produces electrical energy to charge the battery so that supplying for motor and SCM or other dc power equipment, in addition, power can be applied after DC and AC inverter transform for interflow equipment. It can be incorporated into public grid under Conditions, external of single chip can connect with photosensitive sensor and clock chip; Photosensitive sensor test changing of outdoor light providing the signal of light intensity for single chip, the clock chip produces a time signal to read for single chip microcomputer. Single chip reads the current time single chip and stored time when outdoor light become strong—Motor running schedule compares and inquires, output control signal by the motor controller, motor and transmission mechanism to run blade into appointed angle. When outdoor light becomes weaker, it will drive blade to the horizontal position directly. The positive and negative turning of every electric machine is by their motor controller, the motor controller already are in control of both the output of the single chip microcomputer control signal and by the individual manual, remote control switch.

3. PHOTOVOLTAIC SHADING

Sunshade mainly contain points horizontal type, vertical type, comprehensive type, file board type according to the arrangement of points, the latter two things is actually special applications before two kinds, the latter two things is not suit due to the facade requirements, stress conditions in the modern design of architecture, therefore, it can be summarized to horizontal and vertical forms. That Level form can be effectively keep out of the solar altitude angles is the bigger before direct sunlight from the window. In our country's regional speaking, in the area north of the tropic of cancer, it is suitable for the south to nearby the window; however, in the area south of the tropic of cancer, it applies to both south to the window and can be used in the north to the window. That the vertical form can be effectively keep out of the solar altitude angles is lesser from the window of the direct sunlight in lateral slanted down. It is mainly used in the window near west and east.

Photovoltaic sunshade is a structure form outside the building attaching to the outside wall, its mounting surface mainly contain vertical fitting surface, level day lighting top mounting surface and inclined day lighting top in mounting surface, as shown in figure 2. Vertical installing surface is the most common and can effectively control the sun radiation of entering indoor nearby the wall; Day lighting top level mounting surface and inclined day lighting top mounting surface can effectively solve problem for the large area indoor natural lighting and the sun radiation overheat, a large number of them applied in large-scale public buildings, such as the airport, railway stations, the exhibition hall, library, etc., this kind of architecture is general open and no shading, it is very suitable for the layout of the array in wide photovoltaic shading.

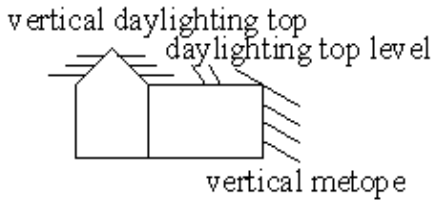

Figure 2. Photovoltaic sunshade

4. DESIGN OF CONTROL SYSTEM

Photovoltaic sunshade components, as a peripheral part of the building structure, are an interactive touch interface of buildings with the environment, they should be make adjustments based on the outside environment and indoor environment change. In an intelligent control, acquisition of various environment variables and signal processing actually constitute a miniature weather stations. Generally, it need to gain acquisition of the signal including light outside of strong, wind speed and the direction of the wind, the rain and snow, fire signal, the amount of indoor temperature, whether there is a maintenance personnel work outside, emergency button and so on.. When the above signal is normal, blade can change to be automatic operation under control program with radial Angle by the time schedule. When the above signal value is over the threshold set, it will drive to the designated position leaves and generally make blade by level. In addition to use the time program to control outside, it still can track the sun by acquisition radial Angle, however, as the sun is regular, the position of the light relative to the blade has uniqueness for a specific position building in a moment of year. Therefore, blade controlled by time program is concise and convenient, good stability, it is the first choice of leaf control.

4.1 The control of output — The design of angle

Blade Angle can be designed according to building in the latitude, the circumstance such as position and use demand. Different engineering can have different design. This paper is based on the building which is located in Beijing, for example (Beijing north latitude is 39 ° latitude, its longitude is 48' east longitude 116 ° 28'), a mounting surface shading is toward the south. Because Beijing is located in the zone with hot summer and cold winter, general summer half a year (April to September)which is shading coefficient SC should be as far as possible big and can be designed close to 100%, namely, little direct sunlight can't access to indoor, day lighting is from diffuse and reflected; however, when it is in the winter-half year (October to march), may be in the control of part direct sunlight to enter indoor in order to improve the indoor temperature, but this still should avoid excessive direct sunlight to enter indoor lest interference of cross bright glared. when parts can be through sunshine, blade can exist between them to keep out of mutual problems in order to make the photovoltaic cells produced the greatest of generating capacity, we should try to make the sum which is trend to 90 degrees in blade Angle B and the vertical shadow Angle of VSA, it is equivalent to uniaxial tracked the sun light (highly direction). Sunshade coefficient can determine according to thermal needs in the winter-half year. Shading coefficient is connected with leaf breadth, spacing and the Angle. This paper are based on the winter solstice (usually in a December 22) and noon shading of coefficient

to meet requirements as a benchmark to carry on the design, this set was 60% at the moment of sunshade coefficient. The calculation of noon VSA in the winter solstice is 26. 7 ° and the blade Angle B is 63. 3 ° , as the 300 wide of blade has determined, the blade spacing D with 560 mm can meet the requirements by coefficient. As shown in figure 3-11 below. When leaves spacing D is determined, we can be used to calculate the winter-half year of blade Angle by each hour according to B + VSA = 90 ° . The coefficient SC is B/Dcos VSA at this time, this type of B is for leaf breadth. Along with the dates from the winter solstice become more far, while VSA is the bigger, the SC is also bigger. Namely, the winter solstice coefficient of shading become the minimum, light transmittance is the most big and can get the most of the radiation in the sun, it meet the demand heating and this also is the cause to meet the design requirements for the benchmark based on above-mentioned in the sunshade coefficient of the winter solstice.

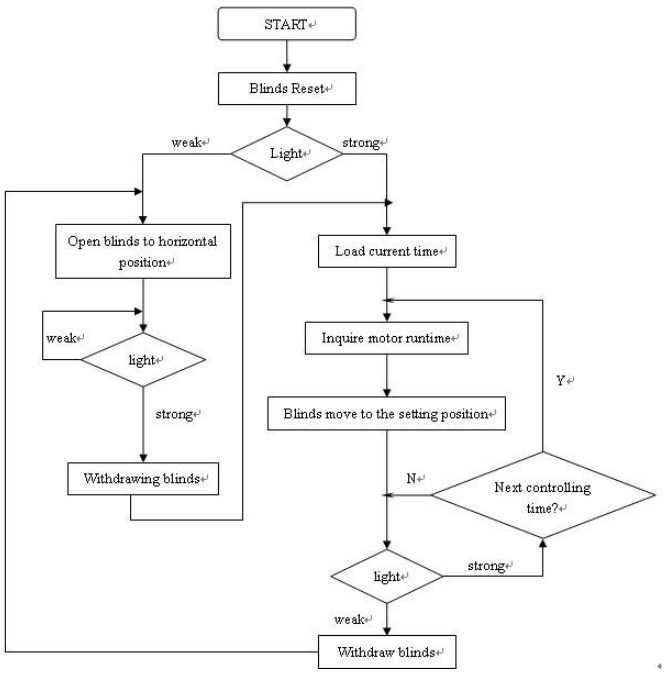

Figure 3. workflow diagram

In the summer half a year, sunshade coefficient SC can be closed to 100%, it can't keep out between blade and cannot play photovoltaic cells of power capacity to achieve the most generating capacity, we should make B + VSA = 90 ° as to finish this point, parts of the single axis in the photovoltaic cells tracks point-blank the sun's rays at this time, a small part can be keep out by the top leaves to accept scattering and reflected radiation. The track of sun changes in a day, but we need adjust a blade Angle every once in a while, it realizes that the basic uniaxial tracked the sun; this article take five time to adjust Angle and need to five Angle value every day. But the sun in the relative changes of trajectory between the next day is very slow, as to calculate and stored in a computer from the point of view of the value for inquires, it is necessary to transform a Angle value each week (this article totally 5). With the typical winter solstice based on calculation every year, calculating a design value is every 7 days.

4.2 Outdoor light intensity test and signal input

Shade leaves can block direct sunlight and adjust the indoor illumination, but cloudy day or when the sun obscured by clouds outdoors, it is not expected that indoor illumination is too low. Now the leaf must be unfolded in order to make it in the horizontal state (i.e. B = 0). The aim is to reduce the impact of indoor illumination. Photosensitive devices can be used to test the outdoor light intensity. When its data is below the set threshold, the controller drives the motor to make the leaves move in order to meet the design requirements.

There are many kinds of accessible photosensitive electronic component. We usually use light-sensitive resistors, photodiode, phototransistor, photovoltaic cells and so on. We choose photosensitive resistor. It works by photoconductive effect

Photosensitive resistor can be divided into visible light dependent resistor, UV light-sensitive resister and infrared light dependent resister according to their spectral characteristics. In this paper, photosensitive resistors are chosen to decide the outdoor light intensity. Visible light dependent resistor is available. Common types of photosensitive resistors are MG and GL. As the GL-type photosensitive resistor is epoxy encapsulated cadmium selenide (CdSe) light-sensitive resistor, it has a small size, reliability, fast response, high sensitivity and good spectral characteristics and other characteristics, so we choose GL5616D type. Specific parameters shown in Table 1.

Table 1. Specific parameters of GL5616D

Maximum operating voltage (V)		150
Maximum power (mW)		100
Light resistance (kΩ)		5～10
Dark resistance (kΩ)		1. 0
Spectral peak (nm)		560
Response time (ms)	Rise	30
	Decline	30
Resistance characteristics of illumination		2

4.3 Signal processing and output control circuit

AT89C2051 microcontroller is the core of the control system, which is used for signal processing, controlling the state of motion of the motor. ATMEL AT89C2051 microcontrollers produced by the U. S. are low-voltage, high-performance CMOS 8-bit microcontroller.

T89C2051 outstanding features MCU ensure the needs of this circuit. Its port P1 and P3 can be used as input ports and output ports. In this circuit to P1. 0 mouth to receive the photosensitive resistors and Schmitt toggle consists of the signal input portion of signal receiver mouth, P1. 1 mouth, P1. 2 mouth as a signal output, control, and the connection of relay, which drive motor controller and motor (at the same time more than in parallel. When the leaves and the motors are of a large array, the motor should be staggered batches start in order to avoid the impact of power, then you can use other ports, such as PI. 3, P1. 4 output control signals such as batches. Circuit shown in Figure 4

When the P1. 1 output high and P1. 2 output low, conduct T1, cut-off T2, relay KA act, its normally open contact closure, A ends 24V output voltage, the drive motor

controller open (c)end, and open the blade. Similarly, P1. 1 output low, P1. 2 output is high, the relay KB action, its normally open contact is closed, B-side head 24V output voltage, the drive motor controller close (c) side, and close the leaves. When P1. 1, P1. 2 are low, A, B ends are not connected to 24VD power supplies, motor controllers aren't controlled by the SCM. When P1. 1, P1. 2 are high, A, B ends are connected to 24VD power supplies, motor controllers are controlled, but remain stationary, see next section circuit, in order to avoid malfunction, it should be avoided that P1. 1, P1. 2 are high there.

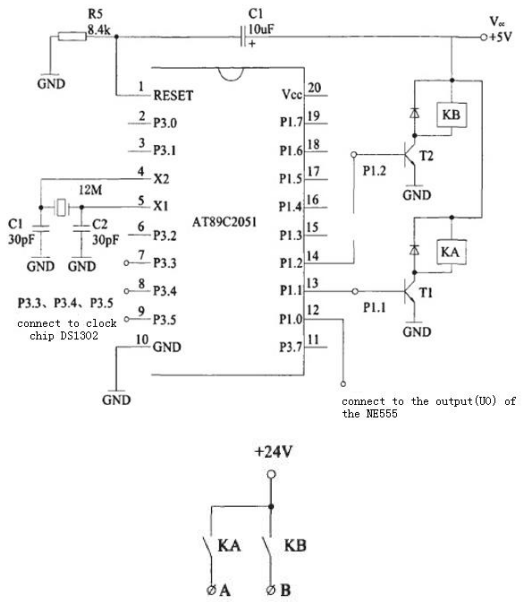

Figure 4. circuit diagram of the SCM controller AT89C2051

5. MOTOR CONTROLLER

Each motor controller is drive the inversion by their respective motor. The motor controller can accept the respective manual, remote switch control and the unified control of the microcontroller output signal which can be run separately for each motor and can be unified under the control of movement in the chip, shown in Figure 5.

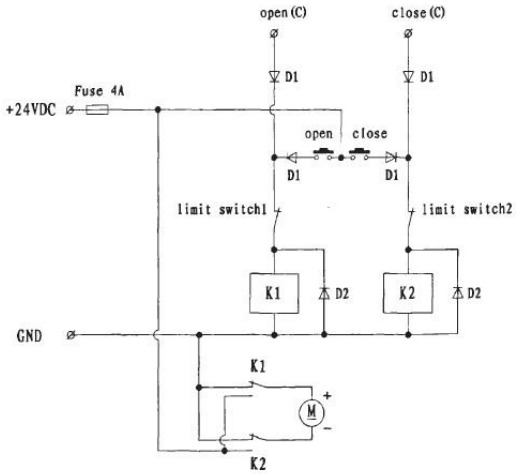

Figure 5. Circuit of Motor controller

ACKNOWLEDGMENT

The amount of building energy consumption is rising year by year in China, total energy consumption in the proportion of from the end of 1970 s vary 10% to 27. 8% in recent years. However, the biggest energy consumption of building is heating and air conditioning point, it is reported that our country in heating and air conditioning on all energy consumption of building the total energy consumption by 55%. Saving energy consumption is imperative. As an effective method of energy saving, construction sunshade will gradually applied in wide. The building combined with photovoltaic, especially it is by the intelligent control system, the design of shading and (pv) power will be further optimized to take the shading of summer and winter heating into account, it also tracks the photovoltaic devices to improve light of generating capacity and is a very worth research and extension of the emerging technology, so it has the very broad development prospects.

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