Scalable Computing: Practice and Experience, ISSN 1895-1767, http://www.scpe.org
© 2024 SCPE. Volume 25, Issues 4, pp. 2229–2239, DOI 10.12694/scpe.v25i4.2942

APPLICATION OF CNC ROBOTS IN DEEP LEARNING INTELLIGENT CONSTRUCTION OF GREEN BUILDINGS

WEI ZHANG*

Abstract. In order to achieve automated cleaning of photovoltaic devices in green buildings and reduce the labor intensity of workers, the author has developed a photovoltaic device intelligent cleaning CNC robot intelligent cleaning system. Through the analysis of the use of the green building photovoltaic device, the green building photovoltaic device cleaning robot and its cleaning system are designed according to the environmental situation and the use requirements. This intelligent cleaner system consists of a transmission guidance system, a cleaning system, and a control system, using only one motor to complete the overall action, at the same time, an independent walking mechanism is designed, and the walking wheel system is not in contact with the photovoltaic device, which does not harm the photovoltaic device, at the same time, it can cross two adjacent photovoltaic panels with included angles to achieve the function of cleaning complex photovoltaic panel surfaces for a single device, the cleaning layer design has a diagonal protrusion similar to a spiral output, which can automatically discharge accumulated dust from the cleaning roller while cleaning, providing a certain self-cleaning function, extending the replacement cycle of the cleaning layer, and can be used for both dry and wet purposes. Realize wet cleaning; when the cleaning solution is not used, use the cleaning layer and its surface oblique raised to remove dust, achieve dry cleaning. On the whole, the robot structure is reasonable, simple control process and high degree of automation, which can effectively solve the cleaning problem of green building photovoltaic devices, and can provide effective guarantee for the efficient work of photovoltaic devices.

Key words: CNC robot, Green buildings, Intelligent construction, Photovoltaic devices, Intelligent cleaning

1. Introduction. Building intelligence is the integration of building systems, structures, services, and management to provide convenience and a reasonable living environment for urban residents. Building intelligence refers to the creation of a people-oriented green building environment, and the organic integration of construction equipment and construction equipment management through the improvement of automation technology for construction equipment.

In recent years, photovoltaic power generation technology has developed on a large scale, and the installation of photovoltaic power generation devices on green buildings for power generation has also increased significantly. The State Council's Development Plan for Zhangjiakou Renewable Energy Demonstration Zone in Hebei Province said that Zhangjiakou will build a national renewable energy demonstration zone by 2030, with an installed photovoltaic power generation capacity of 24 million kilowatts. At present, photovoltaic generating units have been built in the roof of residents, barren hills, both sides of expressways and other areas, and put into use. According to research, due to the existence of dust accumulation, the loss of ordinary 20MW photovoltaic power station caused by dust deposition is more than 2 million yuan per year. According to the year-on-year scale of photovoltaic power generation capacity in Zhangjiakou reaching 24 million kilowatts in 2030, the annual loss caused by dust accumulation problem will reach 240 million yuan.

With the widespread application of intelligent technology in green buildings, green buildings have developed rapidly, providing convenience and safety guarantees for the daily lives of urban residents, and effectively achieving resource conservation. Green buildings have energy-saving characteristics. In green buildings, the application of intelligent technology has effectively improved the energy recovery and utilization rate. The use of recyclable materials during construction can effectively save resources. But from the point of the development of construction industry in our country, intelligent green building is still in its infancy, both in the application effect and penetration are some deficiencies, more concentrated in first-tier cities of large enterprises and institutions and government projects, but for small and medium-sized enterprises and residential areas, the application

*School of Civil Engineering and Architecture, Anyang Normal University, Anyang, Henan, 455000, China (Corresponding author)

of intelligent green building is very limited, especially in three or four line city, the gap is more obvious. In the development of construction industry, intelligent green building has become one of the more advanced technology, but in the specific application will still produce larger energy consumption, in order to solve these problems, must increase investment in technology, to develop more advanced technology and equipment, with the help of all kinds of clean energy, such as photovoltaic power generation technology, provide guarantee for the sustainable development of the construction industry, create a better environment for development.

Green building design meets social needs. Various emerging technologies have been applied in green buildings, making construction operations simple and efficient. Architectural designers carry out green and environmentally friendly design from the perspective of urban residents, with the ultimate goal of solving residential environmental problems. Design a reasonable plan to prevent power outages and utilize the sun to meet the living needs of residents. Building intelligence technology mainly relies on intelligent sensors and other devices, combined with information system integration to complete the overall and framework construction, and can complete the collection, storage, and automatic analysis of information. The function of building shading systems is to reduce "overheating" and "glare", and improve indoor comfort.

Driven by the industrial revolution, the concept of green development has been widely recognized by people. In the process of promoting economic development, more effective measures need to be taken to maintain the balance of the ecological environment and realize the sustainable development of the economy and society. In the development of construction industry, architectural designers in order to better improve the construction project ecology and intelligence, whether in building materials selection, or in the architectural design, need as much as possible to save resources, realize the protection of ecological environment, to create a green healthy living space photovoltaic technology can convert light into usable energy, the light to give full play to the value of the new energy. Through the effective combination of photovoltaic power generation technology and smart green building, the scientific concept of development can be better implemented, and the sustainable development of human society can be realized.

The intelligent lighting control system can perform intelligent adjustment on individual lighting facilities, achieving the goal of saving energy and extending the service life of lamps. The intelligent lighting control system has automation, networking, compatibility, and easy to operate building intelligence technologies, including communication technology, automated management and control technology, computer information technology, system integration technology, and fire safety technology.

In the process of rapid development of science and technology, the application of green intelligent building is increasingly widely, in real application, green intelligent building refers to the building as a platform, automation, intelligent office, at the same time do system service management optimization and communication network centralized building way in green intelligent building, need to emphasize the concept of green environmental protection, for people to create a safe, comfortable, clean office environment and living space. Thus, in the development of the intelligent and green building industry, it is necessary to start from the two aspects of intelligence and green to make up for the deficiencies in the development of the traditional building industry.

Introducing system integration technology in the architectural design process, integrating computer, automatic control, modern communication technology with green buildings, and effectively managing information data through automation technology. Green buildings refer to buildings that maximize resource conservation (energy conservation, land conservation, water conservation, and material conservation), protect the environment, reduce pollution, provide healthy, applicable, and efficient usage space for people, and coexist harmoniously with nature throughout the entire lifespan of the building.

In recent years, China has made remarkable achievements in the development of intelligent green buildings. Under the leadership of the government, the intelligence of comparative systems has been constructed. The green building system is also being implemented nationwide.

The construction process of a building, as an important part of its entire lifecycle, is of great significance for the quality, conservation, and environmental protection of the entire building. At present, the concept of green building has deeply rooted in people's hearts, and related technologies have rapidly developed, however, the construction process of buildings still remains in a labor-intensive, low processing accuracy, and extensive resource utilization mode, this undoubtedly cannot meet the requirements of green building. Therefore, improving the construction process and introducing new construction methods will become an important aspect

of green building development in the future. At present, the domestic cleaning means are mainly manual cleaning, which has problems of low efficiency and high cost. For a 10MW photovoltaic power station to keep its solar panels clean requires at least 20 cleaning workers to work continuously. In addition, the regional characteristics of low temperature, drought and water shortage in winter also make artificial cleaning more difficult. The research and development of robots that can automated operations is of great significance for cleaning photovoltaic devices equipped in green buildings.

In order to realize the automatic cleaning of green building photovoltaic devices and reduce the labor intensity of the staff, a set of photovoltaic device intelligent cleaning CNC robot intelligent cleaning system is developed. This intelligent cleaner system is composed of transmission guide system, cleaning system, and control system, using only 1 motor to complete the overall action, design independent walking mechanism, walking wheel system does not contact with photovoltaic device, no damage to the photovoltaic device, and can cross the Angle and two adjacent photovoltaic panels, realize a complex photovoltaic panel function cleaning system cleaning layer design with similar spiral output oblique raised, can automatically clean roller, cleaning side discharge dust with certain self-cleaning function, prolong the replacement cycle of the cleaning layer, and can dry and wet dual use.

2. Application of CNC robots in intelligent construction of green buildings . The method of building construction based on CNC robot technology emerged in the early 21st century and has become a new hot topic in the current construction field after nearly a decade of rapid development [1]. This method stands out from many explorations mainly because it has the following advantages compared to traditional construction methods. Firstly, CNC robots undertake high-risk and harmful construction operations, which can ensure the occupational health of construction personnel. The harmful factors in the construction process mainly include toxic gases such as SO2 generated during the processing of building materials, as well as a large amount of dust and strong noise generated during the construction process, therefore, it is clearly pointed out in the Green Construction Guidelines that "Occupational hazard such as dust, toxic gas and radiation shall be reduced as far as possible to ensure the long-term occupational health of construction personnel". Traditional building construction is a labor-intensive production mode, construction workers not only have to undertake heavy and dangerous physical labor, but also have long-term Close encounter with toxic gas, dust, noise and other harmful factors, and their bodies are inevitably damaged, therefore, the traditional construction method contradicts the "Green Construction Guidelines" and therefore does not meet the requirements of green buildings. The use of digital control robot technology in building construction can replace the construction personnel to complete some heavy and dangerous work, as well as work such as welding, masonry and other work that produces a lot of toxic gas, dust and other harmful substances. While reducing the labor burden of construction personnel, it can reduce their Occupational hazard and ensure their long-term occupational health. It can be seen that the method of building construction based on CNC robots is more in line with the requirements of green construction and green buildings than traditional construction methods. Figure 1 shows the robot control system [2].

Secondly, in order to achieve certain performance demands of green buildings, components such as shading and curtain walls often adopt complex and irregular shapes. With the development of parameterization technology and computer simulation technology, architects can better calculate and compare complex shapes, thus obtaining the most ecological and energy-saving component forms of buildings. However, these complex shapes increase the difficulty of construction: Traditional construction methods have poor accuracy, usually only reaching the centimeter level, and the reliability of manual calculations is limited, making it inevitable to encounter significant errors, therefore, it is difficult to ensure the accuracy of complex forms completed using traditional construction methods, which in turn affects the ecological performance of these components. In the method of building construction based on CNC robot technology, CNC robots can directly read computer models of complex shapes, accurately locate and move according to digital instructions, with an accuracy of at least millimeters and high reliability, therefore, it can effectively meet the processing and construction requirements of complex shapes. It can be seen that using CNC robot technology for the construction of green buildings can improve the accuracy of complex components and ensure the realization of building ecological performance. Once again, as the foundation of the building process, the pollution and energy consumption caused by the acquisition, production, processing, and other processes of building materials account for a significant proportion

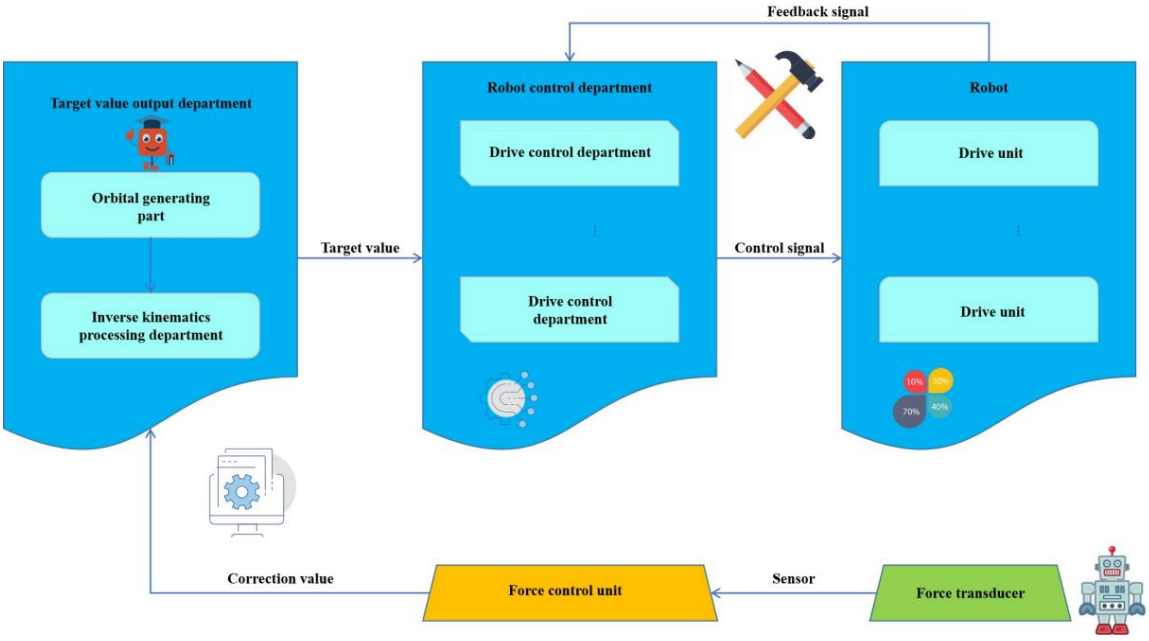

Fig. 2.1: Robot Control System

in the entire life cycle of the building. Therefore, the evaluation standard for green buildings regards "material conservation" as an important content. Due to the limitations of workers' technical level and reliability, traditional construction methods inevitably make mistakes in machining steps that require high process accuracy such as cutting and welding, resulting in waste materials and significant waste of construction materials. In contrast, CNC robots have stronger controllability in processing and construction. As long as the operator's instructions are correct, there will be no material waste caused by misoperation and process accuracy issues. Therefore, using CNC robot technology for building construction can effectively reduce waste of building materials, making buildings more energy-efficient and environmentally friendly throughout their entire life cycle. In summary, the method of building construction based on CNC robots has multiple advantages compared to traditional construction methods and is more in line with the requirements of green buildings. As a result, this method has gradually stepped out of the laboratory exploration stage in recent years and has been applied in practical green building construction [3].

The basic principle of photovoltaic power generation: photovoltaic power generation system refers to the solar energy into electric energy technology, mainly under the action of a new energy of the sunlight, with the aid of solar panels, converted into electricity, and then with the aid of charge and discharge controller, charging battery pack, under the condition of the load appropriate, realize direct power supply. If the AC load is set in the system, it is necessary to use the direct AC inverter to convert the direct current into AC current, to provide convenient conditions for daily use. For this system, the important components are mainly the controller, volt battery module, battery group, inverter and measuring equipment, etc., the photovoltaic cell module can realize the conversion of solar radiation to electric energy, in the module power, must be in strict accordance with the load standard. The controller plays a vital role in the photovoltaic power generation system, which can prevent the shortening of the battery life due to excessive charge and discharge.If there is an AC load in the system, it is necessary to use the inverter to convert the direct current to form the alternating current that meets the load requirements. At the same time, with the help of the charge and discharge controller, the electric energy is connected into the network. The battery is mainly to for electric energy to ensure that the power can power the load at any time. Intelligent measurement equipment can measure the important parameters in the system, and carry out remote information transmission and remote control.

In order to realize the environmental protection, safety, energy saving and efficiency of architectural design and achieve the strategy of sustainable development, it is necessary to promote the integration of smart green building and photovoltaic power generation technology and give play to its advantages in the construction industry. For the development of green intelligent building system, need to build more system of science and technology, a variety of energy technology parameters into among them, various detection of energy, environment, ecology, technology and security elements, so as to build a common ecological management system, to calculate all kinds of energy consumption, realize the combination between resource security and environmental protection.In the application of photovoltaic power generation technology, in order to better meet the development needs of intelligent green buildings, it is necessary to build a co-joint mode control model, parallel operation between each technical component, and then control the energy saving degree, and calculate the green intelligent number. In the controller center, it can complete the data conversion and processing work, providing a scientific energy saving computing system for the development of intelligent green building.

3. Methods.

3.1. Implement automatic cleaning function. It is required to use automation control technology to complete the automated cleaning of solar panels, reduce the labor intensity of workers, simplify the control process, have high system stability, and minimize the number of drive motors selected.

3.2. Separate design of walking mechanism. It is required to design an independent walking mechanism, with the walking wheel system not in contact with the solar panel, which does not cause damage to the solar panel. At the same time, it can achieve the function of crossing two adjacent photovoltaic panels with included angles, that is, one device cleaning the complex photovoltaic panel surface.

3.3. The cleaning operation end is easy to replace and has a certain self-cleaning function. In order to facilitate the replacement of cleaning operations, it is required that the end of the cleaning system be easily replaced, and to reduce the frequency of replacement, the cleaning system should have a certain self-cleaning function [4].

3.4. Detailed design content.

(1) Structural Analysis of Green Building Photovoltaic Devices. Green building refers to maximizing resource conservation throughout the entire life cycle of a building, including energy conservation, land conservation, water conservation, material conservation, etc., protecting the environment and reducing pollution, a building that provides a healthy, comfortable, and efficient space for people to use and coexist harmoniously with nature. Green buildings are a popular means of energy conservation through photovoltaic devices, photovoltaic devices are often installed on the top and sunny side walls of buildings through brackets. The main structure design of the CNC robot, including the transmission and guidance system, is arranged along the direction and inclination of the brackets, allowing the CNC robot to operate completely on the layout route of the photovoltaic device, when there is an angle between two photovoltaic panels, the chain structure of the guidance system is arranged according to the angle, and an intermediate sprocket is set at its bending position [5,6].

(2) Main structure. The main structure design of the CNC robot consists of a transmission guidance system, a cleaning system, and a control system. As shown in Figures 3.1, 3.2 and 3.3, in which: 1. Rack, 2. Transmission chain, 3. Guide rail, 4. Guide wheel, 5. Connecting piece, 6. Cleaning component, 7. Solar panel, 8. Tensioner, 9. Motor, 10. Driving sprocket, 11. Driven sprocket, 12. Center shaft, 13. Follow sprocket, 14. Fixed chain, 15. Cleaning roller, 22. Travel switch A, 23. Travel switch B, 24. Chain tensioner, 25. Bearing, 26. Cleaning cover, 27. Bearing. Among them, the transmission guide system includes frame 1, transmission chain 2, guide rail 3, guide wheel 4, connecting piece 5, tensioning wheel 8, motor 9, driving sprocket 10, driven sprocket 11, fixed chain 14, and chain tensioner 24; Guide rail 3 is fixed on rack 1 and is located on both sides of solar panel 7, it is used to guide the operation of the cleaning system and lift the cleaning system to avoid damage to solar panel 7, guide wheel 4 is located on guide rail 3 and connected to the cleaning system, guide wheel 4 can drag the cleaning system to move flexibly left and right on guide rail 3, driven sprocket 11 and driven sprocket 10 are respectively fixed on frame 1 and located on the upper left and right sides of solar panel 7, drive chain 2 meshes with driven sprocket 10 and driven sprocket 11 to form a chain transmission

pair, and the direction of drive chain 2 is consistent with that of solar panel 7, the chain transmission pair forms the main transmission route and is arranged along the direction of solar panel 7, the tensioning wheel 8 is fixed on frame 1 and meshes with the transmission chain 2, located on the inner side of the transmission chain 2 to tension the transmission chain 2, the cleaning system is fixedly connected to the transmission chain 2 through connector 5, enabling the cleaning system to move together with the transmission chain 2, the active sprocket 10 is connected to the motor 9, which drives the operation of the transmission chain 2 through the active sprocket 10, the fixed chain 14 is located on the upper side of the solar panel 7, and the direction of the fixed chain 14 is consistent with that of the solar panel 7, the fixed chain 14 is arranged along the direction of the solar panel 7, with both ends of the fixed chain 14 fixed to the frame 1, the fixed chain 14 is equipped with a chain tensioner 24 to achieve tension on the fixed chain 14; The cleaning system includes two sets of cleaning components, the front and rear 6, the front cleaning components complete the main cleaning work, and the rear cleaning components complete further cleaning work, cleaning component 6 includes central shaft 12, follower sprocket 13, cleaning roller 15, bearing 25, cleaning cover 26, and bearing 27, both ends of central shaft 12 are connected to guide wheel 4, the central shaft 12 is connected to the connecting piece 5 through the bearing 25, which is fixed on the transmission chain 2, enabling the central shaft to move freely along the guide rail under the drive of the transmission chain 2, the follow-up sprocket 13 is fixed on the central shaft 12 and meshes with the fixed chain 14 to form a transmission pair, the follow-up sprocket 13 is located below the fixed chain 14, and the follow-up sprocket 13 is located below the fixed chain 14 to ensure that the fixed chain 14 sinks under the action of gravity without affecting the meshing effect of the two, the follow-up sprocket 13 rotates synchronously with the central shaft 12, the cleaning roller 15 is fixed in the middle part of the central shaft 12 and rotates synchronously with the central shaft 12, when the central shaft 12 moves left and right, the driven sprocket 13 drives the central shaft 12 to move left and right, due to the simultaneous engagement of the follower sprocket 13 with the fixed chain 14, and the fact that the fixed chain 14 is in a fixed state, the follower sprocket 13 will passively rotate, because the follow-up sprocket 13 is fixedly connected to the central shaft 12, the central shaft 12 also rotates together, thereby achieving the drive chain 2 to drive the cleaning roller 15 to move, the follow-up sprocket 13 drives the cleaning roller 15 to rotate, and since the follow-up sprocket 13 is located below the fixed chain 14, the rotation direction of the cleaning roller 15 precisely causes the linear velocity direction of the edge of the cleaning roller 15 to be in the same direction as the movement direction of the cleaning roller 15, further increasing the relative velocity of the cleaning roller 15 and the solar panel 7, increase the cleaning effect, the upper end of the cleaning cover 26 is fixed on the connecting piece 5, the lower end is connected to the central shaft 12 through the bearing 27, and the cleaning cover 26 is located on the periphery of the cleaning roller 15, the cleaning cover 26 provides protection, encapsulation, and other functions for the cleaning system. The control system includes industrial PLC, travel switch A22, and travel switch B23 [7-8]; Among them, the industrial PLC is responsible for the operation control of the entire machine, and the travel switch A22 is installed on frame 1, located on the right edge of solar panel 7, just in contact with the right running station of cleaning component 6, used to detect the signal of cleaning component entering the working station, the travel switch B23 is installed on frame 1, located on the left edge of solar panel 7, just in contact with the left running station of cleaning component 6, and is used to detect the signal of cleaning component leaving the working station [9].

(3) Clean component design. The design of the cleaning component is shown in Figure 3.4, where: 4. Guide wheel, 12. Center shaft, 13. Follow up sprocket, 15. Cleaning roller, 19. Oblique protrusion. Among them, both ends of the central shaft 12 are connected to the guide wheel 4, and the driven sprocket 13 is fixed on the central shaft, the follow-up sprocket 13 rotates synchronously with the central shaft 12, and the cleaning roller 15 is fixed in the middle part of the central shaft 12 and rotates synchronously with the central shaft 12, a cleaning solution storage layer is designed in the front cleaning component 6, and a cleaning solution absorption layer is designed in the rear cleaning component 6 [10,11].

(4) Design of cleaning rollers. The design of the cleaning roller is shown in Figure 3.5, where: 12. Center shaft, 16. Rigid support ring, 17. Flexible support ring, 18. Cleaning layer. Among them, the rigid support ring 16 is fixedly connected to the central shaft 12 and evenly distributed around the periphery of the central shaft 12. The rigid support ring 16 plays a role in supporting and connecting other peripheral parts, the flexible support ring 17 is fixedly connected to the rigid support ring 16 and evenly distributed around the periphery of

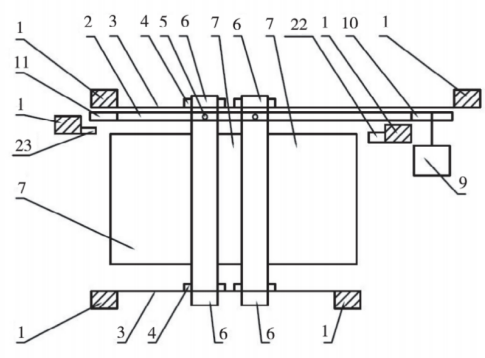

Fig. 3.1: Schematic diagram of the main structure

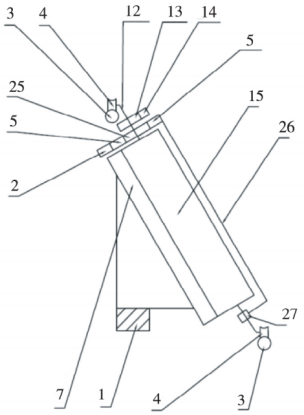

Fig. 3.2: Left view schematic diagram of the main structure

the rigid support ring 16, the flexible support ring 17 serves as a support for the cleaning layer, and the cleaning layer 18 is detachably installed on the flexible support ring 17 and evenly arranged around the periphery of the flexible support ring 17, the cleaning layer 18 is tightly attached to the solar panel 7 and used to clean the dust accumulation on the surface of the solar panel 7, the cleaning layer 18, flexible support ring 17, and rigid support ring 16 can rotate synchronously with the central axis 12, the rotation of the central axis 12 will drive the rotation of the cleaning layer 18, thereby achieving cleaning operations, the flexible support ring 17 is designed as a porous and loose structure, and the flexible support ring 17 located in the front of the cleaning roller 15 stores cleaning fluid, the flexible support ring 17 of the cleaning roller 15 located at the back is used to adsorb residual cleaning solution on the solar panel 7 [12].

(5) Clean layer design. The design of the cleaning layer is shown in Figure 3.6, where: 18. Cleaning layer, 19. Oblique protrusion, 20. Glue A, 21. Glue B. Among them, the front design of 18 has a diagonal protrusion 19, which tilts in the left diagonal direction. The diagonal protrusion 19 on the front is responsible for cleaning the surface dust drop of solar panel 7, the oblique protrusion of 19 is matched with the rotation direction of the central shaft to form a downward spiral output effect, timely eliminating dust accumulation and improving cleaning efficiency, on the other hand, the cleaning roller 15 can have a certain self-cleaning function, reducing the frequency of equipment maintenance, the reverse side of the cleaning layer 18 is designed with fasteners A20 and B21, which can be bonded together to achieve portable disassembly and assembly of the cleaning layer 18, shorten the maintenance time of the equipment and increase its convenience of use [13,14].

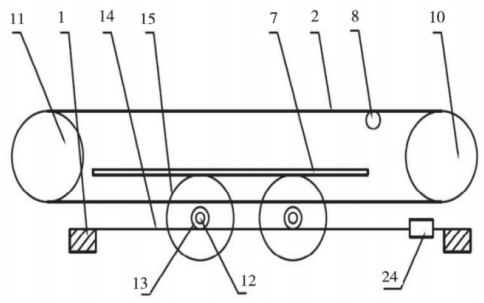

Fig. 3.3: Top view schematic diagram of the main structure

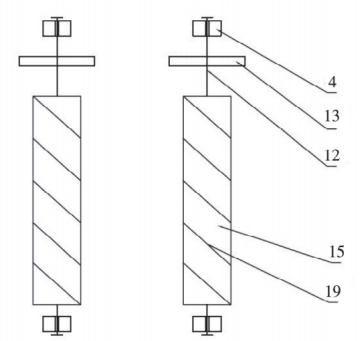

Fig. 3.4: Internal structure diagram of the cleaning system

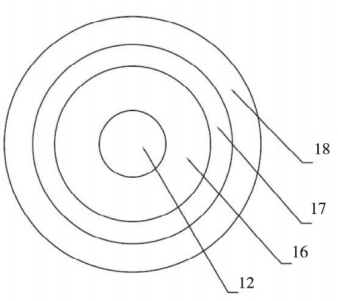

Fig. 3.5: Structural diagram of the cleaning roller

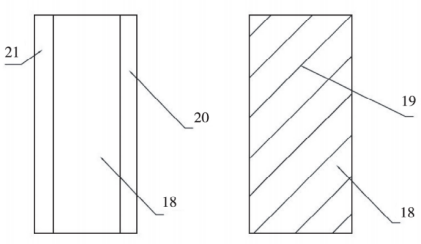

Fig. 3.6: Structural diagram of the front and back sides of the cleaning layer

(6) Other accessory designs. The guide rail 2 of this CNC robot is set to two, with a 45 degree slanting angle and a 20mm spacing between the slanting protrusions, the slanting protrusions coordinate with the rotation direction of the central axis to form a downward spiral output direction, the transmission chain 2 is a double row chain, the fixed chain 14 is a double row chain, and the fasteners A20 and B21 are both set as ribbons, the two sets of cleaning components share the same cleaning cover 26.

Application effect of photovoltaic power generation technology in smart green building: technology energy saving effect: in smart green building, the application of photovoltaic power generation technology can play energy saving effect, through reasonable use of solar energy, effectively reduce the demand for other energy, and then play a role in saving power supply cost. In addition, under the action of photovoltaic power generation equipment, it can effectively absorb solar energy, play a role in cooling in summer, residents in this environment, can reduce the use of air conditioning, and then achieve the reduction of energy consumption. Therefore, under the application of photovoltaic power generation technology, effective energy conservation can be realized, and the cost of thermal power generation in China can be controlled, and the conservation of coal resources can be realized while reducing pollution.

In the process of the rapid development of China's social economy, the level of science and technology is also constantly improved, a complete technical system has been formed in photovoltaic power generation technology, the cost is constantly reduced, can be promoted on a large scale. Although the installation cost of photovoltaic power generation equipment is relatively high, but after the operation, the subsequent maintenance cost is very low, basically does not need too much maintenance, only need to be repaired after the failure. Under the current technical conditions, the photovoltaic power generation equipment can be installed and operated after 7 years of installation and operation, the cost recovery, in the following 18 years of service life, can create huge economic benefits and save a lot of electricity. In a 499kW photovoltaic power generation system, in addition to maintenance and other costs, can create nearly ten million economic benefits.

4. Work process design.

First step, start the device. Start the device, complete self check, restore the original device to its original position, and clean component 6 in the right position of solar panel 7.

Step 2, perform dry cleaning. The CNC robot system starts the operation, and the motor 9 runs, driving the transmission chain 2 to run quickly, and then driving the cleaning component 6 to quickly run, causing the position of the travel switch A22, travel switch A22 detects that cleaning component 6 has entered the work station, and the PLC controls motor 9 to run at low speed to start the cleaning operation, at this time, the spindle 12 moves from right to left under the drive of transmission chain 2, the follow-up sprocket 13 on the main shaft 12 moves to the right together, and due to the meshing between the follow-up sprocket 13 and the fixed chain 14, the follow-up sprocket synchronously and passively rotates, driving the main shaft 12 to rotate, thereby driving the cleaning roller 15 to rotate, the cleaning roller 15 is attached to the surface of the solar panel 7, and the cleaning operation begins, the cleaning layer 18 on the surface of the cleaning roller 15 is equipped with oblique protrusions 19, as the cleaning roller 15 rotates, these oblique protrusions 19 remove the accumulated dust on the surface of solar panel 7 and transport it to the lower side of solar panel 7, thereby achieving cleaning and to some extent self cleaning, the front and rear two sets of cleaning components operate repeatedly, which not only improves cleaning efficiency but also improves the service life of cleaning layer 18, thereby reducing the frequency of equipment maintenance [15].

Step 3, Equipment Reset. When travel switch B23 detects that cleaning component 6 is running to the left edge of solar panel 7, it is considered that the cleaning operation is completed, and the PLC controls motor 9 to run at high speed, quickly drive the cleaning component 6 to the starting station through the active sprocket 10 and the transmission chain 2, and the equipment enters a standby state [16,17].

Wet cleaning. The difference between wet cleaning and dry cleaning is that a certain amount of cleaning solution is stored in the flexible support ring 17 of the cleaning component 6 in the front, the CNC robot automatically wets the cleaning layer 18 and wets the solar panel 7 for the first step of cleaning during the cleaning operation, while the cleaning component located at the back performs a secondary cleaning, clean the accumulated dust on the surface of solar panel 7 again, while adsorbing the residual cleaning solution on the surface of solar panel 7, achieving wet cleaning [18,19,20].

5. Conclusion. By analyzing the usage of green building photovoltaic devices and designing a CNC robot and cleaning system for cleaning green building photovoltaic devices based on environmental conditions and usage needs, the CNC robot achieves automated cleaning of solar panels and reduces the labor intensity of workers, only one motor is used to complete the overall motion, with simple control and high system stability, the CNC robot is designed with an independent walking mechanism, and the walking gear system does not contact the solar panel, causing no harm to the solar panel, at the same time, it can cross two adjacent photovoltaic panels with included angles, achieving the function of cleaning complex photovoltaic panel surfaces for one device, the adhesive type cleaning layer designed for the cleaning system makes it more convenient to replace cleaning materials, the surface of the cleaning layer is designed with a diagonal protrusion similar to a spiral output, which can automatically discharge accumulated dust from the cleaning roller while cleaning, it has a certain self-cleaning function and extends the replacement cycle of the cleaning layer, the dual cleaning roller structure of the CNC robot, on the one hand, it increases the cleaning effect, on the other hand, it reduces the cleaning burden of a single roller, prolongs the maintenance cycle of the cleaning roller, and at the same time, the cleaning layer used up by the rear roller can continue to be used on the front roller, reducing maintenance costs. The cleaning system can be used both wet and dry, the flexible support ring located at the front can carry cleaning solution for cleaning solar panels, while the flexible support ring located at the back can wipe off excess cleaning solution to achieve wet cleaning; When not using cleaning solution, the cleaning layer and its oblique protrusions on the surface are used to remove accumulated dust, achieving dry cleaning. Overall, the CNC robot has a reasonable structure, simple control process, and high degree of automation, which can effectively solve the cleaning problem of green building photovoltaic devices and provide effective guarantee for the efficient work of photovoltaic devices. Build a systematic photovoltaic power generation system, fully tap its own energy-saving effects and economic effects, and inject new vitality into the development of the intelligent green building industry.

REFERENCES

[1] Rui, W., & Qianyi, Z. (2021). Application analysis of bim technology in green intelligent building design. IOP Conference Series Earth and Environmental Science, 768(1), 012154.
[2] Ma, Y., Fan, X., Cai, J., Tao, J., & Yang, Q. (2021). Application of sensor data information cognitive computing algorithm in adaptive control of wheeled robot. IEEE Sensors Journal, PP(99), 1-1.
[3] Zhou, X. (2021). Construction and application of urban intelligent traffic control system based on cloud computing. Journal of Physics: Conference Series, 1952(4), 042006-.
[4] Ren, C., Wang, Y., Xue, K., Zhi, S., & Chen, T. (2021). Research on application of construction model based on 4d visualization in construction of intelligent substation. IOP Conference Series: Earth and Environmental Science, 632(4), 042028 (7pp).
[5] Cheng, J., Liu, Z., He, J., Deng, Y., & Zhang, H. (2021). Application of simultaneous location and map construction algorithms based on lidar in the intelligent robot food runner. Journal of Physics: Conference Series, 1972(1), 012010-.
[6] Zhou, H., & Gu, M. (2021). Application of neural network and computer in intelligent robot. Journal of Physics: Conference Series, 1881(3), 032028 (7pp).
[7] Zhou, L., Wang, F., Wang, N., & Yuan, T. (2021). Application of industrial robots in automated production lines under the background of intelligent manufacturing. Journal of Physics: Conference Series, 1992(4), 042050-.
[8] Jia, X., Yuan, W., Li, H., Jiang, S., & Zhang, Y. (2021). Application of environment-perception intelligent control technology in the inspection robot of coal conveyance corridor in thermal power plant. IOP Conference Series: Earth and Environmental Science, 772(1), 012056 (6pp).
[9] Zhang, X., Zhang, Y., Lv, Y., & Zhang, H. (2021). Innovative application of electrical and intelligent personnel training mode in the construction industry under the background of artificial intelligent technology. Journal of Physics: Conference Series, 1915(4), 042026-.
[10] Shan, X., Wang, Y., Dong, M., & Xia, J. (2021). Application research and analysis of geographic information system in intelligent city surveying and mappinge. Journal of Physics: Conference Series, 1881(4), 042071 (5pp).
[11] Zhao, M., Mao, Y., Hen, Q., & Zhou, Y. (2021). Research on problems and countermeasures in the application of substation intelligent inspection system. Journal of Physics: Conference Series, 1983(1), 012084 (7pp).
[12] Peng, H. (2021). Research on current situation and development direction of civil engineering construction based on intelligent new materials. Journal of Physics: Conference Series, 1992(2), 022111 (5pp).
[13] Su, Z. (2021). The application of intelligent manufacturing technology in cnc tools design and machining. Journal of Physics: Conference Series, 2143(1), 012045-.
[14] Chen, D. (2021). Active disturbance rejection control of indoor inspection robot in intelligent substation based on monocular vision. Journal of Physics Conference Series, 1894(1), 012042.
[15] Yu, M. (2021). Analysis of design characteristics of intelligent system for super high rise building based on bim technology.

Journal of Physics: Conference Series, 1992(2), 022183 (5pp).
[16] Shi, D., & Zhang, L. (2021). Research on application of intelligent prestressed construction technology based on computer software analysis. Journal of Physics: Conference Series, 1915(2), 022019 (7pp).
[17] Qiao, T. (2021). Application of conductive polymer-based hydrogel in multi-robot balance control. Annales de Chimie Science des Matériaux, 45(2), 135-140.
[18] Wang, P. (2021). Application of intelligent manufacturing technology in the field of ship design and manufacturing. Journal of Physics: Conference Series, 2074(1), 012075-.
[19] Hu, M., Xiang, Z., & Li, K. (2021). Application of artificial intelligence voice technology in radio and television media. Journal of Physics: Conference Series, 2031(1), 012051-.
[20] Shao, D. (2021). Application of three-dimensional animation in mechanical control mechanism. Journal of Physics: Conference Series, 2066(1), 012098-.

Edited by: B Nagaraj M.E.
Special issue on: Deep Learning-Based Advanced Research Trends in Scalable Computing
Received: Nov 30, 2023
Accepted: Jan 24, 2024

‘