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Development of Control System of Insulating Glass Gluing Machine Based on CPAC

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Abstract: Aimed at the problems of glue leakage during double insulating glass artificial gluing, the quality of the glue surface rough and applicator of gluing machine can't accurate positioning, a control system based on Computer Programmable Automation Controller (CPAC) was developed. The mechanical structure was designed. The glue coating process of equipment was analyzed. The hardware and software architecture of the system were discussed. Moreover, practical operation of the system was tested, and the results have shown that the system has advantages of high automated level, good reliability and simplicity of the system. It was able to achieve insulating glass glue surface smooth, no glue leakage in the gluing process and it was able to achieve insulating glass surface smoothness, no glue leakage in the gluing process and accurately controlling the applicator of gluing machine movement.

1. Introduction

As a new type of building material with good thermal and acoustic insulation, aesthetics and practicality, insulating glass is widely used in construction, transport, shipping, aviation, refrigeration and other industries [1].

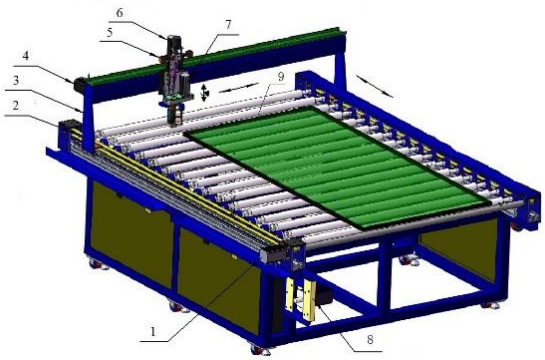
Insulating glass is composed of two or more pieces of glass, which are separated by a spacer frame with a desiccant, and the grooves of the spacer frame on the four sides of the glass are sealed with a sealant [2].

Due to the special structure of insulating glass, insulating glass gluing machine is a crucial equipment in the whole insulating glass production process. At present, most of the small and medium-sized glass production enterprises still use manual gluing or semi-automatic gluing [3]. Although such a system is simple in structure and cheap in price, the degree of automation of the equipment is poor, which makes it difficult to achieve the required effect of sealing and gluing and seriously affects the quality of the finished products of the insulating glass [4].

2. Mechanical design

The mechanical structure of the insulating glass gluing machine adopts vertical gantry structure,

as shown in Figure 1. Vertical gantry structure has the characteristics of large processing span, good structural rigidity, etc.



1. X-axis servo motor; 2. Synchronous belt wheel; 3. Frame; 4. Y-axis servo motor; 5. Glue module; 6. Z-axis servo motor; 7. C-axis servo motor; 8. Step motor; 9. Limit mechanism

Figure 1: Main mechanical structure of automatic insulating glass gluing machine.

2.1. Insulating Glass Applicator Process Flow

The function of the gluing machine designed in this paper is to carry out the second sealing and gluing the aluminium spacer frame grooves on four sides of the insulating glass to bond the two pieces of glass together.

The system first calculates the midline position of point A between two pieces of glass according to the thickness of the glass, the thickness of the groove of the aluminium spacer frame and other parameters. When the insulating glass to be processed stops in the gluing area, the X-axis and Z-axis servo motors start to position the gluing nozzle to the height of point A parallel to the first edge of the insulating glass, then the gluing nozzle translates along the Y-axis, and the photoelectric sensor generates a rising-edge signal when it detects the edge of the groove of the aluminium spacer frame, and according to the distance S between the photoelectric sensor and the installation position of the gluing nozzle, the gluing head continues to move forward for a distance S. At this time, the gluing nozzle of the gluing head reaches the gluing starting point of the first side of the insulating glass. The scraping cylinder extends and presses the fourth border, the solenoid valve opens for dispensing, and after the dispensing is completed, the scraping cylinder retracts and the gluing nozzle glues along the first edge of the insulating glass. When the photoelectric sensor leaves the aluminium frame slot will produce a falling edge signal, close the solenoid valve to stop the glue supply after continuing to glue the distance S, complete the first side of the glue. Then the C-axis servo motor drives the gluing head to rotate 90 degrees, so that the gluing nozzle is right on the second side of the groove, scraping the gluing plate is pressed down and close to the first side of the insulating glass for dispensing, and after completing the dispensing, lift the plate, and then the gantry drives the gluing head to complete the second side of the gluing along the X-axis direction. Next, the equipment completes the gluing work on the remaining two sides according to the previous gluing process.

3. Control system hardware design

Insulating glass gluing machine control system adopts "HMI + motion controller" structure of the CNC system, the hardware mainly includes: Googoltech GUC-800 motion controller, touch screen, glue mixer, servo motors, pressure pumps, stepper motors, sensors, cylinders, etc., as shown in Figure 2:

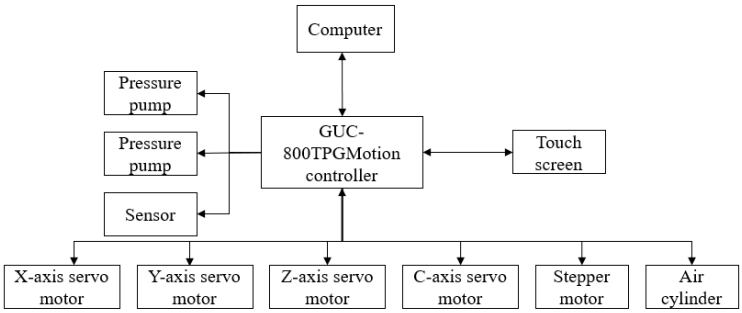


Figure 2: Basic structure of control system hardware of glue applicator.

The Z-axis and C-axis motors of the equipment are Yaskawa SGMJV servo motors, and the X-axis and Y-axis motors are SGMGV servo motors. The touch screen selects Googoltech ACC6-PN5-Y12-K61 model HMI. The limit switch of the limit mechanism in the gluing area selects Delixi LX19-001. The photoelectric sensor selects OMRON's ZX-L-N type sensor, which adopts the reflection type detection method with a resolution of up to 300um to meet the detection requirements.

4. Software design of the control system

The control software of this system is designed and developed based on Googoltech's Otostudio software platform [5]. The Otostudio includes a programming language compliant with the IEC61131-3 standard, and can also support dynamic link libraries developed in the VC language [6].

According to the process flow of insulating glass gluing and software control requirements, the software design is divided into four modules. The initialisation module restores all the execution parts to the initial state after the device is powered on. The motion control module is mainly responsible for controlling the gluing action to ensure that the gluing head moves according to the logic set in the program. The IO logic control module is responsible for the processing of digital signals and analogue signals in the gluing process. The status display module is responsible for detecting the current working status of each executing component, such as limit switch status, motor start status, etc. The log alarm module is responsible for recording the production situation and various alarm signals in the working process of the gluing machine.

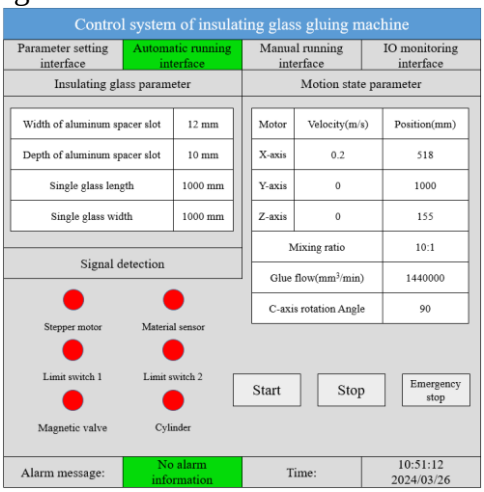


Figure 3: Automatic running Interface.

The user controls the working operation of the gluing machine through the HMI [7]. Automatic operation interface is the main operation interface of equipment control, as shown in Figure 3, this

interface can set the main working parameters of equipment operation. When the start button is pressed, the equipment can enter the automatic operation state. When the device fails, the emergency stop button must be pressed immediately to prevent the device from working.

5. System test results

After building the control system hardware and software of the device, the prototype was tested for system debugging and sample processing. The size of the insulating glass is 1m×1.5m, the width of the aluminium spacer groove is 12mm, and the depth is 10mm. 1min20s is consumed to process a piece of insulating glass of this size, which greatly improves the working efficiency compared with manual gluing. Processed insulating glass four sides of the colloid surface uniformity, smooth, as shown in Figure 4, to meet the insulating glass use standards.

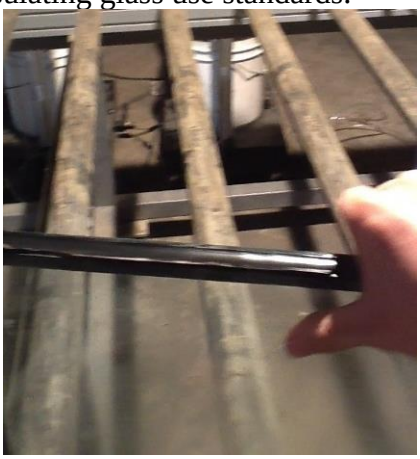


Figure 4: Insulating glass forming surface.

6. Conclusion

CPAC-based insulating glass gluing machine to achieve the second sealing of insulating glass. The system architecture of "HMI+motion controller" was built, and a set of control system of insulating glass gluing machine was developed by using Otostudio configuration software. The system was used to carry out the insulating glass gluing test, the results show that: the glue surface of the four sides of the insulating glass is smooth, the gluing head positioning is accurate and there is no leakage phenomenon, in the overall function and control performance to achieve the desired goal, to meet the requirements of the production of insulating glass.

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