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DESIGN AND SIMULATION OF AUTOMATIC GLASS WASHING MACHINE IN HIGHRISE BUILDING

Ganyuanyan[2], Xieyongzhi[1,2]

[1]Guangxi key laboratory of new energy and building energy saving, Guilin 541004, China
[2]College of Mechanical and Control Engineering, Guilin University of Technology, Guilin 541004, China

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ABSTRACT

In this paper, the automatic cleaning machine for glass curtain wall of high-rise building is designed and the motion simulation is carried out. According to the typical building roof and wall structure, the overall scheme of the structure of cleaning machine was designed, and the structure design and key component motion simulation of the various organs of the cleaning machine were completed. The results show that the design of glass curtain wall cleaning machine is reasonable and feasible.

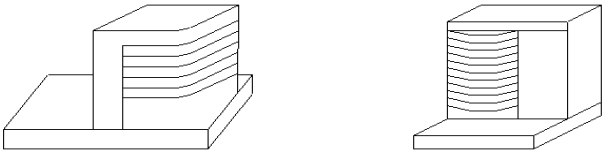
1. Introduction

With the rapid development of the city's modernization, especially the rise of many high-rise buildings, the glass curtain wall structure gradually evolved into a gorgeous "city coat", resulting in heavy glass curtain wall cleaning tasks [1]. Many countries have made some clear requirements for the cleaning requirements of glass curtain walls [2]. On the other hand, in order to highlight the characteristics of a city, more and more strange architectural structures appear in front of us, making the difficulty of cleaning doubled, and some even using traditional cleaning methods cannot do anything [3]. In today's highly developed social civilization, people's love for life has reached an unprecedented height. In the world, there has been a request to stop the use of "Spiderman" (artificial cleaning) voice. In response to such calls, this paper also designed a high-rise glass curtain wall automatic cleaning robot with low investment, low cost, safe and reliable operation and high efficiency in order to deal with the difficult cleaning work [4,5].

2. OVERALL SCHEME DESIGN OF CLEANING MACHINE

2.1 Structural characteristics of roof and wall

The wall structure of typical buildings is shown in figure 1:



a. right angle surface b. arc surface

Figure 1: Wall structure of typical buildings

It can be seen from Figure 1 that the wall structure of glass curtain wall mainly has right angle surface and round arc surface. For the right-angle surface, the cleaning task of the cleaning machine is easier to complete, but for the circular arc surface, the material of the adsorption mechanism of the cleaning machine should have a certain softness, and the surface of the sucker must have a certain sealing, so it can move safely on the wall.

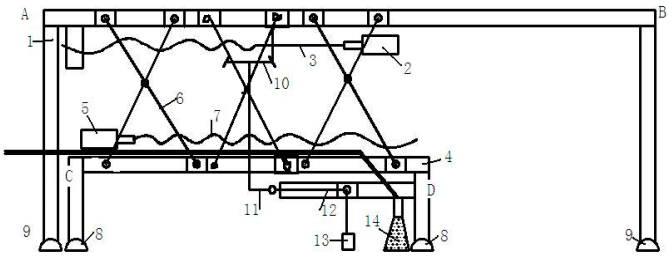
The roof structure of a typical building is shown in figure 2:

Figure 2: Typical building roof structure

As seen in Figure 2, the roof structure is mainly square and 1/4 arc shaped roof. Understanding the roof structure helps the cleaning machine move vertically or laterally on the wall surface.

2.2 Structure design of cleaning machine

The cleaning mechanism is mainly composed of connecting rod support, cleaning brush, gear mechanism, clutch mechanism and crank slider mechanism, so as to realize the movement and cleaning operation of the whole mechanism. The motion mechanism diagram is shown in figure 3:



1. supporting frame 2. Motor 3. Screw 4. scrubbing support mechanism 5. Motor 6. folding bracket 7. Screw 8. scrubbing support mechanism sucker 9. support frame with sucker 10. Gear 11. Disc 12. connecting rod and slider 13. Cleaning 14. cleaning liquid nozzle

Figure 3: Kinematic diagram of mechanism

Brief introduction of movement process:

1)The motor 2 drives the screw 3 to rotate, the scrubbing support mechanism 4 moves forward along the slideway of the support frame 1; At the same time, the scrubbing support mechanism 4 drives the scrubbing mechanism 13 to realize the mobile scrubbing.

2) When the scrubbing support mechanism 4 moves from point A to point B, the control mechanism acts to stop the motor 2. The motor 5 moves and drives the screw 7 to rotate, and the rotation of the screw 7 drives the folding of the splicing bracket 6. Meanwhile, The suction cup of the support mechanism 4 starts to be adsorbed, and the suction cup of the support frame 1 stops the suction. The scrubbing support mechanism 4 is stationary, while 1 becomes a moving bracket.

3) The motor 2 is reversed, the screw 3 drives the support frame 1 to move forward along the slideway, and the scrub support mechanism 4 transforms into a fixed support mechanism; when the end A of the support frame 1 scrubs the support mechanism 4, the movement stops.

3 MECHANISM DESIGN OF CLEANING MACHINE

3.1 The climbing mechanism is shown in Figure 4

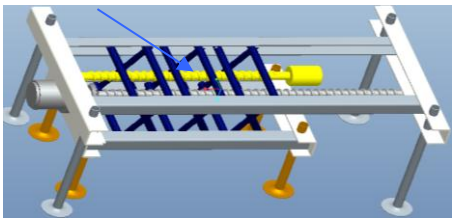


Figure 4: Climbing mechanism

The motor is forward rotating and reversed, and the support frame and the cleaning mechanism bracket are alternately adsorbed, which is alternately taken as the support of the sliding mechanism, so as to realize the alternating movement of the whole mechanism.

3.2 Transmission mechanism

As the cleaning mechanism shown in Figure 5, the power of the motor is transmitted to the disc (Crank) through a pair of bevel gears, and the Crank slider mechanism drives the washer to scrub back and forth along the trajectory.

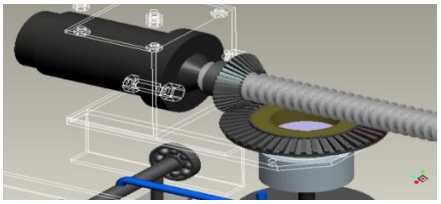


Figure 5: Transmission mechanism

3.3 Washing mechanism

Referring to the relevant data and referring to the reference standard, the distance between the two sliders is 500mm, and the specific parameters of washing are selected. According to the previous calculation, the 3D solid model of the cleaning brush can be obtained, as shown in figure 6:

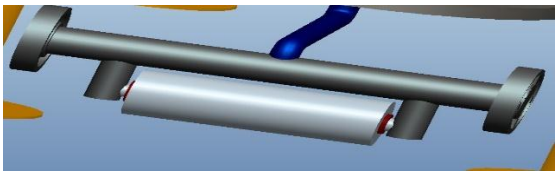


Figure 6: Scouring mechanism

3.4 Adsorption mechanism is shown in figure 7:

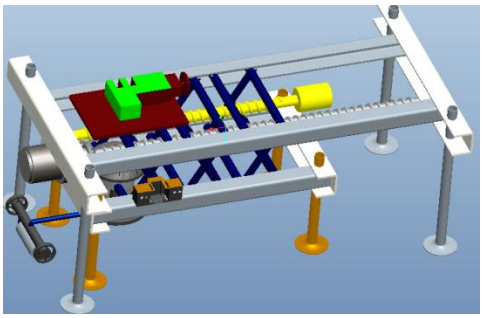


Figure 7: Adsorption mechanism (cleaning machine assembly)

The negative pressure produced by the vacuum pump is connected with the sucker through 2 positions 3 way valve, so as to realize the sucking function of the sucker. The valve control switch is synchronized with the supporting mechanism of the hinged connecting rod, and two 2 positions 3 way valves are controlled. Each valve controls 4 suction cups of the support of the cleaning mechanism, so as to realize the alternate adsorption of each supporting mechanism.

4 MOTION SIMULATION OF CLEANING MECHANISM

4.1 Import model and define constraints

Using Pro/ENGINEER modeling, the file format for the. X_t file, import ADAMS software [27] for motion simulation. Between Pro/ENGINEER and ADAMS through the MECHAISM/Pro interface module two software seamless connection, and can analyze the kinematics and dynamics simulation of the model. The model imported into ADAMS and set constraints is shown in figure 8:

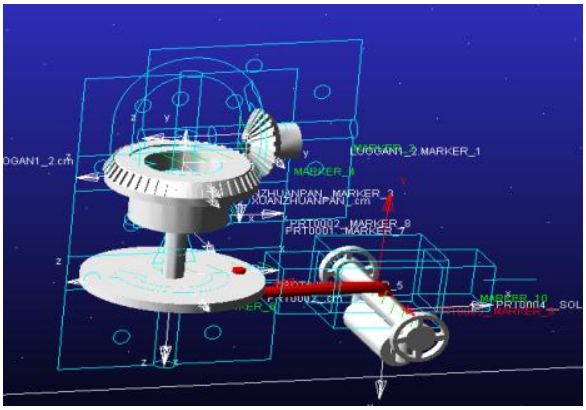


Figure 8: Cleaning mechanism simulation

4.2 Simulation results analysis

The dynamic simulation of the cleaning mechanism only considers the force between the crank and the cleaning brush, and does not take into account the influence factors of the self-excited vibration.

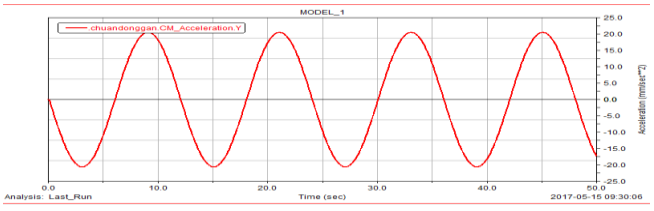


Figure 9: Acceleration of fixed point of transmission rod

As shown in Figure 9, the acceleration of a point on the transmission rod when the cleaning mechanism works. The abscissa represents time (s), and the ordinate represents acceleration. It can be seen from the diagram that when the drive rod starts, the acceleration is 0m2/s. As the motor drives the bevel gear, the bevel gear drives the crank to rotate, and the acceleration of the drive rod changes slowly. Because the crank is circular motion, the acceleration of a certain point of the transmission rod also presents the change of cosine function, and the period of acceleration change is about 12s.

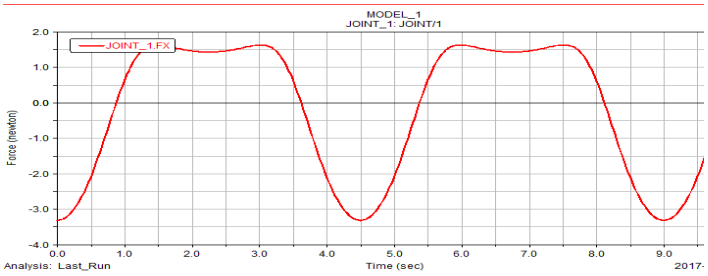


Figure 10: The force between rod and the crank

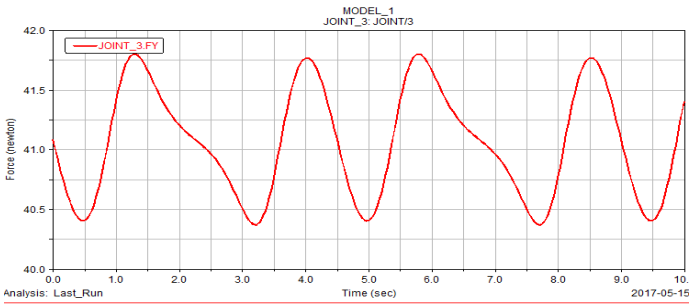


Figure 11: The force of rod and the cleaning brush

Figure 10 is the force curve between the drive rod and the crank. Figure 11 is the force curve between the drive rod and the cleaning brush. The abscissa represents the time (s), and the ordinate represents the force (N). Figures 10 and 11 show the tendency of the force change between the drive rod and the crank and the cleaning brush. It can be seen from the diagram that the force curve of the drive rod and the cleaning brush is not smooth change. Because the drive rod does not only reciprocate in a straight line, but as the crank moves in a circle, and the washer is vertical downward at work. Because at the beginning, the crank will be brushed by the gravity of the brush, that is, F=41.75N. With the start of washing machine, washing machine will move down, the force of the drive rod will be reduced, the lowest point of the value of F=40.27N, the change cycle is about 3.5s. Then, the curve of the force acting on the crank also presents a periodic change with the crank's circular motion.

5 CONCLUSION

In this paper, an efficient and flexible cleaning robot for wall of high-rise buildings is designed. By controlling the plane movement of the robot through the timing belt, the pneumatic muscle controls the leg to be lifted, and each leg can independently move, thereby further improving the flexibility and mobility of the robot on the wall

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