

Research and Design of Robot Mechanism for Cleaning Oil and Smoke Pipe in Hotel Kitchen

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Abstract: Warned by COVID-19, to clean up the hotel kitchen exhaust pipe due to long-term use of the accumulated large amount of dust and dirt, to prevent the spread of infectious diseases like COVID-19, this paper studies and designs a set of light weight, small volume, thorough cleaning, easy to use and other characteristics of a new type of hotel kitchen lampblack pipe cleaning robot. The guide wheel structure is installed on both sides of the front of the robot, the round-head Brush and the telescopic brush rod are driven by the pneumatic motor, and the lighting monitoring system and remote monitoring equipment are installed on the back of the robot. The robot can guide freely, the dead corner and the roof of the hotel kitchen fume exhaust pipe can be thoroughly cleaned by the rotation and up-and-down swing of the brush, and the dirt in the pipe can be clearly observed by the remote monitoring equipment The brush bar can be expanded and contracted to satisfy the cleaning work of oil fume pipe in all sizes of hotel kitchen. The cleaning robot can adapt to the complex environment of the exhaust pipe in the hotel kitchen, and it has reference value for the design and research of the same kind of robot mechanism.

1. Introduction

Before Covid-19, with the development of economy, especially the fast development of tertiary sector of the economy, people had more and more meals and banquets in hotels. With the "COVID-19" epidemic in the global impact of the relevant government departments of the hotel kitchen smoke pipe brought about by the disease more and more attention. Before the outbreak of COVID-19 in China, the Ministry of Health had strict laws on the hygiene of hotels, restaurants, kitchens and public places. By the end of 2005, there were four star hotels in China: 68,425, with different types of kitchen pipes that needed to be cleaned and maintained, most of which had never been cleaned in the long run, there are major health and safety risks, and the number of such hotels increases at the rate of 5-10% every year.[1-3] so the development of the domestic market for the cleaning of kitchen fume pipes has great potential, it is necessary to research and develop the robot for cleaning the oil fume pipe in the hotel kitchen.[4-5]

2. The Overall Design Scheme of the Robot Mechanism for Cleaning the Oil and Fume Pipe in the Kitchen of the Hotel

According to the market demand, this paper designs a new type of cleaning robot for the exhaust pipe of hotel kitchen. Its overall structure and working principle as shown in figure.1: The robot in the pipeline to check and clean up the dirt process is as follows: First of all, the air bag into the pipeline, and inflatable, so that the air bag blocked waiting to clean the two ends of the pipeline, the area to be cleaned is isolated to prevent the dust and dirt in the cleaning from spreading to other areas. After the dust and dirt fall off the inner wall of the pipe, a large dust collecting purifier is used to absorb the dust and dirt swept off the pipe. Finally, a camera sensor is used to check the cleaning condition in the tube. The dust and oil collection unit is shown in figure 6. The advantages and innovations of the cleaning robot system are as follows:

2.1. The Whole Set of Equipment is Small and Light, Convenient to Carry and Carry, and Flexible to Work

The whole equipment adopts crawler walking mode, which can move forward and backward freely, and the guiding device makes the robot turn automatically when encountering obstacles.

2.2. The Wide Visual Range when Operating Equipment

When working, the dust and dirt adhesion on the inner wall of the oil fume discharge pipeline can be observed in real time by the monitoring equipment, so as to carry out the corresponding operation.

2.3. The Thoroughly Remove the Dust and Dirt from the Inner Wall of the Oil Fume Discharge Pipeline

A complete set of ROBOT EQUIPMENT FOR OIL FUME PIPE cleaning. The design and production shall be carried out in strict accordance with the standards proposed by the health department, The whole oil fume pipe cleaning robot is driven by a pneumatic motor to rotate a brush to thoroughly clean the dust at the corners and the top of the pipe, and can use the pneumatic motor to raise or lower the support rod, the dust and dirt in the pipeline can be collected efficiently by using the large-scale dust collecting and purifying device, and then treated.

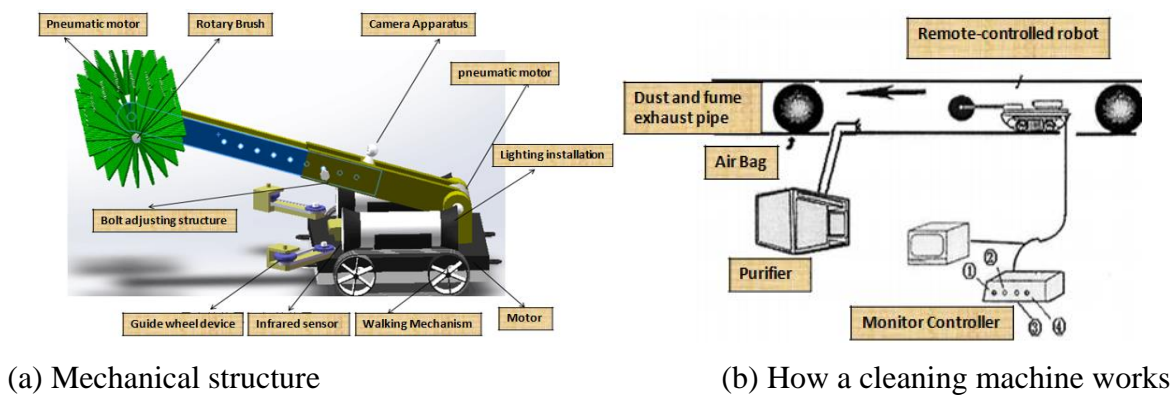


Figure 1: The Mechanical structure and how a cleaning machine works

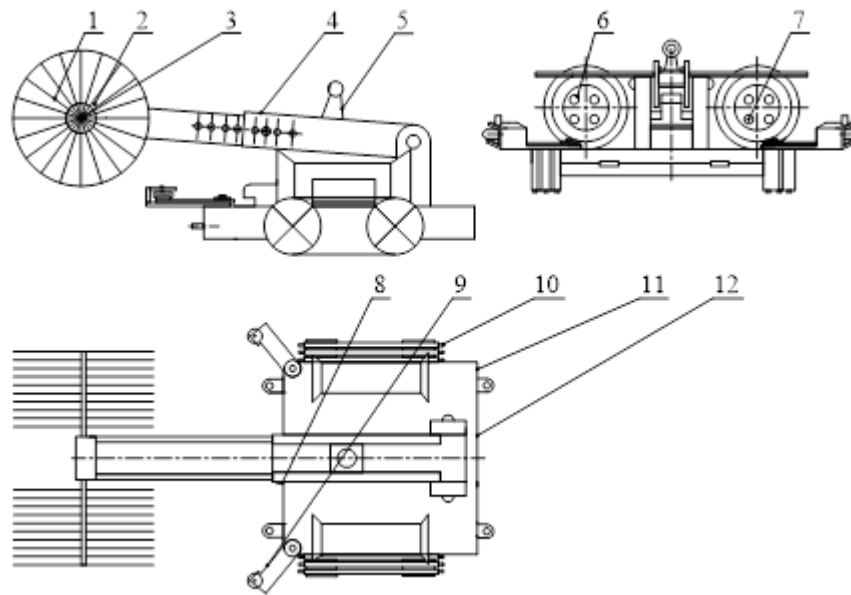


Figure2: The composition of cleaning robot mechanism

1-wash head; 2,4-arm; 3-pneumatic motor; 5-camera device; 6-lighting device; 7-infrared device; 8-adjusting Bolt; 9-guide wheel device; 10-walking mechanism; 11-motor; 12-motor

3. The Mechanism Design of Pipeline Cleaning Robot for Hotel Kitchen

According to the size of various air-conditioning pipes and the requirements of the inside environment of the pipes, the robot designed in this paper is 1550 ~ 7750 mm in length, 300 ~ 800 mm in width and 140 ~ 400 mm in height, the moving speed is from 66.67 mm/s to 200.00 mm/s, and it has strong climbing ability. In the which is mainly composed of three parts: monitoring device, walking mechanism and cleaning mechanism. The quasi-crawling design is shown in figure 3. Tube with wall thickness of 2mm, the climbing angle is more than 40°, and the maximum walking distance is 160m. Figure 2 is the structure of the robot,

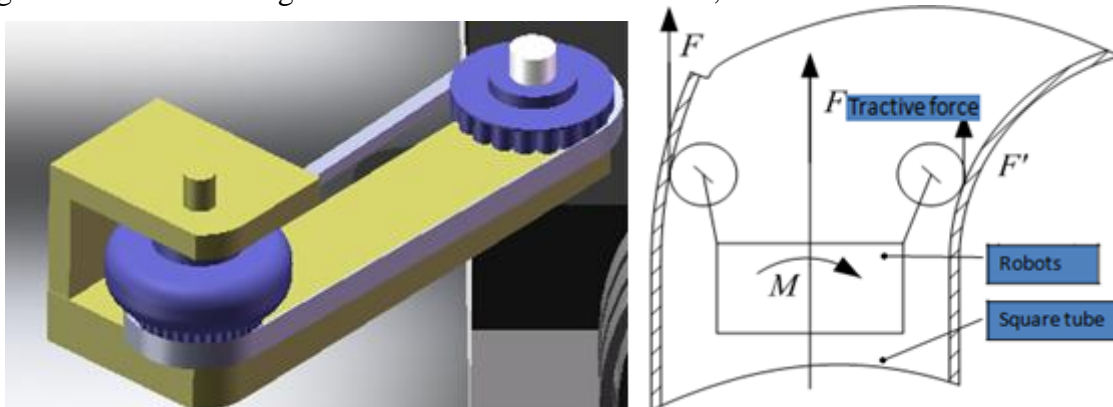


Figure 3: The force analysis of robot during right turn

3.1. The Walking and Steering Mechanism of Pipeline Cleaning Robot for Oil Fume Exhaust Pipe

There are two designs for the steering mechanism of the cleaning robot. The first is to simulate the car's differential steering, which makes it easier to turn. However, considering that this will

make the overall structure more complex and require greater quality, there will be a number of problems. More importantly, the air conditioning duct can not bear too much gravity and impact force, so the robot needs to move slowly in the air duct, and its own mass can not be too big, so the program does not meet the use requirements. The second scheme, as shown in figure 3, is to install a guide wheel on each side of the front part of the robot. The guide wheel device plays an important role in adjusting the direction of the robot when it moves in the pipeline. Before cleaning, the lateral distance of the two guide wheels is set by changing the screws on the support arm, so that when the robot is in the centre of the pipe, the guide wheels are about 20 mm away from the pipe wall. During the cleaning process, the two guide wheels rotate at the same speed and in opposite directions (left guide wheel rotates counter-clockwise, right guide wheel rotates clockwise), the speed of rotation is slightly faster than the robot's forward speed. As shown in figure 3, if the left guiding wheel strikes the left wall of the pipe, the robot will move toward the centre of the pipe under the action of the tangential friction f between the left guiding wheel and the left wall, and generate a clockwise direction torque m , to turn the robot to the right. In the same way, when the right guide wheel collides with the right wall, it produces a torque to the left, causing the robot to turn left.

3.2. The Monitor and Controller of Pipeline Cleaning Robot for Oil Fume Exhaust Pipe

As shown in figure 4, the monitoring controller requires a small camera mounted on the robot's adjustable arm to view the complex environment in the pipe through constantly adjusting the camera's perspective during operation. Currently, there are two main types of sensors used in mainstream cameras.

3.2.1 Complementary Metal Oxide Semiconductor

Complementary Metal Oxide Semiconductor is a kind of low-quality imaging product. It must be equipped with a light source when it works in low-light environment, but it has the advantages of low price, low response and low power consumption, and the imaging effect can meet the imaging needs of air conditioning pipe cleaning. Considering the imaging requirement and cost, the Colour Digital Camera GS-388 is selected and the lighting equipment is also installed. [5]

3.2.2 Charge Coupled Device

Charge coupled device charge-coupled device, with clear imaging, anti-shake, small size, but slightly higher price. [6-7]

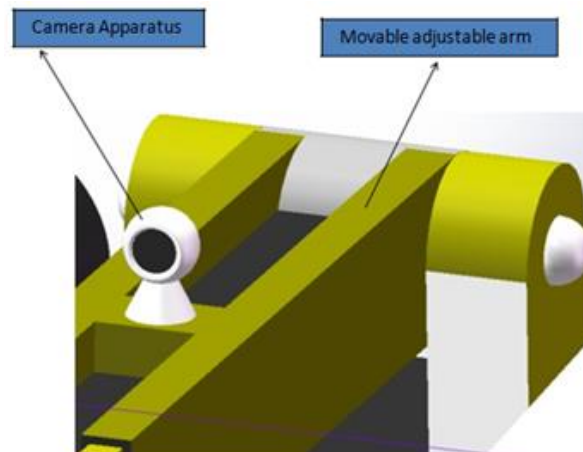


Figure 4: The Supervisory and control mechanism of cleaning robot

3.2.3 The Robot Cleaning Mechanism for Oil Fume Exhaust Pipeline Cleaning

The rotating brush device is the most important part of the cleaning mechanism because the robot uses the rotating brush to complete the cleaning. The Rotary Brush is driven by a pneumatic motor, and the brush rod connected with the pneumatic motor is designed with an adjustable structure, whose length can be changed by adjusting the brush dry bolt. The detachable rotating brush head structure can be installed with different rotary brushes to meet different cleaning environment, and the connecting mechanism of the cleaning mechanism and the pneumatic motor can complete pitch adjustment, ensure the robot in the pipeline convenient and flexible use of rotating brush, the air conditioning pipe inside the dead corner and the top of all the dirt swept off. The cleaning mechanism is driven by a motor to rotate the rotary pipe, while the aeration pipe blows the nylon sand evenly, so that the nylon sand is rubbed evenly on the inner surface of the ventilation pipe, and with the help of a lighting device and a guiding device, the robot can easily walk and turn on the inner wall of the complex pipe, which is helpful to the flexible operation of the device during the moving process and to cooperate with the cleaning mechanism to thoroughly clean all kinds of complex structures inside the air conditioning pipe. [7] The cleaning robot cleaning mechanism is shown in figure 5.

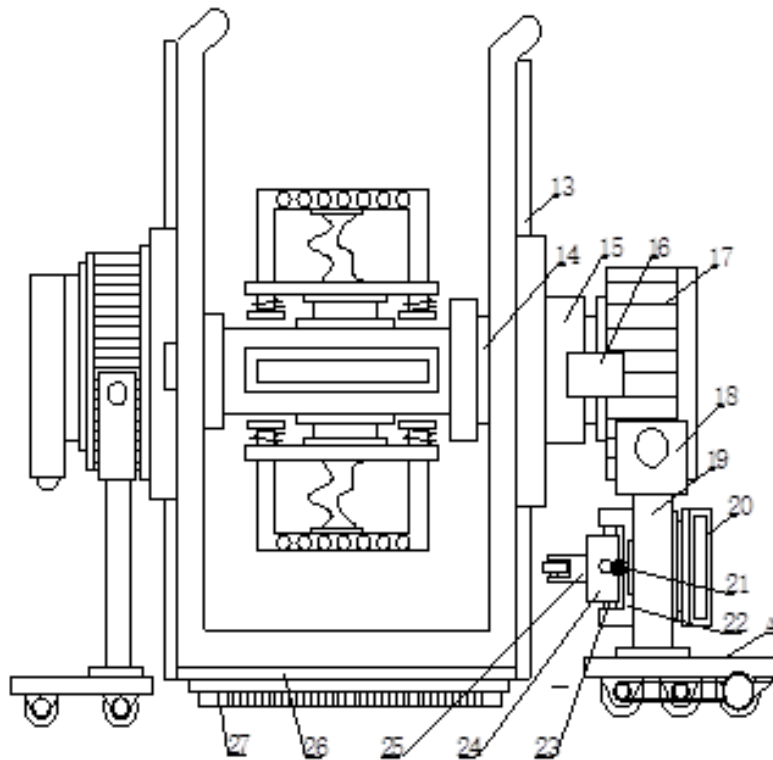


Figure 5: The cleaning robot cleaning mechanism

13-rotary pipe; 14-first bracket; 15-second bracket; 16-fan; 17-air inlet; 18-first Positioning Plate; 19-second Positioning Rod; 20-guide Ring; 21-second spiral spring; 22-block; 23-conduit; 24-through Hole; 25-snorkel; 26-connecting Pipe; 27-second positioning plate

3.3 Design of Rotary Brush for Pipe Cleaning Robot of Oil Fume Exhaust Pipe

As shown in figure 1(b), the air collector is usually called a negative-pressure air machine, which relies on the negative suction force generated to remove the dust and thus complete the collection of swept dust. [8-9]

3.4 Dust Collecting Device of Oil Fume Pipe Cleaning Robot

The quality of the Rotary Brush plays an important role in the complete cleaning of the complicated pipe. In order to clean the inner wall of the pipe more thoroughly and improve the efficiency of use, the two ends of the brush are designed to be circular, the middle part of the rotary brush is connected with the rotating shaft of the pneumatic motor, and the two parts are vertically connected.

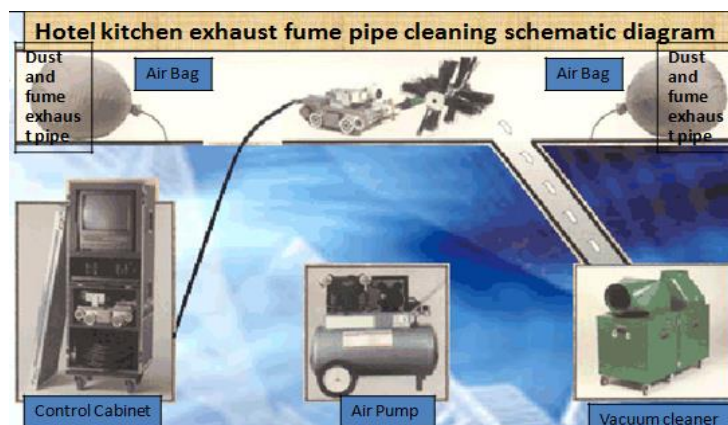


Figure 6: The drawings of dust and oil collection plant

4. Conclusions

The robot designed in this paper has been analyzed, simulated and verified by software. The results show that the robot has solved the problem of cleaning the oil fume exhaust pipe ventilation system in hotel kitchen, it is proved that the robot has strong adaptability to the cleaning work in the pipeline of oil fume drainage in the hotel kitchen, and has reference value to the design and research of the same type of robot mechanism.

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