

Design of cantilever mechanism of endoscopic detection device

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Abstract. As a result of the limitation of testing environment area and testing equipment, the existing rigid structure of the feeding device or multistage hydraulic cylinder cantilever mechanism can't meet the requirement of the stiffness. A scale is developed relatively high stiffness and high cantilever mechanism composed of five box, box at all levels adopt i-steel design, to enhance the rigidity and stability. Driven by a rope between housing at all levels, at the same time, to ensure the position precision. Using the finite element analysis ANSYS platform the cantilever mechanism, validate the rationality of the design. At the same time design of endoscopic detection device charge electric control system, and the control program is based on Vc++ to develop software. This set of equipment has been successfully applied on the inner wall of the column, detection of industrial field, has obtained the good effect.

1. Introduction

Due to a certain type of internal medicine column up to 7 m, in order to perform accurate detection and image acquisition, must be equipped with servo motor drive cameras into the internal medicine column, and its column wall surface containing a special material, can't contact with testing institutions, so can't laid auxiliary orbit, at the same time because of the construction site space is limited, so the original expansion of non-rigid is chosen as the final cantilever agency executive components.

Which are frequently used in China at present is to choose the hydraulic cylinder as a cantilever, high control precision, but the stiffness of the hydraulic cylinder is limited, prone to a larger deflection. In order to achieve control accuracy, this paper designs a box type telescopic jib, its high structure stiffness, the deflection is small, and high control precision, the manufacturing cost is low^[1-4]. The overall effect as shown in figure 1, figure 2.

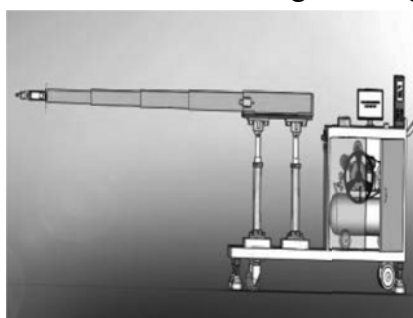


Fig.1 structure chart 1

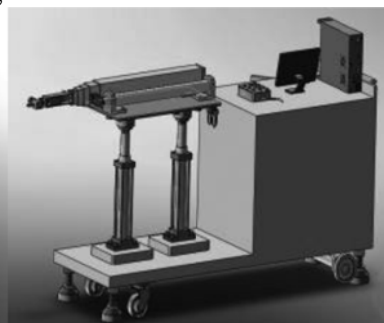


Fig.2 structure chart 2

2. Hardware structure

2.1 The overall structure.

In this paper, design of endoscopic detection device as shown in figure 3, figure 4.

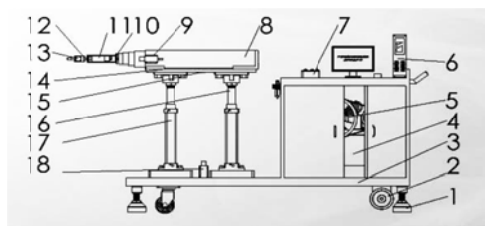


Fig.3 The overall structure main view

1. The fixed foot support; 2. The universal wheel; 3. The base of the car; 4. Storage tanks; 5. Air compressor; 6. Industrial; 7. The control panel; 8. Cantilever; 9. A laser range finder a; 10. The motor connection; 11. Servo explosion-proof motor; 12. The camera connection frame; 13. The camera; 14. The base plate; 15. Reflectors b; 16. A vertical cylinder; 17. The vertical cylinder b; 18. Laser rangefinder b

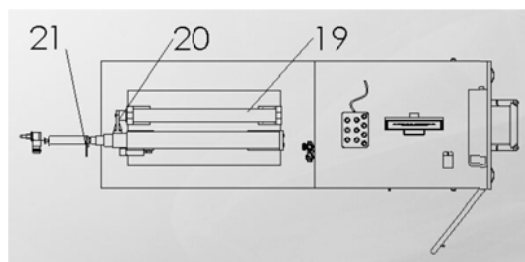


Fig.4 The overall structure of the vertical

19. The flat cylinder; 20. Cylinder cabinet fittings; 21. The reflectors of a

Cantilever car after two cylinder connected to the base, through the telescopic cylinder control the height of the cantilever. The height of the cantilever and telescopic distance through feedback to industrial laser range finder of a and b, control. Cantilever front camera via servo explosion-proof motor connection, through the control of the servo explosion-proof motor, make it easier for camera rotate 360, sample photograph.

2.2 Cantilever telescopic mechanism.

Because of the characteristic of the collection site, need cantilever out 4 m, cantilever section maximum width of less than 50 mm, and the front need to load 5 kg, and to ensure that the deflection is less than 0.1 mm, the motion control accuracy under 0.5 mm. Through the experiment, finally choose driven by clicking on the cylinder, the rope pulley drive, crown block support multi-level box cantilever mechanism.

Cantilever institutions including all five body, the first box fixed to the floor, the remaining four box expansion at the same time, there are single-stage cylinder installed in the front of the second-level cantilever box, through the single-stage cylinder telescopic drive the secondary housing movement, chamber through the ropes connect other tertiary housing, the cantilever expansion process, all four body movement at the same time. Cantilever internal structure as shown in figure 5.

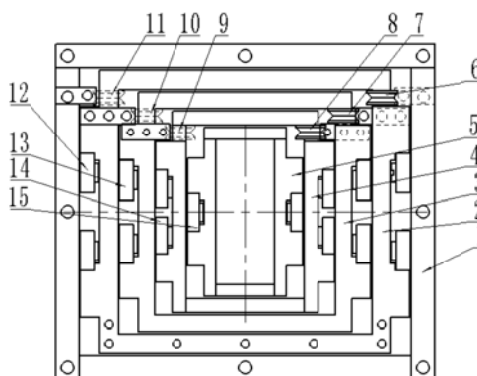


Fig.5 cantilever assembly diagram

1. Level 1 box body; 2. The secondary housing; 3. Level 3 box body; 4. Level 4 box body; 5. Level 5 box body; 6. The rope pulley a.7 . The rope pulley b. 8. The rope pulley c. 9. Supporting pulley a. 10. Supporting pulley b.11. Supporting pulley c. 12. Supporting pulley d.

Level 1 box fixed on the floor, the secondary housing 2 through supporting pulley 12 and other pulley installed on level 1 box body, By supporting pulley12 and other fixed pulley sliding in the primary enclosure, complete cantilever scaling. By the same token, the triple body by supporting pulley 13 installed on the secondary housing, level 4 box body through supporting pulley 14 installed on level 3 box body, 5 case by supporting pulley 15 installed on level 4 box body. Pulley drive makes the housing at all levels between cooperate closely, installation is compact, to ensure the accuracy.

When out of single-stage cylinder drives the secondary housing 2, at the same time, rope pulley 6 out together, and the ends of the rope that rope pulley 6 respectively installed on the box body and level 3 box body, drive level 3 box body stretched out at the same time, the same three leading level 4 box body stretched out, and drive the five boxes out again. Until all the whole cantilever out of maximum amount.

When recycling single-stage cylinder drives the secondary housing retract, at the same time rope pulley 11 retraction together, the rope at both ends of the rope pulley 11 respectively installed on the box body and level 3 box body, retraction impetus tertiary enclosure, the same level 3 box drives the level 4 case retraction, causing the five cabinet retraction. Until all whole cantilever box all back.

3. The stiffness of the cantilever test

Because this set of equipment accuracy is higher, When the field work, the deflection and the vibration of the cantilever will the result of the acquisition data cause great influence, so by using ANSYS software to static stiffness test of cantilever, guarantee the precision of the equipment^[5~7].

Five boxes of deflection:

$$\Delta = \frac{WL^3}{3EJ} \quad (1)$$

Five box body stiffness:

$$K_{\Delta} = \frac{W}{\Delta} = \frac{3EJ}{L^3} \quad (2)$$

Where E = five box of modulus of elasticity; J = five box of neutral axis of inertia; W = applied load; L = five body length value; Δ = deflection; K_{Δ} = five body stiffness.

When five body fully extended, maximum deflection come into being at the forefront of cantilever, body is the root of the joint dangerous points per level. Set the level of the whole body is fixed, and applying 50N of gravity in the forefront of cantilever, direction downward, and bending moment 10 N/m simulation servo explosion-proof motor and the load produced by the camera. For the deflection of cantilever results and stress results are shown in figure 6 and figure 7.

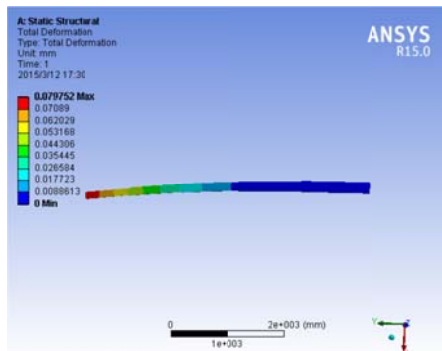


Fig.6 Five cabinet strain diagram

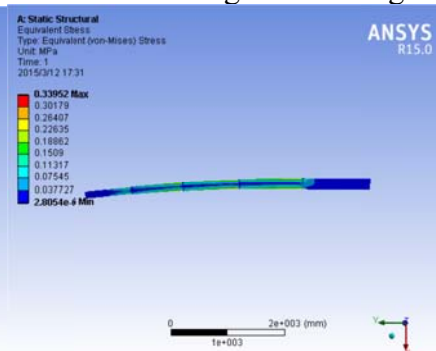


Fig. 7 Five casing stress diagram

From figure 6, the maximum strain cantilever occurred in the forefront cantilever, strain is 0.079 mm, and cantilever mechanism allowable values of 0.1 mm, the strain value is qualified.

From figure 7, the maximum strain cantilever in cantilever secondary housing and level of the joint of casing, the maximum stress is 0.226 Mpa, the cantilever of the aluminum alloy material allowable stress is 90 Mpa, safe.

4. Electrical control system

4.1 Pneumatic control system.

This set of equipment with a total of three single-stage cylinder, two vertical cylinder a, b provide cantilever lifting power. A cantilever flat cylinder connections, driver cantilever scaling. Gas circuit principle diagram as shown in figure 8.

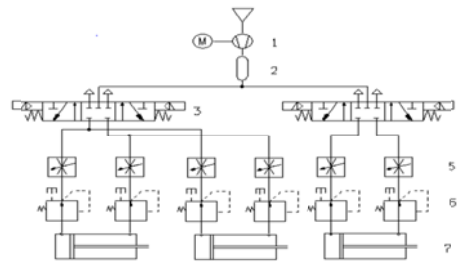


Fig.8 Gas circuit principle diagram

1. Air compressor; 2. Storage tanks; 3. Three five electromagnetic directional valve a; 4. Three of five electromagnetic directional valve b; 5. Speed regulating valve; 6. The pressure regulating valve; 7. The single-stage cylinder;

Air compressor work drawn from atmospheric air stored in the storage tanks, high pressure air into three five-way solenoid directional control valve. Flat electromagnetic directional valve control cylinder driving the whole scale of cantilever. Smooth movement speed regulating valve and the pressure regulating valve to ensure the cylinder, facilitate accurate control of the cantilever. The electromagnetic directional valve to control the movement of two synchronous cylinder. In order to ensure the synchronous movement of the two cylinder, choose the same pressure regulating valve and control valve, and set the same pressure and velocity.

4.2 Circuit control system.

This set of equipment control system uses Visual c++ programming way of soft PLC and industrial control unit. Vc++ program to industrial computer as the carrier to control two solenoid directional valves, servo explosion-proof motor and camera work. In the vertical cylinder and the movement direction of the cantilever respectively installed the laser range finder, through RS232 serial interface real-time feedback the height of the cantilever and cantilever extended distance to the industrial computer, at the same time, servo explosion-proof motor with encoder will data real-time feedback motor rotation Angle to industrial. Industrial computer automatic program every 2ms scan time, complete the cantilever height, distance and explosion-proof servo motor real-time monitoring, and in setting the location of the control sample photograph camera work. This set of equipment of logic control diagram as shown in figure 9.

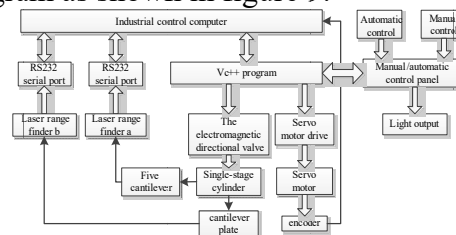


Fig.9 Logic control chart

Based on Visual c++ developed Control system software, use the Timer timer, with the frequency of once every 2ms scan, to ensure the control system of the real-time and accuracy, and control system software interface is shown in figure 10.

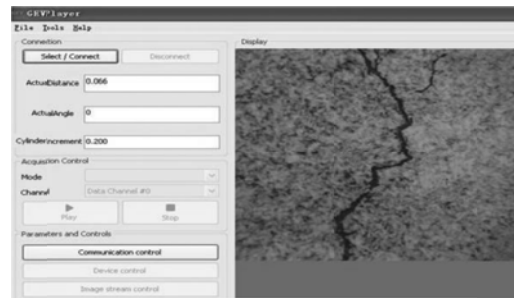


Fig.10 The control system software interface

5. Conclusion

In this paper, the explosive endoscope detection of cantilever mechanism was improved, in order to collect the accurate image samples, design a new type of cantilever mechanism. Cantilever mechanism adopts the crown block and multi-stage portfolio model of box, stable structure and the smooth movement, and by using the ANSYS finite element analysis of cantilever, the stress and strain results conform to the requirements, and designed a complete set of electric control system, and based on Visual c++ developed control system software, control the operation of the system. In this paper, design of cantilever mechanism has been successfully applied in medicine column wall surface detection project, and achieved good results.

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