

Original Research Article

Design of Monitoring PTZ with High Scalability

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Abstract: Provided a design scheme of a lifting PTZ with high-scalability for detecting search and rescue robots based on the analysis and reference of various lifting mechanisms at home and abroad. It proposed a rigid-flexible dual-property automatic lifting mechanism transmission scheme which adopts a roll-up spring as a supporting mechanism, a gear and a sprocket as a transmission mechanism, and a telescopic rod as an auxiliary supporting mechanism, which provides a new solution for the disadvantages of the traditional lifting mechanisms with large original volume and poor telescopic performance. Through the actual test, the mechanism can raise to the target stroke of 2 meters in 60s smoothly and widen the field of view of the image capturing device effectively based on the detection and rescue robot, which improves the ability of passing the narrow space and rescuing obviously.

Keywords: Robot; High Scalability; Automatic Lifting; Flexible Component; Roll-Up Spring; PTZ

Introduction

With the rapid development of modern society and the rapid growth of population, the development into the air has become a trend of space expansion. At the same time, the maintenance of high-altitude equipment has greatly increased the cost of living and risks in the city, so many countries are developing scalable equipment and have achieved certain results. On the other hand, in mining and other fields, the threat of gas explosion cannot be underestimated. However, because the gas density is relatively small and is distributed above roadways and other places, it is not convenient for operators to collect and measure its concentration. Therefore, it is necessary to carry out auxiliary operations with the detection robot with telescopic function.

Therefore, it is necessary to design and install a highly telescopic lifting device on the platform of the

robot so that it can carry the cloud platform to move up and down, thus enabling the platform to have the monitoring and detection capability for a larger area.

1. Classification, comparison and selection of lifting devices

1.1 Classification of elevator installations

According to the different lifting forms, the existing elevators can be roughly divided into three categories:

(1) Rigid lifting form, which uses rigid features to lift, shrink and support the working platform. The commonly used structural forms include screw, plunger, scissor and rack and pinion, etc.

(2) Flexible lifting mode, mainly through the way of pulling, realize lifting operation, common in flexible elevator pulling mechanism has wire rope, chain, etc.

(3) Rigid-flexible dual-attribute lifting. The lifting mechanism in this form is rigid in lifting operation and flexible in contraction state, which can not only reduce

the occupied space of the elevator in contraction state, but also make the internal mechanism arrangement of the elevator more flexible.[1]

1.2 Comparison of elevator devices

1.2.1 Rigid lifting device

Screw type: the lifting function of the platform is realized by using the characteristic that the rotating motion of the mechanism is converted into linear motion by a screw, which belongs to a screw type lifting mechanism and has the advantages of stable operation, accurate transmission, compact structure and the like, but due to the lifting mechanism itself.

The original height of the lead screw is relatively high based on the lead screw itself, so although it can realize the function of lifting the platform, it cannot reach the goal of supporting the platform.

For the purpose of high flexibility, its lifting ratio can only reach 1:1. **Figure 1** is the working principle diagram of ball screw type lifting mechanism.

Plunger type: In a single-acting hydraulic cylinder,

pressure oil only enters one chamber of the hydraulic cylinder, which is made to realize one side by hydraulic pressure.

Direction movement, the opposite direction movement is realized by self-weight and external load, etc. In the double-acting hydraulic cylinder, as shown in **Figure 2**, the movement of the piston in both directions is realized by alternately feeding oil into the two chambers and relying on the action of hydraulic pressure. The plunger only needs the cylinder liner to support.

But not in contact with the cylinder sleeve, and the cylinder sleeve is easy to machine, so that the cylinder sleeve is suitable for being used as a long-stroke hydraulic cylinder and is easy to control. However, at the same time, the original height of the cylinder liner is relatively high and the original volume of the hydraulic device is relatively large, which results in obvious limitation of its telescopic performance. Therefore, this class type lifting device is not conducive to the realization of high expansion ratio performance.

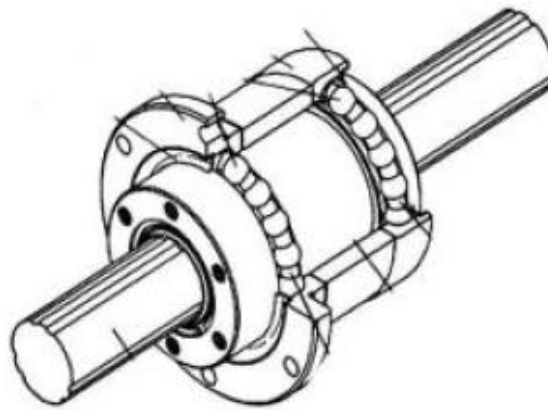


Figure 1. Ball screw type.

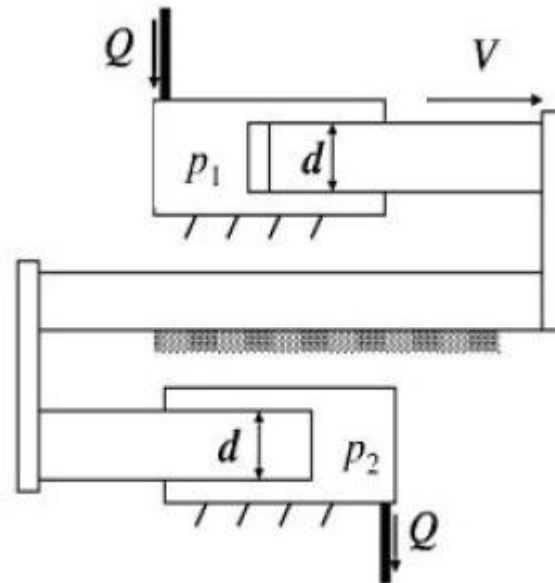


Figure 2. Plunger type (double acting type).

Scissor type: the scissor type lifting mechanism is shown in **Figure 3**, which includes a scissor device and a drive execution device. The driving mechanism drives the actuating device to generate a small displacement stroke and transmits the driving force to the scissor device.

The feature enlarges the small displacement of the driving device to a larger stroke when it is driven, so that the lifting platform can move up and down. This type of device has been widely used because of its compact structure, large load capacity and good handling. However, this mechanism also has a large original volume due to the need to have a scissor device as the main body, and also has the disadvantages of difficulty in realizing uniform speed of the table during the lifting process, small lifting and lowering stroke, etc.

Rack and pinion type: the rack and pinion

mechanism is shown in **Figure 4**, which includes a gear mechanism and a rack mechanism. Through gears, power is transmitted to the rack, thus converting the rotary motion of the gear into the linear motion of the rack in the vertical direction, and driving the platform to carry out lifting operation^[2]. The lifting mechanism has the advantages of continuous operation, fast vertical speed, simple operation, good synchronization and the like; meanwhile, the teeth and the wheel and rack mechanism is easy to level the platform and the positioning is accurate. This advantage provides a direction for the design of our lifting mechanism, that is, using a similar gear and rack mechanism to achieve accurate positioning and control. However, the rack-and-pinion lifting mechanism is also due to the fact that the rack long body length makes it difficult to achieve high scalability.

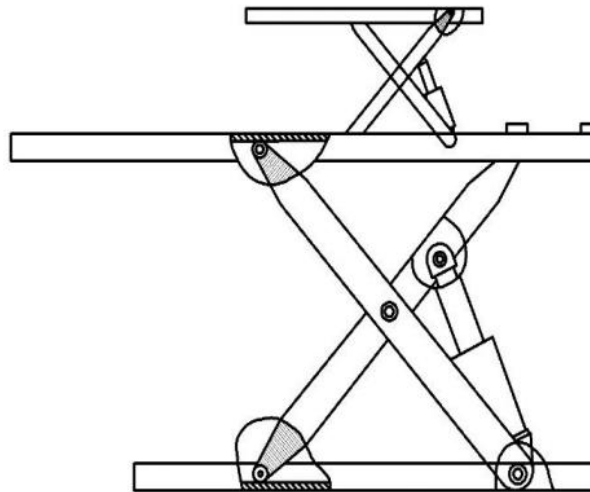


Figure 3. Scissor type.

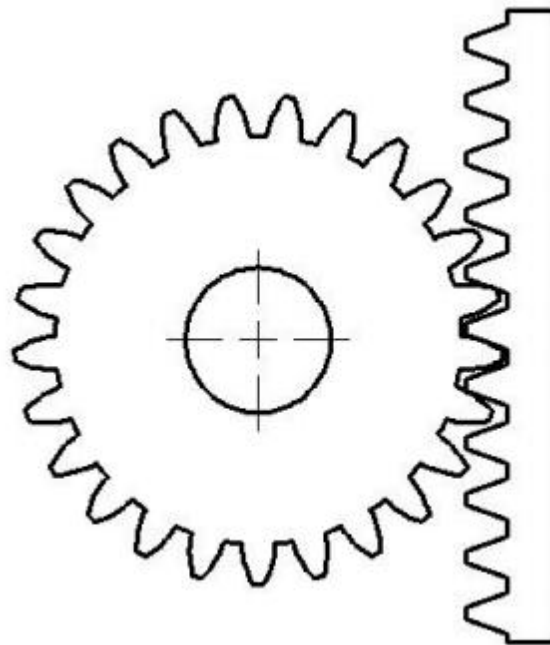


Figure 4. Rack and pinion type.

1.2.2 Flexible lifting device

Wire rope type: Wire rope type mechanism technology is relatively mature and is widely used on various lifting platforms and can be divided into coils. There are two kinds of working forms: the entry type and the lifting type. The winding type comprises a winding drum and a steel wire rope, the driving device drives the winding drum to rotate, and the lifting of the platform is realized through the winding and unwinding of the steel wire rope, and the winding type is commonly used for construction elevators; The jack-up type comprises a

hydraulic plunger and a steel wire rope, and the hydraulic plunger drives the steel wire rope to lift the platform through jacking or shrinking. This type of lifting mechanism has the advantages of good positioning performance, flexible arrangement and stable operation, but it has obvious restrictions on the lifting height, and is limited by its working principle, so it has higher requirements in the height direction, resulting in larger original volume.

Chain type: The chain type mechanism uses the motor and sprocket as the driving mechanism, and realizes its transmission through sprocket, chain and

transmission shaft. This type of mechanism has good positioning, high precision and simple structure, and is commonly used in low-speed occasions with small lifting height. According to the structure and position of the chain bar, the counterweight type structure is simple, but its running stability is poor. The side-mounted structure has good stability but high manufacturing cost. The closed lifting mechanism has complicated structure and high cost. In addition, the chain type lifting mechanism still needs a larger original height to ensure the realization of its lifting movement.

1.2.3 Rigid and flexible double attribute lifting device

The rigid-flexible dual-attribute lifting mechanism is a new type of lifting device with sufficient arrangement flexibility, which only appears in recent years. It presents rigidity when lifting operation, can lift objects or platforms to achieve the goal of specified objects rising or falling within a specified time, presents flexibility when no operation is performed, and can fold and compress to reduce the space occupied by the device. This kind of device provides a new solution to the disadvantages of small expansion ratio and poor flexibility of the traditional lifting mechanism. However, up to now, most dual-attribute lifting mechanisms have adopted chains and wire ropes as auxiliary lifting mechanisms and support frames as rigid support mechanisms. This mechanism makes the lifting

mechanism still not have the advantages of small original volume. The double attributes of the spring coiling mechanism provide a new direction for our research on the lifting mechanism. Due to the rigidity of the spring coiling mechanism, the elevator has both lifting and supporting capabilities, making the original volume of the elevator large due to rigid mechanisms such as supporting frames. The problem was solved immediately, and its flexibility fully ensured its advantages of large expansion ratio and good mechanism flexibility.

In order to realize the goal that the lifting monitoring platform mounted on the detection and collection robot has the characteristics of small original volume and large expansion ratio, this paper proposes a new elevator design scheme with spring coiling mechanism as the supporting lifting mechanism, which provides sufficient guarantee for the slit passing ability of the detection and search robot.

2. The overall design and working principle of lifting system

According to the working conditions and overall requirements of the probe and collection robot, the structure of the lifting mechanism system proposed in this paper is mainly composed of a motor control drive system, a gear chain transmission unit, a jacking support mechanism, a damping mechanism, a pan-tilt head and a box body. As a result, its overall structure is shown in **Figure 5**.

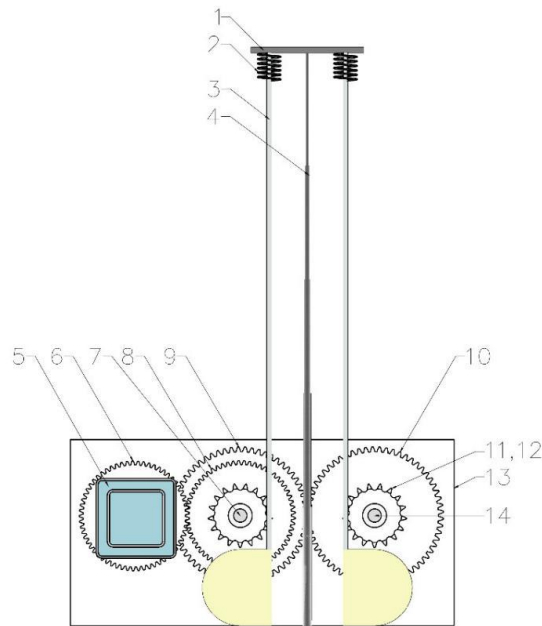


Figure 5. Overall structure diagram of lifting system.

The box body 13 is installed in the groove reserved by the robot for the elevator, which can fully improve the space utilization rate of the search and rescue robot, make the size of the robot in the three dimensions of length, width and height change as small as possible under the condition of adding a lifting system, and effectively avoid the situation that the slit permeability decreases due to the installation of the lifting system.

Yuntai 1 is an important component of the lifting system. Its upper surface can carry the image collector, gas detector and other instruments. It can be matched

with the movement of the robot and the self-rotating ability of the detection and collection instruments, providing basic guarantee for the detection and search robot to obtain a wider field of vision and have a stronger working ability. Its lower surface is connected with coil springs, shock absorbing springs and telescopic rods, so that the lifting force provided by the elevator acts on the Yuntai, enabling the Yuntai to lift along with the expansion and contraction of coil springs. The arrangement of coil spring, damping spring and retraction rod on the lower surface of pan-tilt head is shown in **Figure 6**.^[3]

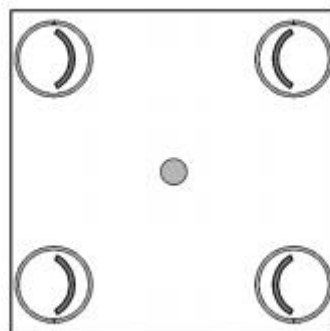


Figure 6. Schematic diagram of the arrangement of coil spring, damping spring and retraction rod on the lower surface of pan head.

3. Anticorrosion measures

Since this elevator design scheme is mainly carried by search and rescue robots that are often used in

ruins, roadways and other harsh environments, in order to ensure the safety and stability of the lifting system, corrosion prevention has become an important issue that should be taken into consideration to minimize the

impact of water vapor and unpredictable chemical components on the lifting mechanism.

However, in this lifting system, the corrosion degree of the parts enclosed in the box is relatively weak, which will not be discussed here, but the probability of external corrosion of the mechanisms that may be directly exposed to the outside in the lifting system cannot be underestimated. Therefore, it is of great practical significance to further study the anti-corrosion measures for the mechanisms such as coil spring, telescopic rod and box. For the spring coiling mechanism, there is a hole punched to cooperate with the chain wheel to realize transmission, and there is a difference in oxygen affinity with the area adjacent to the hole. When water vapor acts around it, a large number of primary cells^[4] will be formed here, thus corroding the coil spring, causing stress concentration and greatly reducing the service life of the spring coiling mechanism. In order to minimize the impact of such corrosion on the coil spring, the surface of the coil spring can be strengthened by anti-corrosion technologies such as zinc plating and aluminum plating^[5] to enhance its corrosion resistance. For shock-absorbing springs and telescopic rods, they also play an extremely important role in the lifting system, therefore, their surfaces should also be galvanized and other processes be carried out surface treatment. As for the box body, due to its large surface area and only supporting and fixing function in the actual operation of the lifting system, its surface can be protected by coating anti-corrosion coating, and at the same time, its surface coating should be carried out every certain period inspection and painting.

4. Conclusion

This paper presents a design scheme of a lifting monitoring platform with high flexibility, which uses spring coiling mechanism as lifting support. This paper mainly introduces the current types of elevators, and

aims at the high flexibility, flexibility of mechanism arrangement and compact type of lifting mechanisms. Based on the analysis and demonstration of its advantages and disadvantages, this paper puts forward a new type of lifting mechanism with rigid and flexible double attributes, and discusses its remote control, pan-tilt damping and anti-corrosion measures for the whole machine, which is the original large volume and expansion ratio of the existing elevator. The small defect provides a new type of solution. After the prototype is built and tested, the lifting mechanism has the ability to stably lift the platform and load mass of 500g in 60 seconds and completely restore the original contracted state in 2 m and 20 s. The lifting system of the is suitable for detection and collection robots that require small original volume and wide monitoring and detection capability. Due to the flexible characteristics of the coil spring adopted in this scheme, the weight of the tripod head and the detection instruments carried by the tripod head is limited. If this lifting scheme is used for design, attention should be paid to it.

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