Wheel-leg two-state retractable bionic mobile platform

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ABSTRACT: *Wheeled mobile robot has the characteristics of high efficiency and flexibility. Compared with other robots, it has simpler structure, smaller weight and lower energy consumption; On this basis, the wheel-leg robot can adapt to different complex terrain, and can work in more environments instead of humans, such as collecting external environment, working in dangerous environments, etc. This device is a bionic mobile platform that can realize the switch between the two states of the wheel and leg and the change of height, height, width and width. It will provide universal technical support for the practical production and application of the deformable robot.*

KEYWORDS *- Bionic robot, portable platform, deformable robot*

I. INTRODUCTION

With the rapid development of science and technology, robots are rising step by step in people's vision. In daily life, robots also undertake many tasks. Bionic robots are a major focus in robot research. Many of people's innovative inspiration comes from the discovery and research of natural organisms. Therefore, bionic robots have many biological structures with practical effects. Mobile robots begin to enter people's vision, and wheeled robots are the focus of human research. Wheeled robots move quickly and efficiently, and have been widely used in many aspects.

There are many advanced wheel-legged robots at home and abroad, but many robots are difficult to pass through narrow areas and some obstacles. When faced with areas that are close to or smaller than their own height and width, they are always difficult to pass because they are not flexible enough, which is very cumbersome. This paper will design a deformable robot to solve the above problems.

II. STRUCTRAL DESIGN OF MECHANICAL PART

2.1 Structural transformation design of wheel leg

In this design, the wheel-leg two-state transformation structure adopts the principle of double-rocker mechanism in four-bar mechanism. The steering gear is installed at the connection between the lower leg and the upper leg to control the rotation of the tripod. At the same time, the tripod is connected with the wheel frame through the connecting rod. The steering gear can complete the deformation of the robot from wheel movement to walking movement by controlling the rotation of the tripod at a certain angle; The stepper motor is installed on the tripod, and the rotating disc is installed on the rotating shaft of the motor. In this way, the control of the wheel and the speed of the robot can be realized. As shown in Figure 2.1. Figure 2.2 is the schematic diagram of the change of wheel leg in two states.

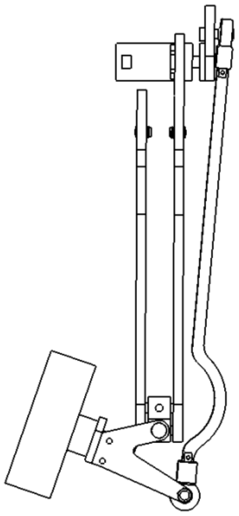

Fig2.1 Diagram of Two-state Change of Wheel Leg

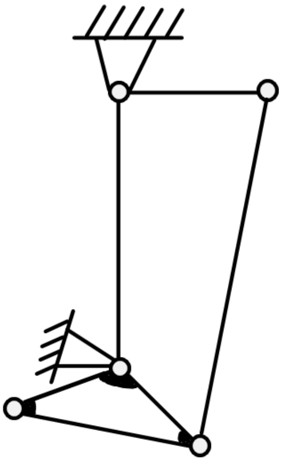

Fig2.2 Schematic Design of Two-state Change of Wheel Leg

2.2 Telescopic part of wheel leg

The deformation of the wheel-leg part is mainly due to the exchange between the wheel-type movement and the leg-type movement of the robot. The wheel-leg changes the vertical height of the robot by changing its own vertical height. This function uses the principle of crank linkage mechanism to connect the upper leg and the lower leg with the electric push rod, which can realize the bending function of the leg, as shown in Figure 2.3. In this design, the electric push rod on the wheel leg of the robot is mainly used to complete the walking of the robot. When a low robot encounters a low environment, it can reduce the height of the robot by controlling the contraction of the electric push rod, so that the robot can pass smoothly without detour.

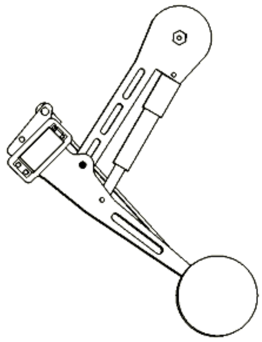

Fig 2.3 Schematic diagram of telescopic part of wheel leg structure

2.3 Center disc design

It mainly includes two large turntables, a freely retractable linear guide rail, and a push rod with a certain arc. The design of the push rod arc will be described below.

The turntable deformation mechanism is mainly used to realize the overall widening and narrowing function of the robot. This function adopts the principle of the crank slider mechanism. The crank slider mechanism adopted by the central wheel plate drives the bending rod through the rotation of the central wheel plate. The other end of the bending rod is hinged with the plate connector and one side of the slide rail to form a rotating pair. At the same time, the slide rail is also a moving pair. One rotary table is used as the load rotary table, and the other rotary table is used as the drive plate. The power of the drive plate mainly comes from the motor. In order to facilitate processing, the rotating pair between the rods uses the same structural design. Therefore, the design of the connecting rod structure includes the design of the rod itself and the design of the rotating pair. As shown in Figures 2.4 and 2.5.

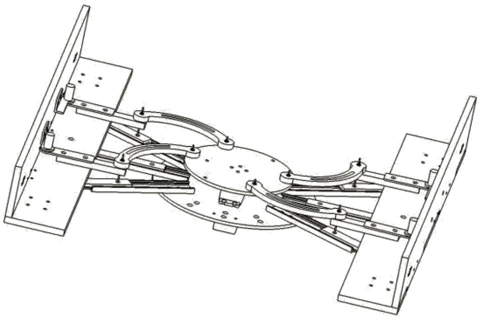

Fig2.4 Design of robot turntable deformation mechanism

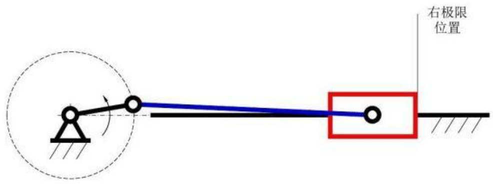

Fig2.5 Centering crank slider mechanism

III. Design and Calculation

3.1linear actuator

In this design, the electric push rod on the wheel leg of the robot is mainly used to complete the walking of the robot. When a low robot encounters a low environment, it can reduce the height of the robot by controlling the contraction of the electric push rod, so that the robot can pass smoothly without detour. Considering the size of the designed robot, we set the target height that the robot can reduce between 50 mm and 70 mm. Because the electric push rod is mainly used to lift the leg and does not require much force, the stroke is mainly considered in the selection of the electric push rod. The calculation principle is as follows:

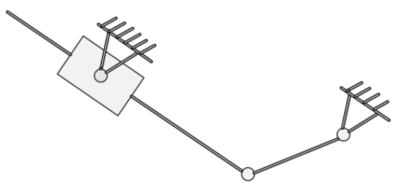

Fig3.1 Simplified diagram of wheel leg

It can be seen from Figure 3.1 that the height h of the robot changes with the change of the angle, which is controlled by the length l of the electric push rod. Therefore, the calculation of the height h of the robot can be simplified to the problem of calculating the length of a triangle bevel, as shown in Figure 3.2:

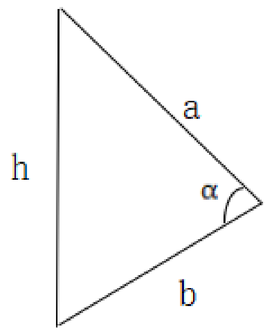

Fig3.2 Schematic diagram of wheel leg calculation

According to cosine theorem:

$$h^2 = a^2 + b^2 - 2ab\cos\alpha$$

Among them, a=149.5mm and b=177.2mm can be obtained by measuring the designed model. According to the size of the design model and the setting of the target height, select the electric push rod with the maximum stroke of 50mm. Assuming that the maximum stroke of the electric push rod is 40mm, the range of angle change will be reduced from 138 ° to 74 °. Thus, the theoretical height of the robot can be reduced by 65mm according to the cosine theorem. Therefore, it meets the expected requirements.

3.2 Arc push rod of rotary table deformation mechanism

When designing the arc-shaped push rod of the rotary table deformation mechanism, the following issues should be considered:

(1) Avoid dead spots during the rotation of the arc push rod and the drive turntable;

(2) Avoid the interference of the arc push rod during the movement of the driving turntable;

(3) When the arc push rod reaches the maximum point, it meets the motion range of the robot;

(4) The power loss during deformation shall be as low as possible.

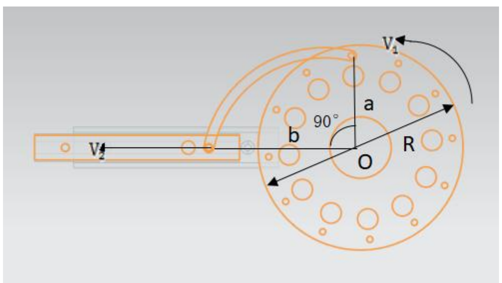

Fig 3.3 Calculation schematic diagram of arc push rod of disc deformation mechanism

In the figure, a is the connecting radius between the starting point of the arc push rod and the driving turntable; B is the distance between the circle point of the driving turntable and the end point of the arc push rod; Is the rotational speed of the driving turntable; Is the movement direction and speed of the end point of the arc push rod; O is the center of the drive turntable; R is the diameter of the drive turntable.

Considering the size of the robot and the size of the driving turntable, the robot's telescopic range is controlled at about 100 mm in diameter of the driving turntable. In order to prevent interference between arc-shaped push rods due to excessive rotation angle, it was defined at the beginning of the design that the elongation target of about 100 mm can be reached when driving the rotary table to turn over 60 ° angle.

According to the above requirements, the radius length of the arc-shaped push rod is r=55mm and the center angle of the circle is n=92 ° by using the drawing method. Through the arc length calculation formula: where n is the center angle, is the circumference, take 3.14, r is the radius, and obtain L=88.269.

IV. Control part

For the motor control part, according to the above theoretical calculation structure, RZ7899 is selected to control the DC motor (Figure 4.1),It has two logic input terminals to control the forward, backward and braking of the motor. The circuit has good dry resistance Disturbance, small standby current and low output internal resistance. At the same time, it also has a built-in diode to release sensitivity Reverse impulse current of load.

The A4988 motor (Figure 4.2) is used to drive the chip to control the stepping motor. The A4988 is a complete micro The stepper motor driver is easy to operate. It can be adjusted to full, half, quarter, eighth and sixteenth step moldThe stepping motor can be precisely regulated.

L298n is a high-voltage, high-current double-full-bridge driver designed to accept standard TTL logic level Driver, providing two enable inputs to enable or disable the device independently of the input signal, with four outputs Interface, so you can use a l298n chip to control two electric push rods.

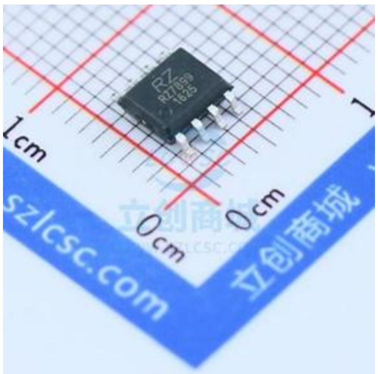

Fig4.1 RZ7899 bidirectional motor drive circuit

Fig4.2 A4988 micro-stepping motor driver

V. Innovation points and promotion and application

5.1 Innovation points

(1) The turntable deformation mechanism composed of crank-slider group can realize the widening and narrowing of the mobile platform;

(2) The single leg composed of four-link mechanism can realize the height and height of the platform through the expansion and contraction of the electric push rod;

(3) The triangle mode switching mechanism cleverly designed by the ankle realizes the wheel-leg two-state switching with the help of the four-bar principle;

(4) Single-motor drive disc-type deployable mechanism makes control simple and reliable.

5.2 application

The wheel leg two state retractable bionic mobile platform can be equipped with image transmission mechanism, fire extinguisher, disinfection and sterilization nozzle, life detection device, etc., and transformed into a variety of robots for detection, rescue, epidemic prevention, etc. Because the bionic mobile platform "body" can be high, short, fat and thin, and has two mobile modes; It can be popularized and applied in fields such as field exploration, mine rescue, highway transportation, public place disinfection and sterilization, and can replace human beings to complete various dangerous, heavy and repetitive labor.

VI. Conclusion

The unpredictability of the working environment indicates that the deformable mechanism of wheeled mobile robot must be superior enough. Otherwise, the robot will be difficult to achieve the expected goal given by human beings. Whether the robot has good terrain adaptability, such as the ability to pass through obstacles, narrow gaps, and rough mountain roads, is directly affected by the design of deformation mechanism. Compared with wheeled mobile robot, the design of deformation mechanism needs to have the performance that the following common mechanisms do not have:

(1) Flexible obstacle-crossing ability: This ability is mainly manifested in the ability of slope gradient, anti-rollover, passing through narrow gaps, and crossing obstacles similar to steps. These abilities indicate that the deformation mechanism of the robot must be flexible and changeable.

(2) It can move quickly on flat ground: wheeled mobile robot is a congenital advantage, so it is still used in design.

(3) You can walk freely on rough roads and adapt well to unknown terrain: the ability to walk steadily is extremely critical when walking on rough roads, especially on rocky and difficult roads.

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