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Optimized design of bionic chameleon robot

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ABSTRACT: *Based on the principle of bionics, this paper combines the characteristics and body structure of the chameleon with the applied research of the robot, and studies and analyzes the chameleon bionic robot with grasping ability and chameleon land gait, and researches its color-changing ability, grasping structure and motion stability. In this paper, the whole robot is designed and optimized from the aspects of leg mechanism, head tongue ejection device, body color changing device, control system hardware and software. The leg mechanism adopts linkage mechanism; the head and tongue ejection device adopts friction wheel to eject and retract; Open MV is used to realize the color changing function. Finally, the feasibility of the robot's gait and color-changing ability are analyzed through simulation, and the motion control of the robot is realized.*

KEYWORDS *-bionic chameleon robot, head and tongue ejection device, linkage mechanism, motion*

I. INTRODUCTION

Bionics is a subject both old and young. People study the principles of the structure and function of living organisms, and based on these principles, they invent new devices, tools, and technologies to create advanced technologies for production, learning, and living. With the rapid development in recent years, especially in recent years, with the in-depth research of basic science, the level of computer control is also constantly improving, and more and more mature robot technology is widely used in various fields such as military industry, medicine, manufacturing, agriculture, aquaculture, etc., to help people complete a lot of difficult and high-intensity work, which greatly shortens the working time. Developing robots requires mastering mechanics, computers, mathematics, physics, mechanics, control science, electronic information, and bionics. Research on the professional knowledge of various disciplines such as science and technology, and continuous in-depth research on robot technology can promote the progress of a country in science and technology. Therefore, research on robots is of great significance and value to the development of science and technology [1-4].

II. LITERATURE REVIEW INTRODUCTION

2.1 Research status of quadruped robot

In 2017, Yushu Technology Research and Development Company developed the "Laikago" robot, which achieved a comprehensive upgrade in terms of overall size, gait planning, control algorithm, power drive, etc., so that it has strong operational stability, and can quickly rise after dumping according to the control algorithm of turning over. Optimization of control algorithm is a further exploration in the field of motion control of quadruped robots [4, 5].

In 2018, Zhejiang University developed a small sensitive quadruped robot "Juying" with strong environmental adaptability and flexibility [6-7].In 2019, the team modified and upgraded the first-generation quadruped robot and released the second-generation "Juying",the body is equipped with a variety of sensors, cameras, radar and other equipment, which can realize the adaptability of the environment and complete difficult and complex actions. In addition, it can also realize the construction and localization of map environment through environment sensing [8-9].

2.2 Research status of chameleon color change

Chameleon bionics research has been conducted essentially by analyzing the mechanism of chameleon skin color change. For example, a research team from Emory University in the United States developed a smart hydrogel skin that ADAPTS to strain and can trigger color changes through optics.In August 2021, a team from Seoul National University in South Korea and others disclosed the results of the "Bionic Chameleon Software Robot," which uses temperature to regulate the color of a bionic chameleon.In 2022, The research team has been working on the development of a bionic chameleon skin by analyzing the mechanism of color change in the chameleon's skin.

2.3 Research status of chameleon tongue

The chameleon's tongue has a powerful grip, and when hunting, the rapid retraction of the tongue will make the prey unable to react. In addition to the study of the chameleon's color-changing function, the chameleon's flexible tongue is also a research direction. Festo, for example, produces a robotic arm with an adaptive gripper. Its functional principle is based on the chameleon's tongue, which is used to grip workpieces. The Beijing Institute of Technology (BIT) drives a soft chameleon tongue through an explosion. Specifically, a controlled fuel explosion generates a driving force that causes the soft chameleon tongue to extend and contract in an axial direction. The above two points either bionic chameleon tongue grip or bionic chameleon tongue speed, bionic chameleon has not been well applied.

III. BIONIC CHAMELEON ROBOT OVERALL DESIGN

3.1 .Bionic chameleon leg design scheme

When the chameleon crawls on land, it claws on the ground, front and back feet flat, and out. Therefore, the overall structure and walking gait should be considered comprehensively in the design.

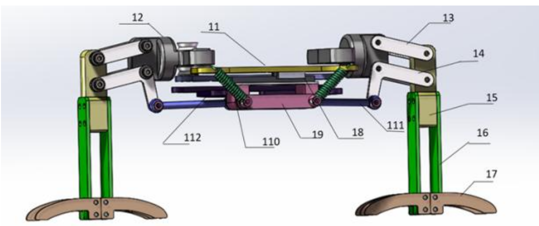

Fig.1. Mechanical structure of the legs

As shown in Figure 1, the mechanical structure of the leg mainly includes active links, leg joints, claws, central connecting plates, etc.

When walking, the rudder arm swings left to right to control the active link to achieve left and right movement, thus driving the first joint of the leg to move back and forth; while the first joint of the leg drives the upper parallel link, the lower L-shaped link, the second joint of the leg, the third joint of the leg, and the claws to move back and forth. At this time, the active connecting rod drives the pull spring, the slide, and the central connecting plate; the limit plate limits when the central connecting plate moves; the central connecting plate makes the L-shaped connecting rod, the second joint of the leg, the third joint of the leg, and the claws move up and down.

It takes only two motors to control the four legs. In terms of shock absorption and obstacle crossing, a shock absorber spring can be installed in the middle of the second joint and the third joint of the leg to improve the stability of walking in different road conditions.

3.2. Bionic chameleon tongue design scheme

Considering the characteristics of the chameleon's tongue: it can extend very long and very fast, the general telescopic mechanism travel and speed will be limited, so it was decided to use the friction wheel drive to realize the function of head tongue ejection. Friction wheel drive is two rollers pressed against each other to transfer motion and power through the friction between the contact surfaces. Due to its simple structure, easy manufacture, smooth operation, low noise, overloading can slip, and can be continuously and smoothly adjust its transmission ratio, so the scope of application is large

The tongue ejection grasping mechanism consists of two friction wheels, two side plates, a cylinder and an ejection tube. When the tongue ejection grasping mechanism works, the motor controls the friction wheel, which rotates at high speed and pushes out the ejector rod, and sucks the objects in front of it through the ejector rod, and the motor drives the friction wheel in the reverse direction to pull the ejector rod back to the barrel, so that the grasping and retracting of the distant objects can be realized while achieving the ejection speed of the tongue, as is shown in Figure 2.

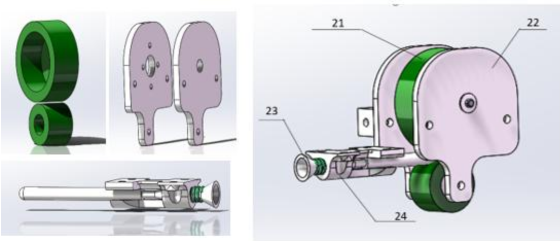

Fig.2 Head tongue ejection and grasping mechanism

3.3. Electronic control design scheme

The bionic chameleon robot control system uses Arduino development board, steering machine, brushless motor, 5v deceleration motor, Open MV visual recognition module, light belt, HC05 Bluetooth module to realize the bionic chameleon walking, tongue launch and recovery, tail swing, visual recognition, change their own color according to the environmental color and other functions.

The bionic chameleon robot realizes the walking function through the control of the two sg 90 steering on the Arduino development board, realizes the tongue firing and recovery function of the S nail 2305 brushless motor, realizes the tail swing through the control of the 5v deceleration motor; and uses the Open MV for visual identification, which can extract the color threshold in the field of vision, so as to control the color change of the RGB light and then realize the discoloration function. The Bionic chameleon can also be connected to the mobile phone app through the Bluetooth module to realize the control and information transmission of the bionic chameleon.

3.4. Institutional design and calculation

By observing the gait of the chameleon crawling, we can find that the chameleon's gait is diagonal. If the start is the right front leg moves forward, the left hind leg of the diagonal will follow forward, then the left front leg will move forward, and then the right hind leg will follow forward, so as to complete a cycle.

So in the design, let the bionic Chameleleon robot lift the wrong legs at the same time, then step, and then put the legs down. For example: the first right, left hind legs, chameleon robot legs in state 1, after a leg process, two legs in the position of the state 2, when left, right hind legs, right, left hind legs driven by the motor back state 1, because right, left front legs, left, right legs off the ground, the body will move forward, achieve the purpose of "walking". Because the limbs of the chameleon robot are closely connected, the instability of the robot when walking is avoided to a large extent. Similarly, when backward, the state of the leg starts from state 2 to state 1, and then cycles in turn. The movement cycle diagram of each leg during the bionic Chameleon robot walking is shown in Figure 3.

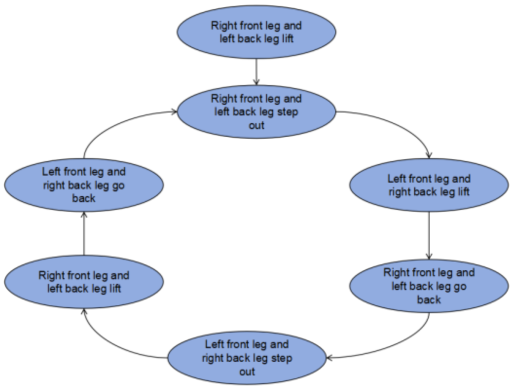

Fig.3. Movement cycle diagram of each leg of the bionic chameleon robot

Therefore, the bionic chameleon leg uses a single rudder machine to control the diagonal two legs, the parallelogram mechanism increases the opening and closing stability, and the steering gear is installed on the front and rear connecting plate of the load-bearing structure. The details of the leg structure are shown in Figure Figure 4.

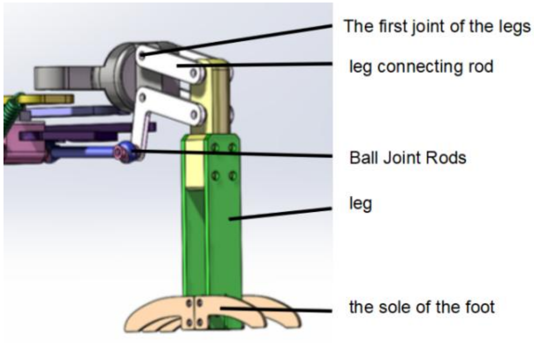

Fig.4. Leg structure details

Through the following calculation, the minimum power required for the steering gear is 15kg, which is used as the basis for the selection of the steering gear. Two sg90 steering gear are selected for this product.

$$M_0(F)=r\times(F_1+F_2+\ldots\ldots+F_n)=r\times F_1+r\times F_2+\ldots+r\times F_n=M_{01}+M_{02}\ldots+M_{0n}$$

IV. CONCLUSION

This paper mainly takes the bionic chameleon robot as the research object, completes the structural design and three-dimensional modeling of the robot's mechanical system according to the practical application requirements, completes the corresponding kinematics solution and foot gait planning based on the simplified kinematic model, and implements simulation analysis and prototype production, and mainly uses the model-based gait planning strategy research. The trajectory algorithm and control strategy are improved.

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