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Review of Bionic Hexapod Robot

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Abstract: The unique flexibility and terrain adaptability of multi legged bionic robot make it have unique application value in the rugged environment where human and other walking robots can not work normally. Nowadays, with people's more and more in-depth exploration of the world, the research on hexapod robot is also improving. This paper deeply analyzes the hexapod bionic robot from the aspects of bionic principle, characteristic analysis, research status and operation principle, and puts forward the prospect of its future development.

1. Introduction

Since the 21st century, the basic theory and technology of robot have developed by leaps and bounds. Robots are gradually used in industry, agriculture, transportation, aviation and other fields. At present, the motion modes of robots developed and manufactured by people mainly include wheel type, crawler type, foot type, peristaltic type, vibration impact type, swimming type and flying type[1].

Compared with traditional wheeled and tracked walking machines, multi legged robots have strong movement ability and have advantages that many other robots do not have. Among the multi legged robots, the hexapod robot is relatively excellent. Because of its discrete hexapod, it can better support the ground and maintain the stability of the whole machine. Hexapod robot can bionic a variety of hexapod creatures in nature, and the degree of freedom of mechanism design is very large. The integration of ingenious joint bionic design forms a single foot, and the coordinated operation between feet forms a rich gait. Therefore, when dealing with complex and unpredictable terrain environment, such as obstacles, ditches and sand, the hexapod robot can well realize the functions of obstacle avoidance, obstacle crossing and passing through uneven sections. At the same time, it can also maintain good stability and have strong terrain adaptability.

Therefore, in the case of complex terrain, the hexapod robot can give full play to its unique advantages. In a variety of special occasions such as complex terrain, high temperature, vacuum and oxygen free, it can replace human beings to complete corresponding tasks, such as ecological restoration, interstellar exploration, emergency rescue, seabed operation and so on.

2. Research status

At present, the hexapod robot has a relatively mature development in China. For example, the analysis and design of the Hexapod Robot Based on parallel mechanical legs studied by Yanshan University applies the parallel mechanism to the leg mechanism of the hexapod robot (Fig. 1), which

can well change the shortcomings of the traditional hexapod robot and make the hexapod robot in terms of bearing capacity, flexibility, accuracy and stiffness are well improved, and the compact structure can be ensured, so as to enhance the adaptability of the hexapod robot to the environment and work [2]. The development of the gait planning and control system of the hexapod bionic robot by Wang Qian of Harbin Institute of Technology is based on the research and induction of the gait law of stick insects (Fig. 2). Combined with Walknet, the research results of foreign hexapod robots, this research not only observes and studies hexapods existing in nature to optimize hexapod robots, but also conducts in-depth research and optimization on the existing research results of predecessors, and then propoes a new gait mechanism for a hexapod robot [3]; The development of hexapod bionic robot and its motion planning research by Chen Fu of Harbin Institute of Technology(Fig. 3), studys the behavior of multi-legged robots in nature and the reflex action of legs when passing through different terrains are studied. The walking of multi-legged insects is simplified to the structure of elliptical limb distribution with three-degree-of-freedom legs, and the reflection mode for different environments is proposed, and a new direction for the development of the hexapod robot is proposed through the research.

In general, with the deepening of people's research on multi legged animals in nature, people have continuously improved the current mechanical structure, and constantly put forward new and better ideas in new directions. Therefore, multi legged robots still have a bright prospect in the future.

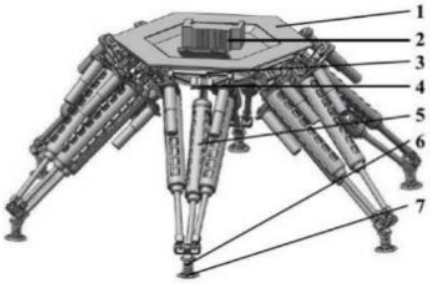

Figure 1: Parallel manipulator leg robot

Figure 2: Gait mechanism of Hexapod Robot

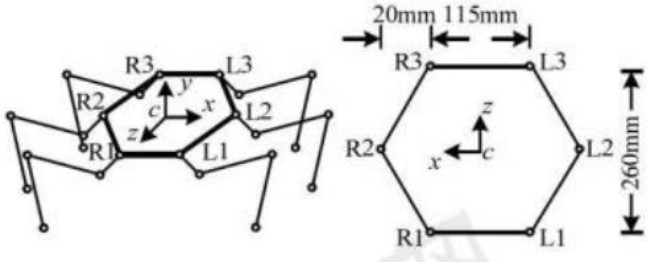

Figure 3: Three degree of freedom leg structure

3. Main technical analysis

3.1 Design of bionic mechanical structure

In the process of mechanical structure design of hexapod robot, excluding the scheme of parallel mechanism design between feet, the mechanism design of hexapod robot mainly needs to consider the design of single foot structure and body mechanism. The single foot structure design can be divided into 3-DOF single foot, less DOF single foot and multi DOF single foot. The common body mechanism design includes rectangular arrangement, elliptical arrangement and circumferential

arrangement [4]. The problems to be considered in the design of robot mechanism include the movement of each joint of bionic organism, the analysis of simultaneous movement of multiple joints, whether the movement of bionic mechanism is flexible, and whether the stiffness and strength of mechanical structure meet the requirements of motion stability.

3.2 Gait planning

Gait planning is the core content of the research theory of foot robot. In order to make the hexapod robot have better motion form and posture, it is essential for the gait planning of the hexapod robot. At present, through experiments, it is found that organisms present periodic rhythmic gait on flat terrain and free gait on rough terrain [5].

(1) Classical periodic gait

Three-legged gait is to divide the six legged robot into two groups for gait planning to realize walking. The six legs is divided into two groups, such as alternating back and forth with people's left and right legs, so as to realize walking. The three legged gait is the fastest of the classical gait schemes.

Four-legged gait refers to that four of the six legs of the hexapod robot are supported on the ground, and the other two legs swing horizontally to drive the whole machine to move. The hexapod is divided into three groups, and the three groups of feet are executed alternately in order to realize the movement form of quadruped gait. Compared with the three legged gait, the four-legged gait divides the six legged into three groups alternately, which increases the process of robot walking. Therefore, in the same case, the movement speed of the six legged robot using the four legged gait is slower than the three legged gait, but the stability of the four legged gait is better than the three legged gait.

Five-legged gait means that five of the six legs of a six legged robot are supported on the ground, and one of the legs swings horizontally to drive the whole machine to move. The movement form of pentapod gait can be realized by alternately executing the six feet in order. Similarly, the pentapod gait is the slowest and most stable of the classical gait schemes.

(2) Free gait

When the free gait is adopted in the movement process of the hexapod robot, it can timely adjust the motion parameters such as the floor area coefficient of the foot end, play an important role in the speed regulation, turning, obstacle avoidance and obstacle crossing of the robot, and give better play to the motion potential of the hexapod robot. Based on the imitation of the hexapod gait from different angles, the bionic gait is set according to the interaction between the foot and the environment, and each foot of the hexapod robot is regarded as a neuron to control the robot walking by periodically triggering the movement of each foot, including free gait planning based on local planning and free gait planning based on GPC principle [4].

3.3 Control system and scheme

The control of the hexapod robot can be mainly considered from three aspects: the overall structure program design of the robot, the gait control design during the operation of the robot and the coordinated control design during the operation of the robot [6]. When designing the overall structure program of the mechanism of the hexapod robot, it is first necessary to consider the internal layout of the robot, namely the structure and length of each limb, the motion form of the joint and the corresponding driving mode. The motion parameters of each limb are transmitted, and then the motion parameters of each limb are collected for integration and data processing. Through the data collection and processing, the program is edited and designed, and then the program is output to control the robot, so as to ensure the feasibility of the whole robot movement.

In gait control, it is often necessary to number the hexapod and control the robot motion according to the predetermined gait program. Sequential processing, local processing and neural gait planning

are commonly used. At the same time, collect the physical parameters of the robot in the movement process in time, such as foot grounding coefficient and force condition, monitor and detect the foot equipment, and feed back to the terminal controller through data transmission, then the controller analyzes the feedback data. If the robot motion abnormality is detected, the controller will call the program for real-time control and adjustment to realize real-time data processing, and ensure the rapidity of robot adjustment and the stability of motion.

4. Prospect and development

With the rapid development of global science and technology, robot technology will be closely combined with emerging scientific information technologies such as artificial intelligence, 5G technology and big data. The bionic structure of the hexapod robot will be continuously optimized, and will become more realistic. The flexibility and stability of the mechanism will be continuously improved. In addition, the hexapod robot has the ability to work together. The robot can perform its duties together or work together with human beings, which will greatly reduce the labor force of human beings. It can be predicted that the hexapod robot will be continuously optimized and upgraded in the direction of high speed, flexibility, stability and intelligence. It can be used in special occasions such as complex and rugged terrain, and has broad development prospects [7].

5. Conclusion

With the continuous development of human exploration and the continuous progress of science and technology, the related research of hexapod bionic robot will continue to improve and make new breakthroughs. This paper summarizes the development status of hexapod bionic robot, analyzes the technical points and difficulties, and points out the feasible direction of its future development. It is believed that through the continuous efforts of researchers, hexapod bionic robot will play a greater role in more fields.

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