Development of Running Robot Based on Charge Coupled Device

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Abstract

Robot technology is undoubtedly the future of strategic high-tech, full of opportunities and challenges. The humanoid robot has a high degree of intelligence, and it can recognize the movement and direction of the robot independently. Compared with other robots, humanoid robot has the characteristics of small supporting area and high relative position of center of gravity. Humanoid robot has higher flexibility and higher intelligence than other kinds of robots, so it has its own unique advantages and is more suitable to work with human beings in human life or working environment. These environments do not need to be modified on a large scale. This paper mainly introduces the development process of humanoid racing robot in detail, including three parts The establishment and improvement of dimensional graphics, the assembly and programming of robots, and the final debugging of robots.

Keywords

Humanoid racing robot,Charge Coupled Device, center of gravity.

1. Introduction

1.1 Research Background and Significance

Robot technology is undoubtedly the future of strategic high technology, full of opportunities and challenges. The humanoid robot is highly intelligent and capable of autonomous walking and direction recognition. Compared with other robots, the humanoid robot has the characteristics of small support area and high relative position of the center of gravity. Humanoid robots have higher flexibility and higher intelligence than other types of robots, and therefore have their own unique advantages. They are more suitable for working in harmony with humans in human life or work environments, and do not need to be dedicated to them. These environments are undergoing major transformations. For example, to replace workers in dangerous working environments (such as nuclear power plants), transport goods on uneven ground, etc. In addition, the changes in the social environment in the future will make imitative human robots have great potential in the care of the elderly, rehabilitation medicine, and general household chores. At present, there are roughly 8 billion to 10 billion robots in the international market, of which industrial robots account for the largest proportion. In 2025, the entire robot market will reach 50 billion, service robots will increase from more than 3 million units to more than 12 million units, and the demand for special robots (such as explosive robots, medical robots, etc.) will increase[1].

Humanoid robots are an important area for robotics. Humanoid racing robots require the production of humanoid robots that imitate the walking of human feet upright and require coordinated coordination of the head and arms. It can assist with various types of sensors in order to enable the robot to recognize the surrounding environment from the king and complete the racing quickly and flexibly.

To successfully complete the above requirements, the robot needs to have high biped walking maneuverability and sensitive and reliable sensing control performance. Due to the pursuit of excellent maneuverability and sensing control performance, the number of steering gears is increased, the structure is complicated, and the cost is increased. The degree of freedom of robots that can currently fulfill the above requirements is generally high or depends on the high-speed steering gear, resulting in an increase in the cost of the robot. The design and production method of the existing robot for flexible steering with a small number of degrees of freedom needs to be improved. Therefore, starting from optimizing the layout of robot servos and sensors, ingeniously designing the structure of the robot, it is of great significance to explore humanoid racing robots with less freedom, simple structure but strong mobility, sensitive and reliable sensing, and high cost performance[2].

1.2 Status of Research

1.2.1 Situation Abroad

In foreign countries, robots used in the manufacturing industry have made significant progress. They have become a standard device and have been widely used in the industrial sector, and thus have formed a group of well-known and well-known robot companies that are internationally influential. Such as Germany's KUKA, Sweden's ABB and so on. According to the United Nations Economic Commission for Europe (UNECE) and the International Federation of Robotics (IFR) statistics, from 2002 to 2004, the annual growth rate of the world robot market averaged about 10%, reaching a record 30% in 2005, the global robot in 2007 The actual installed capacity reached 6.5 million units, and the installed capacity of robots increased by 3% compared to 2006 to 114,365 units [3].

1.2.2 Domestic Situation

Domestic situation: Research on domestic bionic robots started late, and there are many backward countries and the gap is relatively large. Currently, research institutes such as Beijing University of Aeronautics and Astronautics, Shanghai Jiao Tong University, Beijing University of Science and Technology, National University of Defense Technology, Southeast University, and Shenyang Institute of Automation are engaged in the research of bionic robots. The first smart hand of humanoid multi-finger with multiple sensing functions in China was successfully developed by the Robot Research Institute of Harbin Institute of Technology in 2001. It can carry out dangerous operations such as mine detection in the battlefield, mine clearance, and overhaul of nuclear industrial equipment. Beijing University of Aeronautics and Astronautics has developed a multi-finger dexterous hand that can achieve simple grasping and operation. The first serpentine robot developed by the National University of Defense Technology can twist its body and crawl on the ground. Prof. Qing Xin Men from Harbin Engineering University proposed the arch mud biomimetic robot based on the creep theory and studied it in detail. Beijing University of Aeronautics and Astronautics has made gratifying achievements in robotic fish research. Shanghai Jiao tong University has developed underwater worm robots by mimicking water frogs.

China's robotic product manufacturers are relatively few. At present, Shenyang Xin song Robot Co., Ltd., Harbin Bodhi Automation Equipment Co., Ltd. and the Beijing Machinery Industry Automation Research Institute Engineering Center are the three major production bases. The annual output value of each enterprise is compared with that of foreign companies. There is still a large gap, which also includes some peripheral products of robots. There is no scale production, and economies of scale are not prominent. Due to the robot's development, design, and testing process, it is often necessary to analyze its kinematics and dynamic performance, and to perform trajectory planning. The robot is also a multi-degree-of-freedom, multi-link space mechanism with kinematics and dynamics issues. It is very complicated and it is very difficult to calculate and calculate.Organization of the Text

1.3 Content of Research

This article mainly develops a new type of humanoid racing robot, which can realize the robot can finish the race at a faster speed. Therefore, in this topic, we have reduced the center of gravity of the robot to make it more stable during the walking process. The track information is collected and processed by the sensor installed on the robot to determine the relative position of the robot on the current track, so that the robot can autonomously walk along the black line on the track, allowing the robot to autonomously determine the walking situation and provide the fastest speed. Finish the game:

1. Make full use of professional knowledge, complete the design and production of the robot model, and basically realize the running tracking function of the humanoid racing robot to achieve the design goal.

2. The structure and assembly of the humanoid racing robot.

3. Learn the operation method of the upper computer of the humanoid racing robot servo, the using method of the humanoid racing robot controller and the procedure of controlling the sequence of the robot action group. Including the use of its supporting software and the final use of Charge Coupled Device to make the robot complete the tracking program. Using a Charge Coupled Device linear sensor as a method for path identification and proximity recognition, the servo-driven use of the servo can realize that the humanoid racing robot can run according to a specified path, and the indication of sound and light can be increased as needed. Achieve automatic obstacle avoidance tracking.

4. Complete the design and manufacture of the control circuit and invest in the application of the experiment.

5. Use STM32 single chip to complete the overall model of the motion control, including the humanoid racing robot's left turn, right turn, linear walk and tracking, and finally installed on the Charge Coupled Device sensor to make it more accurate and rapid judgment.

2. Research Technical Programme

2.1 Hardware Part

2.2.1 Robot joints and Overall Architecture

(1) steering engine :

The joint of the robot is driven by the AX-12A steering engine. This servo has greater torque and accuracy than the ordinary steering gear, which makes the robot movement more agile and can perform some more complicated actions. The robot has one degree of freedom in the head, two degrees of freedom in the arm, and three degrees of freedom in the leg. The robot uses a total of six AX-12A steering gears and four 9-gram small steering gears. The steering gear diagram is shown in Figure 1.

Fig 1. Steering gear of robot

(2) Overall structure:

The robot's overall support is made up of hard aluminum alloy with 1mm thickness, which makes the support lighter and stronger, reduces the weight and reduces the pressure between the steering gear of the legs. Good for the durability of the whole system. Its overall structure is shown in figure 2.

Fig 2. Overall Structure Diagram of Robot

(3) Steering gear controller

The steering gear controller adopts the auxiliary controller of the steering gear, which can drive the steering gear normally and output 32 PWM square waves on time to meet the requirements of the robot. The controller is shown in figure 3.

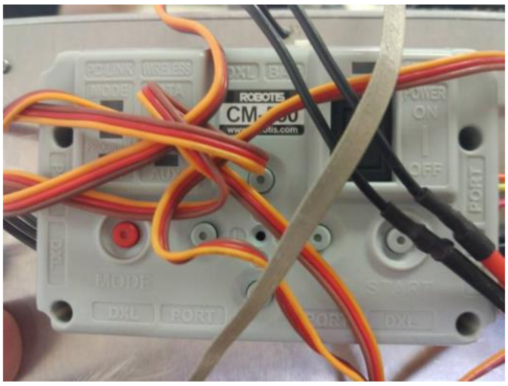

Fig 3. Steering gear controller

2.1.2 Single Chip Microcomputer and Steering Board Module

(1) Single chip computer

After many times of practice, it is found that the stm32 single chip microcomputer has high processing speed, but its weight is large, which is not good for the robot to walk. Therefore, we use the minimum system single chip microcomputer in practice. The actual structure is shown in figure 4.

Fig 4. Minimum system board of single chip microcomputer

(2) Steering gear control panel

The steering gear controller uses the 32 channel steering gear board which is commonly used in the market to drive 32 channels steering gear normally and outputs 32 PWM square waves on time to meet the requirements of the robot. The actual control board is shown in figure 5.

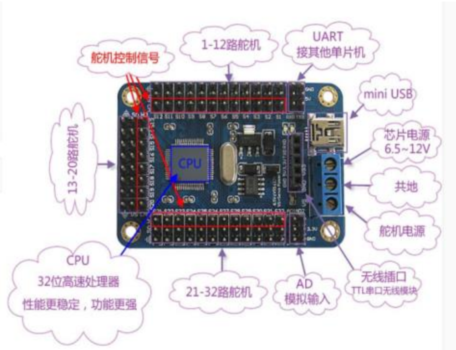

Fig 5. Control plate of 32 - way steering gear

2.1.3 Sensor Modules

In order to identify the black line and white line accurately, the linear Charge Coupled Device is used as the sensor module of the robot. The parameters of the Charge Coupled Device are judged and modified by the upper computer software, and then the setting of the action is matched by the single chip microcomputer. The actual module is shown in figure 6.

Fig 6. Linear Charge Coupled Device gray sensor

2.1.4 Robot Power Supply Module

In order to make the robot more stable and accurate to judge the position, a stable power supply is needed. The robot uses a 12.4V power supply, as shown in figure 7.

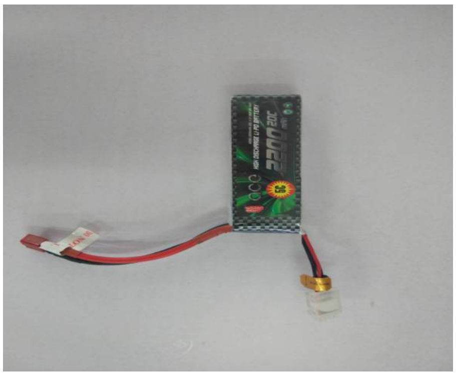

Figure 7. Power supply

3. The Train of Thought of Debugging

3.1 Robot Action Design

The goal of this robot is to realize race speed on the basis of line patrol, so the robot needs three basic actions that is, go straight, turn left and turn right. The difficulty of this design is to grasp the center of gravity of the robot. When the speed is too fast or the action amplitude is too large, the inertia of the robot will be too large, so the robot will lose balance and make the robot fall down. According to many experiments, the gait scheme used by the robot needs to be adjusted according to the site.

3.2 data acquisition and processing of sensors

Data acquisition and processing of the sensor: this system uses linear CCD (Charge Coupled Device), which has a row of pixels, and can collect the gray value of a line in front of the front. In our system, the range of the gray value is 0~255. The data collected from the single chip computer is sent to the PC observation data through the serial port and can be found. The gray value of the white area on the runway is several dozen higher than that of the black area, so the coordinate value of white to black can be calculated by the method of successive difference.

Fig 8. Linear CCD sensor

3.3Combination of Sensors and Actions

After the successful debugging of the motion and the sensor, the two will be combined together. The road information will be collected by the single-chip microcomputer control sensor, and the actions to be performed after processing will be sent to the steering gear controller through the serial port. The steering gear controller performs the required actions, takes the road information again after the appropriate delay waiting for the action to be executed, continues to process, and then sends the necessary action to the steering gear controller again, so that the track can be completed in a circular way. Decide to go straight, turn left or right depending on the location of the black line. In this process, the main debugging is the delay time between the actions, too long time will cause the robot to be slow to react, and after one action is done, the meeting will be in between. It took a while to make another move. Too short a time will cause the robot to react wrong, and the next action will be sent when the last action has not been completed. At this time, the robot is likely to lose balance and fall to the ground, so the delay time has to be repeatedly debugged many times. And this process can also optimize the previous action, so that the robot walks faster and more smoothly.

3.4 Program Design

In order to achieve the optimal control effect, the STM32 single chip microcomputer is used as the control board, Kiel 5 is the main programming software, and the effective control strategy is adopted to avoid or reduce the disturbance and realize the stable operation of the whole system.

This chapter mainly discusses the construction of the control system based on STM32 single chip microcomputer from the hardware. By extending IO port to connect various sensors, the hardware structure of the control system is successfully completed. In the software aspect, Kiel 5 programming software is adopted directly. Through J-Link download, the program can be quickly burned in, and the system program can be written and debugged smoothly.

4. Summary and Prospect

After 10 months, after continuous debugging and groping, the robot can finally complete the autonomous line patrol, and can complete the left and right turn, arm swing and other action requirements. In this process, my hands-on ability has been greatly improved, the innovation of the robot mainly lies in the robot's walking posture design idea, sensor module and power supply mode, after many times of practice before the robot competition. After many debugging, from the failure to find the reason, to get the current program, all of the above plans are the results of our team's independent practice.

1. The hardware joint of the robot is driven by AX-12A servo steering gear. The torque of the servo actuator is larger and more accurate than that of the simulated steering gear, which makes the robot more agile and can complete some more complex actions. The robot has one degree of freedom in its head, two degrees of freedom in arms and three degrees of freedom in its legs. The robot uses 6 AX-12A steering gear.

2. The whole support of the robot is composed of hard aluminum alloy with 1mm thickness, which makes the support lighter and stronger, reduces the weight and makes the pressure between the leg steering gear smaller, which is beneficial to the durability of the whole system.

3, the robot's leg steering gear uses AX-12 servo steering gear. According to different load requirements, the gear of the steering gear can be distinguished by plastic and metal, and the steering gear of the metal gear is generally suitable for the situation of higher torque and higher frequency of swing. The steering gear has the advantage of not breaking teeth due to excessive load. A ball bearing is installed in the steering gear to make it more light and accurate when rotating. Thus, the robot moves more smoothly and harmoniously.

4. The material of the lower part of the robot is ferroalloy, while the upper part of the body is mainly composed of acrylic, so that the center of gravity of the robot is reduced, not only the torque of the legs is reduced, but also the stability and coordination of the walking of the robot are improved.

5, the number of the steering gear in the leg of the robot is less than that of the common robot in China. At the same time, the arm of the robot is mainly composed of small steering gear. This not only improves the performance of the robot, but also reduces the price of the robot, and the cost performance is obviously improved.

6. The core of control is STM32 single chip computer. Through wireless module, the code sweeper can interact with the database of the host computer. STM32 single chip microcomputer is a stable and controllable single chip microcomputer, and the whole single chip microcomputer is highly integrated.

Compared with the general use of 51 single-chip microcomputer has a great improvement. Linear CCD sensor is used to detect the black and white line of road surface, so the judgment is more accurate.

Acknowledgements

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