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Human-like autonomous fighting robot design

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Abstract

Design a human-like arena competition. Two robots are on a square arena. Through different sensors and controllers, combined with self-designed programs as brains, they can identify and strike their opponents, so as to knock down their opponents or knock them out of the ring. the goal of. The robot waits in the waiting area to start, and starts the robot in a non-contact way under the ring to quickly and accurately take the stage. The robot judges the position through the infrared sensor, can detect the edge of the ring and make timely adjustments according to the situation to prevent it from falling off the ring. With the addition of visual processing content, the robot must be able to distinguish between energy blocks and bombs in the arena in addition to normal ring fights. The robot can identify and judge blocks independently, and can distinguish energy blocks and bombs according to the QR code information and make corresponding push, carry or avoid behaviors.

Keywords

Artificial intelligence,Intelligent control,Robot Vision,Machine learning.

1. Introduction

The humanoid autonomous fighting robot I designed consists of a perception module, a control module, an execution module and an energy module. The sensing module realizes the information collection function, and can detect the surrounding information on the stage by using 8 infrared proximity sensors, 1 infrared ranging sensor and camera, and obtain the current state of the robot and the surrounding environment information. The control module realizes the function of reasonable motion settings for the robot, and adopts periodic control to realize cyclic operation. The combination with the perception module is the logic algorithm basis for the robot to complete various functions. For example, the robot judges the running direction and speed and whether it needs to enter the arena according to the detection information, makes edge judgment through the detection of the sensor, and executes the behavior of avoiding the edge. The execution module realizes the movement of each joint of the robot to achieve fixed attack, handling, climbing, defense, standing preparation and other actions. By using two open-loop motors, the motion mechanism can complete the set direction, according to the motion command issued by the control module. speed etc. The energy module provides power for the operation of the robot, including an open-loop battery for 2 open-loop motors and a power supply for the controller and steering gear.

2. Basic hardware introduction

2.1. Robot Brain - Controller

The MultiFLEX2-AVR controller is a general purpose controller for small robots. The controller adopts AVR series ATmega128 micro-controller as the main processor. ATmega128 can run at a frequency of 16MHz, which is sufficient data processing capability for lightweight automatic control systems. The MultiFLEX2-AVR controller can process IO, AD and bus data, control R/C

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servos, digital servos, and is the best choice for building small robots. The functions of the MultiFLEX2-AVR controller are highly integrated, with 12 channels of IO and 8 channels of AD interfaces with 10-bit precision, which can control R/C servos and robot servos. It has RS-232 interface and RS-422 bus interface, which is enough Competent with conventional robot control. The MultiFLEX2-AVR controller is easy to develop. Using the matching graphical integrated development environment NorthStar, you only need to write the program logic flow chart, and the program can automatically generate C code. After compiling and downloading to the controller, various functions of the controller can be realized. a control function.

2.2. Robotic Energy - Power Supply

The power supply of the controller is powered by the servo interface of the sampling bus, and a set of 7.4V lithium-ion batteries are built-in, which are powered by batteries. The MultiFLEX2-AVR uses a 7.4V lithium-ion battery with a built-in charge-discharge protection board with a discharge capacity of 8A. MultiFLEX2-AVR DC regulated power supply, the output of the power supply is 12V/5A, and the peak current can reach 8A.

2.3. Robot drive - open loop motor

The open-loop motor has high power and high output torque, and its structure is a hollow cup DC motor, which runs smoothly and has high efficiency. The matching reducer also has good mechanical properties and is very suitable as a wheel drive.

2.4. Robot Actions - Steering gear

The CDS5516 robot steering gear is an integrated servo unit that integrates motor, servo drive, and bus-type communication interface. It adopts advanced servo control technology and high-speed microprocessor, and has fast response speed, accurate in-position and no jitter,see Figure 1.

Figure 1: Schematic diagram of steering gear connection

The CDS5516 can be set to motor mode or position control mode by sending and receiving commands through the asynchronous serial interface. In motor mode, the CDS5516 can be used as a DC geared motor with adjustable speed. In the position control mode, the CDS5516 has a rotation range of 0-300°, within this range, it has precise position control performance and the speed can be adjusted. The debugging of the steering gear is mainly to adjust the median position of the steering gear and simple adjustment of the steering gear position through Robot Servo,see Figure2.Terminal, so as to test and adjust the use of the steering gear in the subsequent control algorithm.

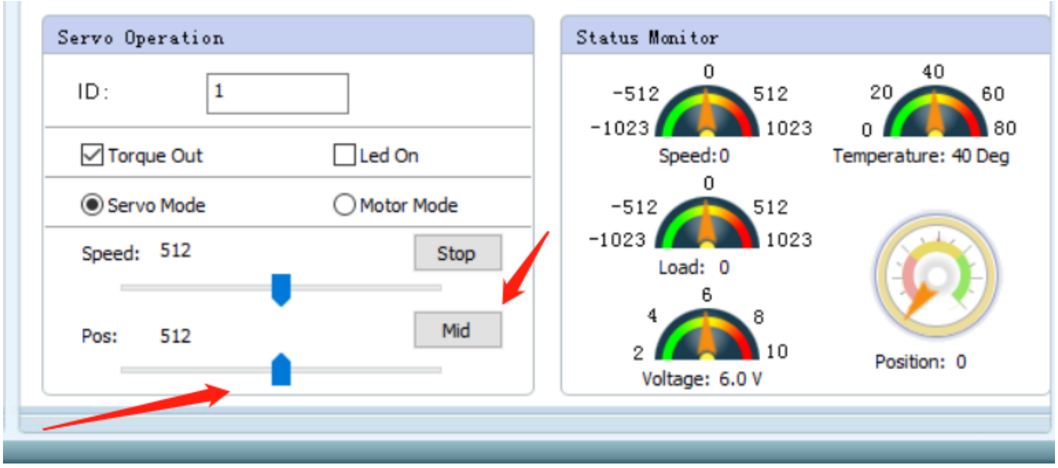

Figure 2: Steering gear angle control and debugging

2.5. Robot Sensing - Sensors

Infrared proximity sensors are commonly known as photoelectric switches. It uses the shielding or reflection of the detected object to the light beam, and the circuit is gated by the synchronous loop, so as to detect the presence or absence of the object. Since the output is a switch value, it can only be judged that there is no obstacle within the measurement distance, and the actual distance of the obstacle cannot be given. But the sensor comes with a sensitivity adjustment knob that adjusts the distance at which the sensor triggers. Infrared proximity sensors are mainly used to avoid surrounding obstacles, or to detect the presence of various objects without contact, and it has many uses,see Figure 3.

Figure 3: Infrared proximity sensor

The infrared ranging sensor uses the principle that the intensity of the reflection of the infrared signal at different distances from the obstacle is different to detect the distance of the obstacle. The infrared ranging sensor ,see Figure 4, has a pair of infrared signal transmitting and receiving diodes. The transmitting tube emits infrared signals of a specific frequency, and the receiving tube receives the infrared signals of this frequency. When the infrared detection direction encounters obstacles, the infrared signals are reflected back and received. After receiving the tube, after processing, it is returned to the robot host through the digital sensor interface, and the robot can use the infrared return signal to identify changes in the surrounding environment. The infrared ranging sensor is an analog sensor. When the measurement distance is different, the returned voltage is also different, and the corresponding quantitative value is also different.

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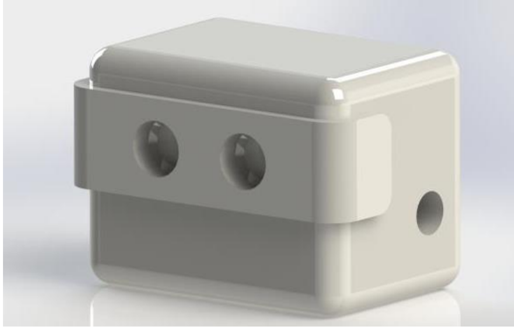

Figure 4: Infrared ranging sensor

2.6. Robot Recognition - Vision

The camera used is the basic hardware of unified configuration. It is connected to the controller using the USB interface, which can correctly identify the energy block and feedback information to make the robot implement corresponding actions. In this process, python and opencv are mainly used to realize some digital image processing and computer. The visual case is also used in conjunction with the need to use a computing stick to achieve target detection based on openvino.

3. Mechanical structure

3.1. Structural Design

The design uses a double-layer bottom plate to connect the upper and lower components to strengthen the body. In order to realize the movement of the robot, the chassis part adopts four rubber wheels. To drive its movement, two speed governors and corresponding four open-loop motor devices are installed in the chassis part. On the base to lower the center of gravity of the robot, the open-loop battery and four infrared sensors are also placed on the base plate, so that the robot components are evenly distributed and the center of gravity is as low as possible. In order to maintain the stability of the robot when attacking, the parts are placed horizontally at the leg position, the forearm part is lengthened to facilitate the support after being dumped and then stand again, and the steering gear is placed at the connection with the controller to increase weight and flexibility. The facing direction of the robot is perpendicular to the advancing direction of the chassis, which can maintain stability and avoid enemy attacks more easily. In order to ensure the flexibility of the robot's actions such as attacking and standing up after being dumped, the steering gear is placed laterally on the shoulder so that the shoulder can rotate 180°, which increases the range of motion of the robotic arm. The cooperation of the three steering gears on the robotic arm ensures the attack. The amplitude of the robot arm is similar to a hammer, and the contact area with the ground is also increased to make the standing up action more rapid and stable.

3.2. Assembly process

The chassis is the core motion component of the robot's motion. It is composed of a bottom plate, a motor, and a wheel for installation, while maintaining the straightness of the bracket. First fix the motor, bushing and wheels, then put the motor into the L bracket, fix it with three end screws, then put the hexagonal bushing, fix it with screws, and finally install the wheels. Then install the grayscale sensor to the underside of the chassis and fix it with straps, install four rectangular parts on the bottom, front, rear, left, right, and four directions, and fix the four infrared sensors inside the rectangular part, which not only stabilizes the sensor but also protects the sensor from damage. The camera used in the vision part needs to be recognized from a higher angle, so the camera is wrapped in a white casing and fixed on the robot's shoulder as the head.

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3.3. Improvement process

Before the improvement, there were only two grayscale sensors on the chassis to detect the edge of the ring. The grayscale sensor was affected by factors such as light source and ring boundary blur. After the improvement, four infrared sensors were installed in four different directions on the high-rise chassis. , the edge of the ring is detected twice to reduce the grayscale sensor's misjudgment of the edge of the ring due to different ambient light. At the same time, an infrared ranging sensor is added to the front chassis of the robot to perform a secondary search for the enemy's position to increase and improve the accuracy. At first, only eight infrared sensors were used, and then an infrared ranging sensor was added on the left side, which improved the accuracy of the original enemy search and could attack the enemy more accurately.

4. Conclusion

After starting, the robot is in an upright state. It senses the slope through the distance sensor in front of it, detects the enemy by rotating on the table, and after sensing the enemy through the four-way enemy search sensor, it enters the attack state, and uses the contraction of the mechanical arm and the momentum of the body to lean forward. The enemy pushed down. At the same time, the detection edge sensor has a higher priority than the design and improvement process of the hardware and software of this robot to ensure that it does not fall off the ring itself. If the robot leans forward or backward, it will use the rotation angle and weight of the steering gear to support itself. It can realize the functions of autonomous staging, automatic enemy search and attack, edge detection and overturning. The current disadvantage is that the weight of the machine is too heavy. I want to improve the weight to make it more stable when attacking and to get up quickly after a fall.

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