Appearance design of intelligent garbage robot through computer visual recognition technology

Jingjing Yang*
Wuchang University of Technology, Wuhan 430223, Hubei, China

*Corresponding author: JingjingYang@wut.edu.cn

Abstract. In this paper, STM32 single-chip microcomputer is used as the motion control center of intelligent garbage robot. The track of ground runway is tracked by visual recognition technology. The position of garbage is determined by ultrasonic technology and visual recognition technology. The robot is recharged continuously by solar energy technology. The intelligent garbage robot is developed and established. The robot has the functions of road information detection, tracking, looking for plastic bottles and picking up garbage. Experiments show that the intelligent garbage robot based on visual recognition technology can meet the functional requirements well.

Keywords: Special robot, intelligent, The garbage can be picked up automatically, Visual recognition.

1. Introduction
In recent years, with the acceleration of the aging trend of population, the labor cost of China's service industry is rising year by year, the demographic dividend is gradually lost, and the lack of labor force in the service industry has become a bottleneck problem faced by the industry. A society with fewer children will also result in more jobs being left undone. On the other hand, with the aggravation of urbanization, the urban area is increasing, and the corresponding urban sanitation workload is also increasing with the development of the city. This leads to the increasing market demand for service robots. Driven by the growth of demand, the improvement of consumption level and other factors, service robots will become a hot spot in the robot industry, and China's service robot industry will usher in huge opportunities and development space.

With the development of artificial intelligence, it is a feasible solution to develop intelligent robots with sensing, thinking and action functions with the help of science and technology. In recent years, the technology of robot is becoming more and more mature and the cost performance is improving, which makes the wide application of intelligent robot possible. In this paper, according to the social needs, an intelligent garbage robot based on visual recognition technology is developed, and the robot samples are tested.

2. Overall design of robot
In this paper, taking a specific area runway as an example, a robot is developed to automatically walk according to the identified runway route, automatically identify the garbage, automatically run to the
garbage location and automatically pick up, so as to complete the automatic cleaning of the garbage in the area.

The robot uses solar photovoltaic panels to charge automatically, so as to achieve the purpose of saving energy. The design of the robot is divided into two parts, mechanical part and control part.

The intelligent garbage robot works as follows: First, place the robot on the runway, turn on the power switch of the robot, and power up the system. The robot automatically takes pictures of its front through the image module, and the control system binaries the acquired images. After image binarization, the collected image is turned into a black and white image, and the final realization of the track line of the sports ground is white, and the rest of the background color is black. Then, the garbage robot walks along the white track line and constantly calculates the central coordinates of the white line area according to the values in the images. Control system of the image center coordinates center coordinates, comparing with the white area and if the two do not match the coordinates, the garbage robot and the runway line is there is a deviation, when the deviation exceeds a certain scope, system, signal deviation, and according to the deviation of four motor speed control, in order to adjust the garbage robot location.

In the process of walking, if the robot finds similar garbage images, the control system will obtain feature data according to the processed images and compare them with the garbage feature values stored in the system library. If the similarity of comparison is more than 80%, the system will identify it as garbage. The system then according to the location of the image and ultrasonic ranging, to determine the location and distance of plastic bottles and other garbage. The robot drives the wheels along by calculating the position between the garbage and the robot. Until it reaches a certain position, the robot automatically stops, at the same time, it controls the manipulator to pick up garbage, and puts the garbage into its own trash can. Then move on to the next goal. When the robot is working, the solar photovoltaic panel can charge it, reducing artificial charging, so as to achieve energy saving and emission reduction.

3. Mechanical design
The main function of the mechanical part is to ensure the robot to complete the walking and picking action. This part is mainly composed of wheel, frame, manipulator, dustbin and solar energy system. The overall structure of the robot is shown in Figure 1.

The wheel of the robot is mainly used for walking. There are four wheels in total. The model toy wheel with a diameter of 75 mm is selected; It is a high-quality high friction wheel, with rubber tire skin on the outside, sponge liner in the middle and plastic wheel hub. Because only the corresponding model needs to be made to test, the selected wheel can meet the requirements of the system.

![Overall outline drawing of robot](image-url)
The frame Mainly plays a supporting role. The whole frame is made of a 2 mm thick aluminum alloy bottom plate and 3 aluminum alloy plates 2 mm thick upper layer. Among them, the bottom plate mainly supports the components of the whole system, which can meet the mechanical performance requirements; 3 aluminum alloy plates are mainly used to support and install the control system and solar panels.

The machine hand Used for picking up rubbish. Considering the production cost of the system, in its development process, purchased LD-3015MG digital/digital steering gear, 30 cm steering gear extension wire, LDX-335MG digital steering gear, metal steering wheel, mechanical grip, 3D printing manipulator, etc., assembled into a manipulator.

The bin The box is used for placing garbage. The box is made of 3D printing and the material is PLA. According to the design requirements, the dustbin can store about 0.03 m2 of garbage.

Solar energy systems the solar energy system is capable of self-charging, providing power for the garbage robot. Through the solar energy system, the robot can be guaranteed to continuously receive solar energy during operation, and the solar energy will be converted into electric energy through photoelectric conversion, and the electric energy will be stored in the power group, so as to provide the power supply for the operation of the whole garbage robot. The solar panels are photovoltaic panels made by Shandong Shangpin Company, with 12 V volts and 135 mm×125 mm×2.5 mm in specification.

4. control system design
The robot control system is mainly used to control the robot's walking, garbage discrimination and picking, solar automatic charging, etc. The control system takes STM32 single chip microcomputer as the control core [3], which is composed of main control module, image module, recognition module, ultrasonic ranging module, WiFi module, etc.

The control board of the robot is the Cortex-M4 small system board of STM32 development board, which has powerful functions and can meet the needs of system operation. The power supply of the system is solar photovoltaic panel and 18650 lithium battery pack 12 V, so as to provide reliable power for each functional module. The overall control process of the system is shown in Figure 2.

![Flow chart of robot control system](image-url)
4.1. Walking control design of robot

The robot's walking control part adopts four wheels controlled by DC deceleration motor JGA25-370. The motor is mainly used to drive the intelligent robot to walk. The voltage of the motor is 12 V, and it is driven by the L9110 intelligent car 4-way drive plate module. The drive module itself has four L9110S chips, the module also uses 12 V voltage, the maximum working current of 0.8A, can drive four DC motors at the same time. The L9110S in the drive module is a two-channel push-pull power amplifier special integrated circuit device designed to control and drive the motor. The discrete circuit is integrated into a single chip IC, which reduces the cost of peripheral components and improves the reliability of the whole machine. The drive module can meet the needs of JGA25-370 DC reducer motor and system operation.

The garbage robot walks along the white runway line, and the image module collects the pictures taken by the garbage robot in operation, and then processes the pictures taken by the system. In the process, the system will image data to carry on the numerical value, setting the threshold value within the system as a benchmark of image binarization, based on threshold, image threshold value will be defined as more than 255, lower than the threshold value will be defined as 0, so as to realize numerical binary image, and make the image into a black and white images, finally realizes the runway line is white in the gym, The rest of the background is black; Based on the value of the picture, the central coordinates of the white line region are constantly calculated. System coordinates with the white area at the center of the image center coordinates. If the coordinates of the two, the garbage robot and the runway line is there is a deviation, when the deviation exceeds a certain scope, system, signal deviation, meanwhile according to the deviation of four motor speed control, in order to adjust the garbage robot location.

The specific point finding process for the center point of the runway patrol line is as follows (as shown in Figure 3):

1. Collection of camera pictures, as shown in Fig. 3 (a);
2. Since there are only two colors of the runway: red and black, the collected images are converted to black and white. The converted images are shown in Fig. 3 (b).
3. The black and white images are filtered by Gauss to prepare for the next step of edge detection, as shown in Fig. 3 (c);
4. Edge detection is performed on the filtered image, and the detection results are shown in Fig. 3 (d).
5. Line extraction is carried out on the image after edge detection. 1. The innovative algorithm is used to screen the lines, and the vertical lines on the left and right sides of the runway line are obtained and displayed on the original image.
6. Through the innovative algorithm, the central coordinates of the runway are obtained and displayed on the runway, as shown in Figure 3 (f);
7. The actual distance between the camera and the runway can be obtained by subtracting the midpoint coordinate of the algorithm and the midpoint coordinate of the picture and multiplying by a scale coefficient, and the runway can be patrolled by driving motor.
4.2. Discrimination control design of garbage

For garbage identification, the robot system adopts advanced visual image recognition and ultrasonic technology. The specific working process of garbage discrimination is as follows:

In the process of walking, the robot sends out ultrasonic waves. According to the signal returned by the ultrasonic waves, if garbage is found, the background of the runway will be changed to white by image processing, and the garbage image will be contorted. The system obtains the feature data according to the processed image and compares it with the garbage feature values stored in the system library. When the similarity of the comparison exceeds 80%, the system will identify it as garbage.

In order to ensure the accuracy of data collection, the camera is set on the right side of the garbage robot, and the midpoint of the robot arm chassis is the reference point for subsequent operations, which is executed by a single thread.

Image module uses OV2640 camera module for image acquisition. The module uses 0.635cm OV2640M high-definition CMOS sensor, with high sensitivity, high flexibility, support JPEG output and other characteristics, and can support exposure, white balance, color, saturation, contrast and many other parameter Settings, support JPEG/RGB565 format output. Support automatic exposure control, automatic gain control, automatic white balance, automatic light stripe elimination, automatic black level calibration and other automatic control functions, while supporting color saturation, hue, gamma,
sharpness and other Settings, can meet the needs of different occasions. The specific execution process of garbage discrimination is shown in Figure 4.

![Flow chart of control for discriminant garbage](image)

Figure 4. Flow chart of control for discriminant garbage

4.3. Control design of garbage collection system

The control part of the robot garbage picking system is mainly used to control the manipulator to correctly pick up garbage from the runway to the fixed garbage box. This part realizes various actions of the robot hand by controlling the steering gear of the manipulator [4].

The garbage picking system of the robot is controlled by three LDX-335MG digital steering gear and three LDX-315MG digital steering gear control manipulators. This steering gear has the characteristics of large torque, small virtual position, fast speed, burning resistance, high temperature resistance and so on. The steering gear adopts PWM pulse width type to adjust the Angle, the period is 20 ms, and the duty ratio (0.5 ~ 2.5) ms pulse width level corresponds to the steering gear 0 ~ 180° Angle range and shows a linear relationship, which is suitable for controlling various actions of the manipulator.

The manipulator is composed of a segmented arm and its front-end claws [5]. The segmented arm is used to drive the jaw movement, and the jaw is used to pick up garbage. After the system identifies the garbage, the garbage robot first determines the distance and orientation between the robot and the garbage through ultrasonic wave, and then controls the robot to run to the corresponding correct position, and controls the various actions of the robot hand by controlling the digital steering gear [6]: (1) the manipulator is extended to the position where the garbage is; (2) the manipulator sends out the signal of the garbage, the manipulator clamps the garbage through the claw; (3) through the control of the steering gear will be sent to the garbage bin; (4) The manipulator is reset to the original position to complete a garbage pickup work. The connection between the robot steering gear and the SCM is shown in Fig. 5.
5. Epilogue
By combining embedded system technology, image processing technology and Ethernet communication technology, this paper designs a water level monitoring system, which can realize the real-time monitoring of the water level of the front and back pools of the pump station. According to the existing structural framework of pumping station system, the system is designed hierarchically, and the specific implementation of each part is introduced in detail. Experiments show that the system can realize the basic functions of water level monitoring, has high stability and reliability, and has broad application prospects.

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