Research and Implementation of Intelligent Garbage Collection Car System

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Abstract. With the development of artificial intelligence technology, the conditions for the introduction of intelligent garbage sorting and recycling tools in garbage sorting and recycling have gradually matured. Compared with the traditional manual recycling, intelligent garbage collection tools have considerable advantages in terms of work efficiency, personal safety and virus transmission. In this paper, an intelligent garbage collection system is designed. Through camera tracking, obstacle avoidance by laser radar and other technologies, the garbage in the area to be recycled will be automatically recycled to the designated location, and the operation and loading of the garbage car will be uploaded to the cloud server. Users can view the situation of the intelligent garbage collection system through their mobile phones or web pages.

1. Introduction

With the rapid development of China's industrialization and urbanization, 2020 is the time to build a moderately prosperous society in an all-round way, and the urbanization rate has reached the highest level in China's history. However, our living environment problems also follow. At present, our garbage production in the world is only lower than the United States, ranking second. Compared with the developed countries such as the United States, our modern waste treatment industry is still very backward. The market coverage is very small and the degree of intelligence is seriously insufficient. Also, the harmless treatment of waste, resource recovery and other processes are seriously missing, which has become an important bottleneck restricting the development of China's environmental protection industry. Because the traditional garbage collection is mainly manual, the work efficiency is not high, and it is easy to make mistakes. In the face of toxic and harmful garbage, we should also worry about life safety. For example, in the recycle of medical waste, waste pesticides and hazardous chemicals, if no protective measures are taken, the viruses, pesticides and hazardous chemicals on medical waste will cause harm to human body and even life. Because of the lack of detailed classification, a large number of garbage can not be effectively recycled. The intelligent garbage robot can effectively avoid the human body from directly contacting the hazardous waste. The hazardous waste classification which is difficult to operate can be effectively recycled under the work of the intelligent robot. In order to meet the current social needs, reduce labour, and effectively reduce the way of virus infection, we designed an intelligent garbage collection car system [1].

2. System introduction

The system combines software and hardware, uses sensor technology, scans the garbage cart through infrared distance sensor to get the amount of garbage in the bin, and transmits the information to the mobile app in real time through the wireless Wi-Fi module. Through different number information, the amount of garbage in different positions can be viewed in real time on the mobile terminal, and when
the amount can be collected, the notice can be received for fixed-point collection. In high-risk areas, such as the location of the ward, in order to avoid manual garbage collection, magnets or black tracks can be laid in the channel, electromagnetic tracing or camera tracing can be used, and laser sensor detection and obstacle avoidance can be combined to complete the garbage collection [2].

2.1. System features
The sensor on the garbage collection vehicle is small, easy to install and energy saving. It is usually in a dormant state. When someone throws garbage, after triggering the wake-up switch of the sensor controller on the garbage can, the garbage in the can will be scanned, and the information about the amount of garbage will be updated to the mobile phone client or collection robot. Timely information updating, fast processing speed, reducing the number of staff activities to check the trash can, and the cost of manpower. Also, it is conducive to the maintenance of public order. In order to meet the needs of different scenarios, the structure of the recycling bin is designed as two types: the compression structure with pedal and the non-compression structure. The compression structure is suitable for the place with fast garbage generation, which can reduce the collection times.

2.2. System application scenarios
The original intention of this system is to reduce the manual recycling of garbage, to avoid the occurrence of medical waste, especially the new coronavirus epidemic. The garbage generated by protection needs intelligent tools to assist in recycling, reduce human contact, so as to avoid the spread of the virus. Therefore, the system can be used in hospital wards and other high-risk occasions, and can also be applied to large shopping malls, office buildings and other scenes.

2.3. Overall structure of the system
This system mainly realizes the garbage collection car according to the camera trace to the need to collect garbage location, garbage collection and return, midway can detect and avoid obstacles, find the right path. At the same time, the status and control of the garbage truck can be monitored and operated by mobile phone applet or web client. Therefore, the overall structure of the system is shown in Figure 1.

![Figure 1. Overall structure of the system](image-url)
3. The main technology of system realization

3.1. Camera tracking

The system is based on the preset location information to control the garbage collection car for intelligent recycling, as shown in Figure 2. We assume that the layout of the room needs to recycle garbage, according to the room location, preset the black track line for tracing. Then, according to the corresponding position of the recycling car and the room, we plan the running track of the recycling car. For example, the car will go to the designated room 6, we set the path. That is: start → North → West → South → destination. From this path information, we can know the direction of the robot, and the number of cross nodes in each direction, so as to avoid the wrong room.

In the process of the car running, the camera vo7670 installed on the car detects the black line image information. After binary image processing, the forward direction is determined, and then the trajectory is corrected by calculating the deviation of the centre line of the black track from the centre line of the actual car. However, when encountering right angles or crossroads, the camera can detect it in real time through the feature detection algorithm of the route, and then read the orientation information of the destination node, so as to select the corresponding route for driving. The data of the camera is output in RGB format. When processing, it only needs to set the appropriate threshold to process the black and white effect. However, the appropriate threshold may be different in different environments. The following is the analysis of the binary image processing results after the camera collects the image signal.

The RGB thresholds of the collected pictures are set as follows: (a) RGB is 12, 31, 12, (b) RGB is 13, 33, 13, (c) RGB is 14, 35, 14, (d) RGB is 15, 37, 15, (e) RGB is 16, 39, 16. From the above image and RGB threshold information, it can be seen that the higher the threshold setting in RGB, the larger the black range of visual field after processing. When the threshold value is set too low, the path in front of the field of vision is easy to be handled by exposure, while when the threshold value is set too high,
the white area in the back of the field of vision is easy to be processed into black due to the shadow of
the robot itself. From the above image processing results, the effect of group (d) is better.

3.2. Laser radar obstacle avoidance

Laser radar is a laser beam emitted by laser, when the laser beam is reflected on the object. The laser radar calculates the distance between itself and the object by the time difference between receiving the reflected laser and transmitting the laser beam. Laser radar is widely used in robot navigation, positioning, environment modeling and other aspects with the advantages of fast computing speed, high accuracy and free from light environment limitation. The delta-2a laser radar used in this system communicates with external devices through UART. The laser radar actively sends data frames to peripherals. The peripherals only need to extract effective data from the data frames, and do not need to make any response. All data in the communication frame is in hexadecimal format. The radar rotates to measure a circle and scans to get the information of evenly distributed points in a circle, that is, points, angles and distances. The schematic diagram of radar scanning detection is shown in Figure 4[3].

The radar detects a circle of 360° and is divided into 16 scanning information frames averagely, so the starting angles of each frame of 16 frames are 0°, 22.5°, 45°, 67.5°, 90°... 360° and 16 frames add up to a complete circle. Then, the total number of points in a circle M = 16 * the number of points in each frame K. The total number of points K of each frame can be obtained by calculating the number of distances according to the scanning information frame (that is, the number of distances = the total number of points). Information of data points in each frame (angle and distance): the distance of the nth point in a frame is the distance value of N in the scanning information frame. The angle corresponding to the distance of the Nth point in that frame = the starting angle of this frame + (n-1) * 22.5 / (total number of points in each frame). In this way, the point information (angle and distance) of a frame is available. Then according to the communication protocol to analyse the communication data, we can analyse the real-time measurement information and equipment health status information [4].

We tested the laser radar, recorded and analysed the data as follows. The test distance is the distance from the centre of the radar circle to the obstacle.

| Test group | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|
| actual     | 100.00 | 150.00 | 160.00 | 180.00 | 200.00 | 250.00 | 280.00 | 1000.00 |
| distance(mm)|     |      |      |      |      |      |      |      |
| measured distance (mm) | 0   | 0   | 160.25 | 179.50 | 201.50 | 250.75 | 282.50 | 1004.75 |
|------------------------|-----|-----|--------|--------|--------|--------|--------|---------|

It can be seen from the data that the distance measured by radar is 0 within 160mm, and the data larger than 160mm is relatively accurate, which can fully meet the obstacle avoidance or navigation function of robot. In the process of the test, it is found that when the sunlight is relatively strong, the measured data will suddenly change to 0, but it has little effect on the general lighting, and there is no obvious change when using the mobile phone flash, so it is completely possible to carry out obstacle avoidance detection indoors.

4. Summary
Under the premise of limited cost, the system realizes the basic functions of the intelligent garbage collection vehicle, that is, according to the planned path to complete the camera tracking, driving the recycling vehicle, at the same time, according to the laser radar real-time detection of the environment, judge whether there are obstacles in the current path, when there are no obstacles in the current detection range, the driving wheel drive realizes navigation; if the obstacles of current path is detected, the path planning of the target point is carried out again from the current position until the target navigation point is reached. In the whole process, laser radar monitors the surrounding environment in real time, and constantly corrects its own position through path information comparison. There is still a lot of room for expansion and in-depth research in the system, such as adding robot arm to pack and deliver garbage, and identifying garbage classification, which can be considered for further research.

References
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