

# A New Design of Intelligent Classification Using ISM Band Communication

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## Abstract

Due to the inefficient efficiency of community garbage classification in cities, the confusion of the four kinds of garbage cans alone, and the weak enthusiasm of residents for recycling. In order to change this phenomenon, an idea and model are proposed for merging four types of garbage sorting bins. Through modeling and 3D printing technology, an integrated four-column garbage can is manufactured to simulate the garbage sorting box and open turntable. The 51 series MCU generates PWM wave control steering gear to realize the setting of different gears of the open turntable. At the same time, in order to improve the human-computer interaction, a small program and app are designed to realize the interactive connection control of human-mobile phone and trash can through the mobile ISM band module, and the enthusiasm of residents for recycling is improved through the basic idea of feedback. This project provides a new idea for the mode of garbage can renovation and recycling, which improves the efficiency of garbage recycling and achieves the function of energy saving and emission reduction.

## Keywords

Human-computer Interaction; Steering Control; Scoring Mechanism; Recycling Mode Transformation; The ISM Frequency Band Communication.

## 1. Introduction

A set of interactive classification bins based on ISM band communication (model ratio of 1 to 10). Through the modeling software, a four-column cylindrical trash can was established, connected with a controlled steering machine to drive 3 / 4 fan cover, and then regulated different classification bars. Our basic module consists of the classic STC89C52RC series MCCM and the HC-08 ISM band module. By compiling the software design, the mobile phone software controls the microcontroller through ISM band, and the PWM wave can realize the conversion of different angles of the steering gear, and then realize the basic function of human control and delivery. In the future, the stacking height of the fixed-capacity garbage box can be detected by connecting the ultrasonic or infrared module, and then determine whether it needs to be recycled.

## 2. Design Scheme

Through modeling to build a four-bar resin model, provide the central platform point to install the steering gear, design the program for the PWM wave driving the steering gear and adjusting the duty cycle, and design the reading program for improving the frequency ISM band module. According to the specific character design program obtained in the ISM frequency band of the mobile phone, turn different angles under different characters to turn the opening to point to the corresponding recovery bar.

### 2.1. System Design

Through the 51 microcontroller programming to receive the specific characters of the mobile phone ISM frequency band signal and judge, and adjust the duty cycle under different conditions to achieve different gears. Based on the ultrasonic module to detect the height of the fixed capacity garbage box, to determine whether the recycling is needed.

### 2.2. Mechanical Part

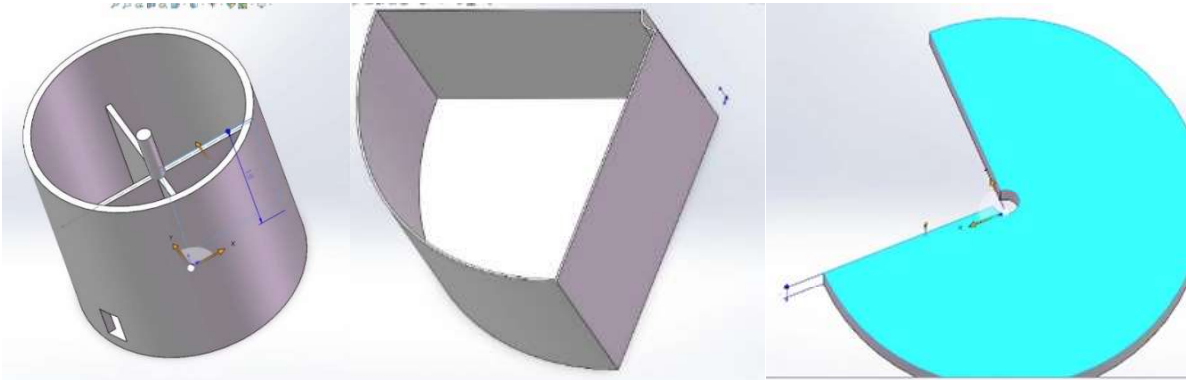


Figure 1. Garbage box model diagram

The main problems to be considered in the design: the proportion of the equivalent model (saving printing expenses), the width of the central cylinder, the size to be left for the steering gear, and the height and size of the garbage box, the radius should be slightly smaller than the original space.

### 3. Theoretical Design Calculation

This calculation is based on the control of the C51 MCU, first there is a reference voltage inside the steering gear. If we want to control the rotation of this wheel gear. So we will through a certain signal line to give it a certain period of dc bias voltage, which will make the internal reference voltage and offset voltage difference, the voltage difference can also affect the motor positive reverse, the next is how to give a DC bias voltage rotation fixed Angle, by the duty cycle we can know that should use square wave to control the steering wheel. In the actual procedure, we mainly use a 20ms time base pulse to realize the rotation of different angles, and control the drive according to its rotation angle and duty cycle (Figure 2).

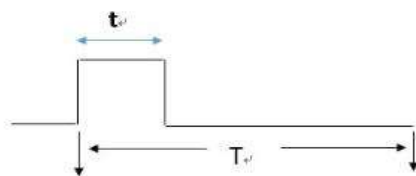


Figure 2. Square wave diagram

### 4. Working Principle and Performance Analysis

Our project of this time -- The interactive classification garbage can based on ISM band communication will report the data and classification of the residents to the headquarters and the superior garbage recycling station and submit it to the staff for secondary classification and recycle the garbage. This project optimizes garbage bins based on the current garbage classification and recycling policy and the current low garbage classification efficiency. The

purpose is to improve residents' awareness and skills of garbage classification so as to better beautify the city. Our project mainly uses the two principles of ISM frequency band transmission

#### 4.1. ISM Band Bluetooth Technology

An Internet-based data transfer and receiving tool, The principle is to set the matching information between the two ISM band devices, such as PIN code, address, etc., for the ISM band products before the equipment leaves the factory, And the ISM band technology also has a master-slave relationship, When the ISM frequency band is passed between each pair of devices, there needs to be a master setting to exchange information, and the device must be found and paired by the main end, but the connection process does not need to use other circuits, It can also be set to two states, The first is the silent state, This connected only to a fixed primary end, Not identified by other equipment, The second type is the development status, The state can be looked up by any ISM frequency band device, It can also ensure that the designated main end lookup pairing, For example, the often used ISM band headphones are found on the main phone, The headset is paired as the slave device after the main device gives the playback command, Receive the desired play data from the terminal headset and complete the play command, And it covers the stereo, This is a simple workflow for an ISM frequency band device.

#### 4.2. Steering Engine

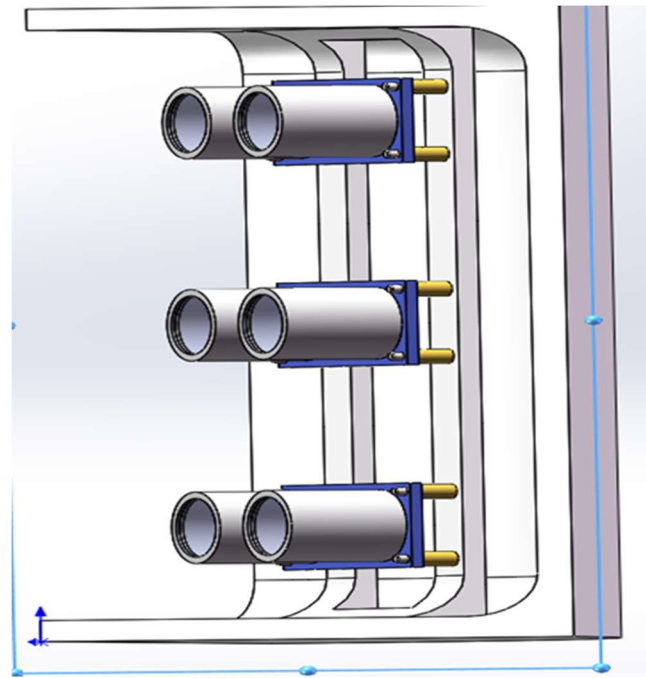
A driver, mainly by changing the direction of movement of the rudder blade, so that some parts of the movement, is an important part of the control system. The structure of the steering gear is composed of circuit board, drive motor, swing arm and deceleration device. When the resistance value will change and the rotation Angle can be known. Since then, the steering gear has completed a rotation. The steering gear can also be used as a remote controlled device, and the more responsive feature makes it widely used in the field of life. For example: remote control external switch, some simple physical experiments of the start device, timing switch, etc.

#### 4.3. Ultrasound Module

Choose the cheaper HC-SR 04 ultrasonic sensor. The transmitting pin trig and receiving pin echo of the module are connected to two ordinary I / O ports of the microcontroller. The control port of the microcontroller sends a high level above  $10 \mu s$  to the transmitting pin of the module, and then the receiving end detects whether it is a high level. When the receiving pin echo reads the high level, the timer is turned off after the high level ends. The duration of the high level is the propagation time of the ultrasound wave. The distance between the measured point and the sensor is easily measured by using the time difference between sending and receiving and the propagation speed of the sound wave in the air (measured distance = (high level time sound speed) / 2).

The system has a strong expansibility: such as the installation of ultrasonic module, infrared module to achieve remote monitoring and display alarm function, users can understand the status of the trash can through wechat small program anytime and anywhere, so as to reduce the burden of cleaning personnel, reduce the cost of garbage recycling.

This project mainly use part of the sensor to receive specific signals, and then through the chip command to microchip, judging through the program to generate a specific duty cycle of different PWM control steering wheel, steering wheel in different direction different angles into the garbage into the correct trash can, so as to achieve the role of correct garbage sorting recycling.



**Figure 3.** Basic design of the ultrasonic module

## 5. Innovation Points and Applications

- (1) The four-column trash can covers a small, clean and beautiful area, easy to operate and control, and easy to use.
- (2) There is a feedback mechanism for garbage classification to improve residents' participation in garbage classification.
- (3) A human-computer interaction mechanism for controlling garbage classification with mobile phone ISM frequency band has been established.

It improves the sense of participation in garbage classification and improves the yield rate of garbage classification. It improves the recovery rate of resources and improves the difficulty of community recycling. With this device, we can identify the amount and volume of garbage put. The application of WeChat small program: first collect all the information at the main terminal and then transmit the information to the cloud, The cloud is then sent to each user's small program, Cloud information can be updated in real-time, You can also enrich the content in small programs, Add teaching videos and publicity materials of garbage classification, set up questions and questionnaires with prizes, add customer service, service hotline, online q & A and other functions not only ensure the timeliness of service but also promote the process of intelligent garbage classification, at the same time add a set of incentive mechanism in the small program, Using ultrasonic sensing and satellite positioning systems to evaluate the garbage classification of each household, Users who reach a certain high level of classification can get some substantial rewards similar to toothbrush toothpaste, This is also of great help to the formation of garbage classification consciousness.

## 6. Economic Benefit and Feasibility Analysis

Taking Beijing household waste as an example, according to the social practice survey, the model parameters are as follows:

The effective rate of residents to classify garbage according to the requirements is 85%; ② The penetration rate of classified collection is 90%; ③ Waste purchase price: 0.50 yuan / kg, Waste plastic: 0.80 yuan / kg, Waste glass is 0.2 yuan / kg, Scrap metal (average) 0.5 yuan / kg; ④ The

cost of household garbage collection, transportation and treatment is 65 yuan / t; ⑤ Follow-up treatment, disposal, investment and operation expenses after garbage classification (calculated according to the normal cost after investigation); The buried treatment cost is 35 yuan / t, Investment cost is 55 yuan / t; Unclassified follow-up treatment, disposal, investment and operation cost of the rubbish (calculated according to the normal cost after the investigation): the landfill treatment cost is RMB 45 yuan / t, Investment cost is 65 yuan / t; ⑦ The average daily sorting of sorting workers is 0.5t / person, Management personnel by 10% of the total number of workers, The average annual salary of the sorting worker is 10,000 yuan per person, The average annual salary of management personnel is 15,000 yuan / person; ⑧ Sorting tools and sorting labor protection articles are RMB 1,000 yuan per person per year.

Specific methods:

The household garbage is roughly divided into recyclable garbage and non-recyclable garbage, and then the recyclable waste products (paper, plastic, glass, metal) is sorted and recycled in the transfer station; the recyclable garbage is transported to the landfill for sanitary landfill. Calculate the recycling amount and income according to the above model parameters and household waste composition. It is calculated that the amount of waste can be recycled in 3 years: paper 1,573,100 t, plastic 1,0932 million t, metal 205,800 t and glass 263,700 t. According to calculation, the total benefit of waste recycling in three years is 181675 million yuan, the reduced waste transportation and treatment cost after recycling is 203.827 million yuan, the investment and disposal cost of landfill is 570.6 million yuan, and the cost of manual sorting waste is 71.6 million yuan. In conclusion, the total benefit cost of recycling in the scheme is 1378377 million yuan. For the products we design, the preliminary budget is 200,000 yuan per year. In our way, we can know that through the reward system, 60% active participation can be increased to 90%, and the garbage classification can be increased from 76.4% to 91.2%. Only 0.4 yuan per ton, 1 million tons of recyclable garbage, can reach 200,000 yuan. Reward system: a reward system for citizens, every successful delivery of garbage classification accumulates 10 energy. After 50 energy, materials can be donated to the mountainous areas through the platform. You can also accumulate energy and complete the goods exchange on the platform.

Feasibility analysis:

After reasonable prediction and analysis, we can find that the application of the classified trash can effectively improve the recovery and utilization of resources in Beijing, greatly improve the enthusiasm of residents for classification, meet the demand of energy conservation and emission reduction, and effectively transform the urban garbage management problem.

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