Research Article

Automatic Classification and Recovery System of Beverage Bottles Based on STM32

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ABSTRACT

At present, the problems of environmental pollution and resource waste in China need to be solved. The existing beverage bottle recycling system in the market has the problems of high cost, imperfect function and inflexible rebate mode. Based on the sensor detection technology, the WiFi wireless communication and software development technology, this paper designs a comprehensive system of beverage bottle classification and recycling, which includes intelligent classification and recycling machine, Mini Program and Web remote monitoring platform. The system can automatically identify and classify metal bottles and plastic bottles, and can give users integrals, which has certain environmental protection significance.

1. Introduction

At present, due to people's weak awareness of garbage classification, a large number of recyclable resources are put into the garbage system, resulting in the waste of recyclable resources. According to statistics in 2017, discarded beverage bottles accounted for up to 30 to 40 percent of household waste. Waste beverage bottles have high recycling value, such as waste plastic bottles can be made into elastic fiber, textiles and fuel after being correctly processed, while waste cans can be recycled 100% to rebuild new cans. It can be seen that the waste beverage bottles that seriously pollute the environment are actually valuable resources in the wrong place, and effective measures must be taken to recycle them.

At present, the recycling rate of waste beverage bottles in China is far lower than that in other developed countries. The beverage bottle recycling system in the market can realize the round-the-clock recycling function, which improves the resource recovery to a certain extent, and also brings economic benefits to investors. But its cost and maintenance cost is high, the function is not perfect, the rebate mode is not flexible enough, and has not been widely promoted in the market. Therefore, it is necessary for the society and the market to develop a set of beverage bottle automatic classification and recycling system which is easy to promote.

2. Overall design scheme of the system

According to the actual application scenarios and market demand, combined with sensor detection technology, WiFi wireless communication technology and software development technology, this paper designs an automatic beverage bottle classification and recycling system based on STM32, including intelligent classification and recycling machine, WeChat Mini Program and Web remote monitoring platform.

The intelligent sorting and recycling machine can identify and classify the plastic and metal bottles automatically, which avoids the secondary pollution caused by users' mixed throwing, and reduces the

maintenance cost in the later stage. The recovery machine is also equipped with automatic counting, voice prompt, overflow alarm and the detection of ambient temperature and humidity and other functions, and through wireless communication to upload all data information to the server in real time.

User can use the WeChat applet to scan the code of the equipment on the recycling machine and then place the beverage bottles. The system will return the corresponding points according to the material and number of the beverage bottles. The method of using WeChat Mini Program to get points is more flexible than the traditional method of swiping IC card to get points, which effectively improves the user experience. The Web remote monitoring platform can monitor the running state of the intelligent recycling machine in real time. The administrator can receive the automatic alarm information of the recycling machine and take measures in time. The overall structure of the automatic classification and recycling system of beverage bottles based on STM32 is shown in Figure 1.
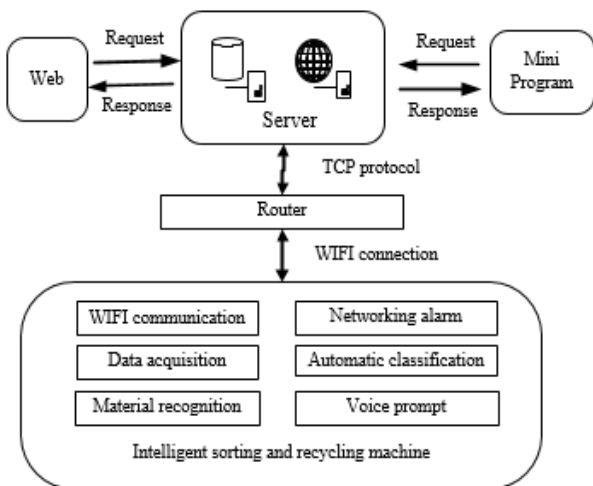

Fig.1. The overall structure of the automatic classification and recycling system of beverage bottles based on STM32

3. Design of hardware control system

In this system, STM32F103 single-chip microcomputer is selected as the core controller, and the control system functions are realized by combining the peripheral modules. The hardware control system mainly includes: core controller, power module, WiFi communication module, each sensor module and other peripheral modules. The following describes the parts of the hardware control system.

3.1. *Main control chip*

In this system, STM32f103vet6 is selected as the core controller of the hardware control system, which is mainly used to realize the functions of data acquisition and analysis, motion control of executive components, etc. The processor of STM32f103vet6 is Arm Cortex-M3 high-performance kernel, with the maximum working frequency of 72mHz, flash memory of 512KB, SRAM of 64KB, and packaging form of lqfp64. Its peripheral configuration is powerful, supporting SPI interface, I2C interface, USB interface, USART interface and other communication interfaces, as well as ADC, timer and other peripheral devices [1].

3.2. *Voltage stabilizing module*

The power supply module is responsible for power supply for each module of the system. The power supply voltage required by each module of the system is different: the power supply voltage required by the actuator is 12V, the power supply voltage required by MCU and Esp8266 WiFi module is 3.3V, and that of peripheral modules such as sensors is 5V. Therefore, the main power supply of the system is 12V DC power supply, and the voltage stabilizing module adopts Ams1117 series voltage stabilizing chip to stabilize the voltage, so as to meet all power supply requirements.

Ams1117 voltage regulator chip belongs to linear voltage regulator chip (LDO), and the pressure difference between input and output shall not be less than 1.3V. This series of chips have two versions: adjustable voltage stabilizing output and fixed voltage stabilizing output. This system uses Ams1117-5.0 and Ams1117-3.3 chip to stabilize voltage, and its package form is SOT-223 chip package. As ripple may occur during power supply and the peak voltage may cause the main control chip to burn down, it is necessary to filter the output voltage, and the control voltage amplitude is within 5%. When using Ams1117 voltage stabilizing chip, a capacitor shall be connected in parallel at the input and output terminals respectively for filtering. The voltage stabilizing circuit of Ams1117-5.0 and Ams1117-3.3 is shown in Figure 2.
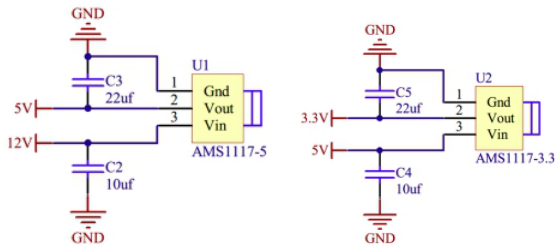
Fig.2. 5V and 3.3V voltage stabilizing circuit

3.3. *Motion actuator*

The actuator of intelligent sorting and recycling machine is zsm14k12 steering gear. The working voltage of the steering gear is 9.5V-12V, the electrical standard of the control signal is 5.0V TTL signal, and the maximum working angle is 270º. Zsm14k12 actuator works fast and has stable performance. Its control mode can be serial control or PWM control. The actuator can quickly respond to the movement command of the system, and transfer different kinds of beverage bottles to the corresponding bin. The appearance of the steering gear is shown in the Figure 3.

Fig.3. The appearance of the steering gear

3.4. *Material identification module*

Material identification is an important function of the hardware control system of the intelligent sorting and recycling machine. The function of material identification depends on the metal sensor module. The system can distinguish the metal bottle from the plastic bottle through the metal sensor. LJ18A3-8-Z/B type metal sensor is used in this system. The sensor has the advantages of fast response, strong anti-interference, waterproof and corrosion resistance, and very stable performance. It is often used in automatic assembly line, intelligent hardware and security system.

The working voltage of the sensor is 6-36vdc, which is composed of high frequency oscillation circuit, detection circuit, amplification circuit and output circuit.
After the normal power supply of the sensor, the oscillator generates an alternating electromagnetic field on the detection surface of the sensor. When the metal beverage bottle is close to the magnetic field, it will absorb the energy of the alternating magnetic field, which will cause the vibration attenuation and stop. The changes of oscillator oscillation and stop oscillation are processed by the subsequent circuit and converted into a switch signal. The physical drawing of metal sensor is shown in Figure 4.

Fig 4 Physical figure of metal sensor

3.5. *Wireless communication module*

Esp8266 wireless communication module is selected to send the data collected by the hardware terminal to the server. The Esp8266 module provides a complete WiFi network solution with a built-in 32-bit low-power processor. Because of its low cost, high performance and small size, the module is widely used in smart home, wearable electronic equipment, wireless positioning and other fields.

TCP is a link oriented and reliable protocol. It needs to wait for the confirmation of the receiver to establish a connection [2]. It is safe and reliable and can ensure data integrity. In this system, the esp8266 module uses TCP protocol to set the WiFi application mode of Esp8266 as sta mode and select TCP connection through at command, so as to realize the function of establishing data connection with ECS. The Esp8266wifi module is shown in Figure 5.

Fig.5. ESP8266 Profile Diagram

4. System server design

This paper selects Alibaba cloud server and builds a Wamp framework for server development, providing services such as communication management, data storage and processing, logical analysis, API interface, etc. for the whole system. The applet is configured with the relevant domain name, and the self-built server can be accessed through HTTPS protocol to realize communication. The developed web management platform is deployed to the

ECS, and the administrator can log in to the web management platform with a browser to remotely monitor the real-time running status of the recycler.

4.1. *Socket network communication*

This system selects the Alicloud server as the TCP server, and designs the TCP console software according to the socket communication principle. Socket is in the form of (host IP address: port number), which is located between the application layer and the transport layer of TCP/IP protocol [3]. Using socket can quickly and stably establish the communication connection between TCP client and server.

The ECS waits for and accepts the TCP connection request from the hardware terminal by running the socket.py file. The data collected by the intelligent sorting and recycling machine is stored in the database.

4.2. *WAMP framework*

The common Wamp application framework is selected for the server development of this system, which is composed of windows, Apache, MySQL and PHP. Windows is the operating system. Apache is the website server. MySQL is the relational database. PHP is the background development script language. They are independent in themselves, but they are often combined to build the server due to their good compatibility [4].

5. Client development

This project uses the Wechat developer tools to develop mini programs based on Mina framework. After the user logs in to the applet, click the scan code button on the navigation bar at the bottom of the main page to scan the QR code of the device on the recycling machine. After the scanning, user can enter the throwing page. After the user throws the drink bottles, the system will send the settlement by itself and return the corresponding points to the user's account. The function of small program scanning QR code mainly depends on calling wx. Scancode ( ) interface.

The web management platform of intelligent classification and recycling system is developed based on B/S mode, and Ajax technology is used to realize asynchronous request operation of web pages. Ajax implementation does not load the entire page, the part of the content of the page is updated quickly [5]. After logging into the website, the administrator can enter the dynamic monitoring interface, which can remotely monitor the operation status of the intelligent sorting reclaimer in real time.

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Authors Introduction

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He received an M.E. and Doctor of Engineering (PhD) from the Beijing Institute of Technology, China in 1998 and Oita University, Japan in 2004 respectively. His main research interests are artificial intelligence, pattern recognition and robotics. He worked in National Institute of Technology, Matsue College, Japan from 2003 to 2009. Since October 2009, he has been the staff in Tianjin University of Science and Technology, China, where he is currently an associate Professor of the College of Electronic Information and Automation.

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