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# Design of Intelligent Garbage Bin Control System Based on PLC Technology

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## ABSTRACT

In recent years, driven by global environmental policies and technological innovation, smart trash cans have become an important innovative tool for urban environmental health management, as a product of the deep integration of Internet of Things technology, sensor technology, and automatic control technology. This type of garbage bin not only achieves intelligent operations that traditional containers cannot match, such as automatic sensing of opening and closing, precise guidance for garbage classification and disposal, but also monitors the garbage loading in real time through built-in sensors, accurately determines whether the garbage bin is fully loaded, and timely notifies for cleaning, avoiding environmental pollution problems caused by overflow. In addition, some high-end smart trash cans are even equipped with automatic compression function, significantly improving the garbage carrying capacity per unit volume, reducing the number of cleaning times, and saving resources.

## KEYWORDS

PLC; Sensor network

## 1. INTRODUCTION

Home intelligent trash can control system based on PLC technology, the system integrates Internet of Things technology, sensor technology and automatic control technology, aiming to improve the level of urban environmental health management, adapt to the requirements of global environmental protection policies, and meet the needs of modern life for convenient and efficient garbage classification and treatment. Intelligent trash can has a variety of intelligent functions, such as automatic induction opening and closing, garbage classification guidance, and the use of built-in sensors to monitor the garbage load in real time, accurately judge whether the trash can is full and timely send the clearance information, to prevent environmental pollution caused by garbage overflow.

## 2. OVERALL SYSTEM DESIGN PLAN

To ensure the efficient and stable operation of the home smart trash can, we have adopted high-quality hardware configuration.

The upper computer uses Intel high-performance processors as the core control unit of the system, responsible for the overall operation, debugging, and control of the trash can[1]. Provide powerful computing power for data processing, ensure smooth operation of various functions of the smart trash can, and improve the stability of the smart trash can.

Provide powerful computing power for data processing, ensure smooth operation of various functions of the smart trash can, and improve the stability of the smart trash can. By using the ModBus communication protocol [2] for communication, ensure the efficient and stable operation of the trash can in various scenarios. Through powerful hardware configuration, home smart trash cans can achieve efficient and stable operation, providing better user experience and garbage management effects.

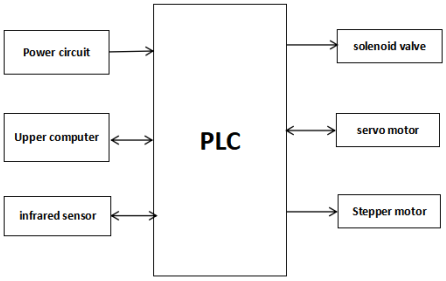


**Figure 1** Overall structure diagram

# 3. HARDWARE STRUCTURE

## 3.1. Garbage classification module

In order to provide a wider operating range and excellent stable mobility performance to the garbage bin, a gantry structure was adopted as the basic module for gripper movement. This gantry architecture design has extremely high rigidity and deformation resistance, which can provide a solid and stable support platform for the gripper, ensuring accurate and error free movement in XYZ three-dimensional space. Even in the face of complex and ever-changing garbage disposal scenes, it can be finely adjusted.

A precision stepper motor is installed at the gripper bracket, and its power is transmitted to the gripper components through a carefully designed connecting rod and pivot mechanism. This allows for precise adjustment of the stepper motor rotation to the corresponding position according to the specific angle of garbage placement before executing the garbage grabbing task, ensuring that the gripper can contact and pick up garbage in the best posture.

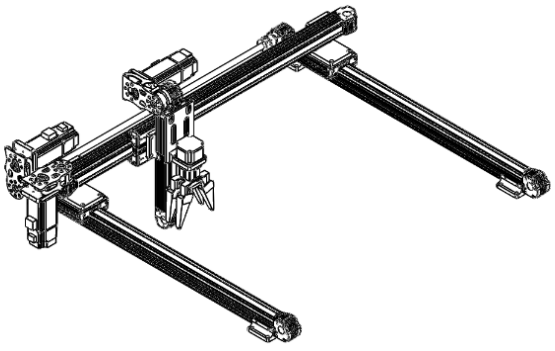

**Figure 2** Claw motion module

## 3.2. Full load detection module

We have installed the WT53R-485 series high-precision laser ranging sensor at an appropriate location in each garbage bin. Its working principle is to emit a laser beam to the top of the garbage heap, and then receive the reflected laser signal. Based on the principle of time difference between light pulses and constant speed of light, this sensor can accurately calculate the distance traveled by

the laser beam from emission to reception and reflection signal, and indirectly measure the height and volume of the garbage heap, reflecting the level of garbage filling in the garbage bin in real time.

By continuously monitoring and calculating the data obtained from the laser ranging sensor, the system can track the growth of garbage inside each garbage bin in real time, and accurately grasp the capacity and usage status of the garbage bin. This not only helps with timely scheduling and transportation, avoiding environmental pollution caused by overflowing garbage, but also provides reliable data support for the efficient management and maintenance of intelligent garbage bins.

### 3.3. Compression device module

The intelligent garbage bin is equipped with a compression mechanism with a cylinder with a diameter of 80 millimeters and a stroke of up to 100 millimeters as the core. The mechanism is independently set in a sturdy and durable cage frame, ensuring the stability and durability of the overall structure. When compressible waste such as cans are thrown into the trash can, this compression device begins to function.

The cylinder will drive the compression plate to apply continuous and appropriate pressure to the garbage, causing the garbage to be orderly flattened and compacted along the vertical direction. This compression process will continue until the garbage is maximally reduced in volume, and the final form remains as a tightly solid block.

After completing compression, the cylinder will release the pressure in a timely manner, restoring the compression plate to its initial position and preparing for the next round of compression tasks. Through this method, the large volume occupied by the garbage can be significantly reduced, thereby greatly reducing the internal space occupied by the garbage can and effectively extending the interval time when the garbage can does not need to be cleaned.

The intelligent compression device designed in this way, with its efficient space saving characteristics, not only optimizes the garbage storage capacity, but also significantly improves the efficiency of using garbage bins.

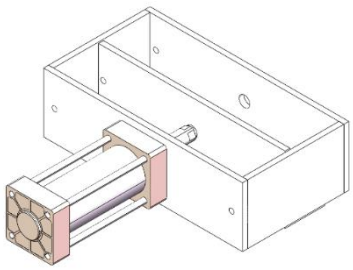

**Figure 3** Cylinder compression module

## 4. MOTION CONTROL PROGRAM

In the design of the motion control system for the intelligent trash can, we have selected the Huichuan Easy series programmable controller as the core control component, fully utilizing its powerful and flexible motion control functions to ensure precise control of complex actions such as lifting, opening and closing the lid, and compressing garbage in the trash can. Through the intuitive and easy to understand ladder diagram programming language, we can plan and organize various motion logic and control instructions of the trash can in a concise and clear manner, greatly simplifying the programming steps and reducing development difficulty.

Huichuan Easy series programmable controllers[3]. Not only does it provide excellent motion control performance, but it also has rich interface resources and supports various mainstream industrial

communication protocols such as CAN open, Ether CAT, Mod bus, etc. It facilitates seamless linkage and efficient data exchange with various sensors, actuators, and other intelligent devices, thereby improving the overall coordination and intelligence level of the intelligent garbage bin.

In addition, we adopt an integrated modular programming method to package a series of relatively independent operation sets into reusable functional blocks. This not only improves the code reuse rate, but also greatly enhances the readability and maintainability of the program, making it more convenient in subsequent debugging optimization and even troubleshooting stages, effectively ensuring the stable and efficient operation of the intelligent garbage bin system.

## 5. PERORATION

The trash can control circuit based on PLC technology can realize the humanization and intelligence of the trash can, improve the efficiency of garbage classification, green environmental protection, complete functions, and has certain practical application value.

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