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A Device for Sorting and Recycling Dry Batteries Automatically

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Abstract. At present, more than 98% of Chinese waste batteries are disposed with municipal living garbage, resulting in water, air and soil pollution. However the general discarded batteries still have some power, which can be carried out for the second recycling.
Aiming at reducing the pollution of waste batteries and solving the problem of energy waste, I developed an automatic-sorting device to recycle dry batteries. Using single-chip principle and mechanical transmission, the stepper motor drives the mechanical structure to accurately feed the battery into different storage devices with the electricity detection results. Therefore, the battery which remains electricity can be reused for users.
The device makes the waste batteries to be fully recycled, which can not only protect the environment owing to the second recovery of raw materials, but make the efficiency of a single battery significantly improved. The device has the advantages of simple operation control, simple installation and maintenance, low production cost, and can play the role of protecting the environment, which contributes it to be popularized.

Research Background and Significance

At present, none of any battery recovery device is widely used. Waste batteries are usually placed in the natural environment for a long time, where the acid and alkali electrolyte solution will affect the pH of soil and water, so that they will be acidified or alkalized. The civil battery is currently the largest use, but also the most fragmented battery products. What's more, its collection and recycle are generally more dispersed and complex. But most of the batteries still remain power and can be used, so they should be secondary recycling.

Based on the above background, I proposed a battery sorting device for the recovery of civil dry batteries.

Designe Scheme

The device control electrical parts through a C51 single-chip, and the main components used are the collision switch, stepper motor and stepper motor driver.

After a dry battery slides into the entrance, the collision switch sends a signal to the microcontroller, and the single-chip controls stepper motor forward, so the power and model of the battery will be measured. The module sends the signal to the microcontroller, which judges whether the battery still remains power or not, then the single-chip controls the stepper motor to send it to the corresponding battery box.

When you need to remove the battery, you can press the key to control the microcontroller and then the battery will be pushed out.

The main circuit block diagram is shown in Fig. 1.

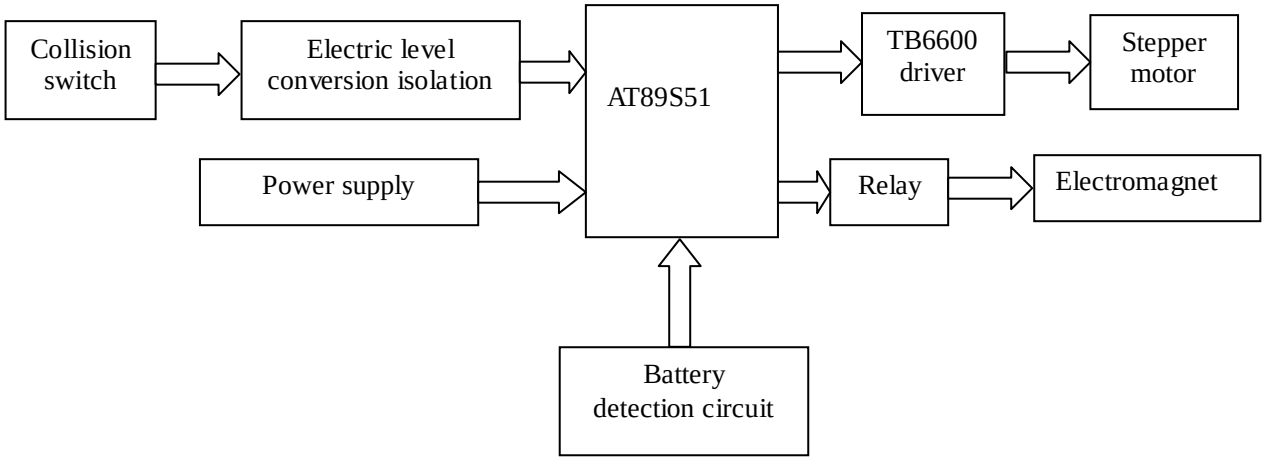

Figure 1. Single chip microcomputer's main circuit block diagram

Working principle and Performance Analysis

The mechanical part of the device is based on Solidworks modeling design. The overall assembly structure is shown in fig. 2.

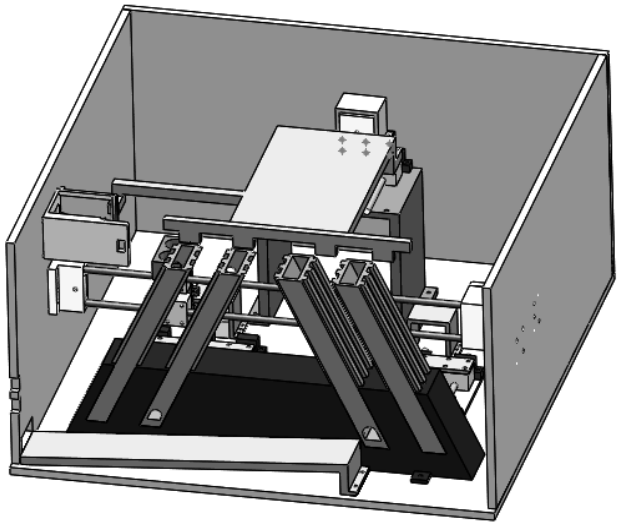

Figure 2. The overall assembly structure

Working Principle. The battery recycling device is a combination of battery measurement module, battery transmission module and battery removal module.

Measurement Module. Measure power section: the user puts the battery into the receiver inlet and presses the switch, then the system begins to measure the battery charge.

Measure model section: The system calculates the battery type by recording the time interval at which the stepper motor drives the battery to trigger the pressure sensor.

30% of the electricity is regarded as a measure of electricity or no electricity.

The measurement module is shown in Fig. 3.

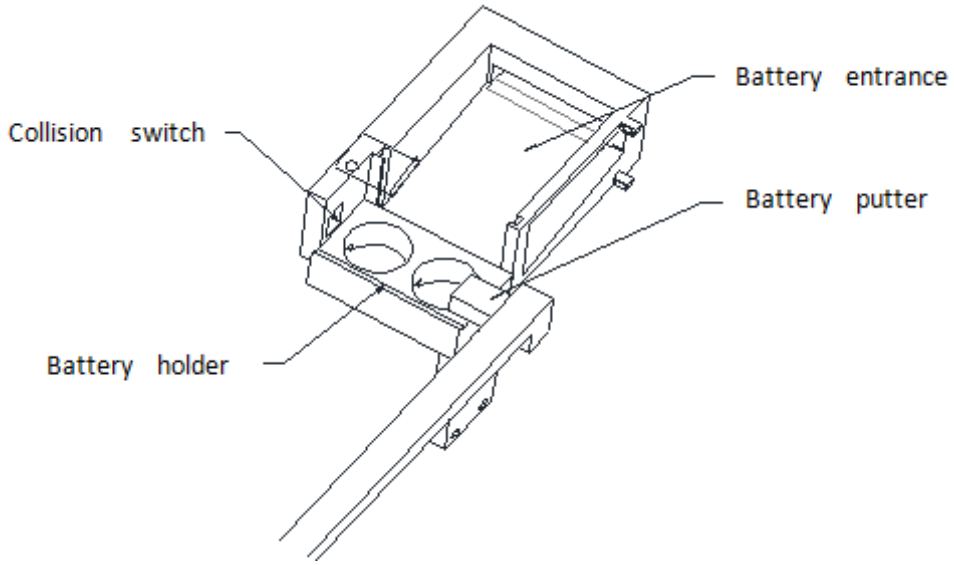

Figure 3. Measurement module

Battery Transfer Module. The module receives the battery measurement information and converts it into the battery's moving distance to trigger the stepping motor. According to the battery power and models, it will be divided into four categories of batteries: AA wastes batteries, AA old batteries, AAA wastes batteries, AAA old batteries, and the four different battery packs are set up to store the battery. The battery transfer module is shown in fig. 4.

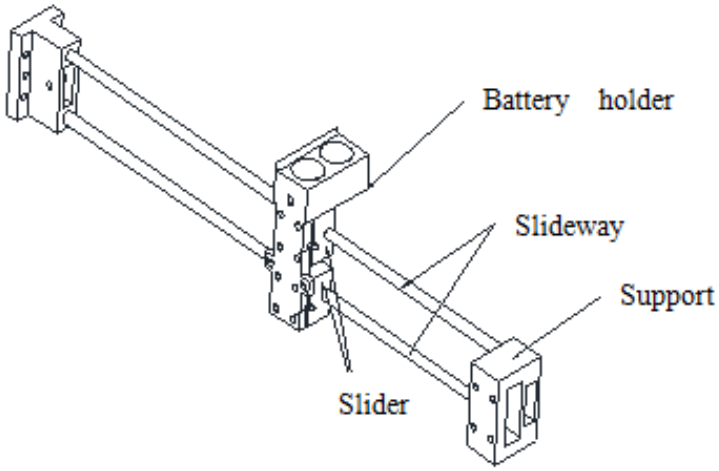

Figure 4. Battery transfer module

Battery Removal Module. The outside of the battery recycling device is equipped with a button to take out the old battery. When users press the button to trigger the collision switch, the system receives the collision switch command, then the stepper motor is drived to take out the old battery.

Performance Analysis. Because this work involves the coordination of electrical control and mechanical action, this paper will analyze its performance from three aspects: quickness, reliability and economy:

(1)Quick-movement refers to the device can identify the type of dry cells as soon as possible, and send it to the appropriate location. The purpose of it is to improve the operating efficiency of the device and reduce users' waiting time as much as possible. For the experimental device, using the collision switch can collect 100 times the time of the battery classification, the average of it is 0.53s in our experiment. For this reason, it can be controlled within 0.5s for those finish machining devices.

(2) Reliability refers to the device classify dry batteries correctly, and dry cells are in place during the transmission process. Dividing and locating dry battery wrongly are called wrong actions.

Its reliability can be evaluated by the rate of correct operation of the device. The calculation method is as follows:
During the experiment, the total number of actions was 200 times, and the correct operation rate was 98.5% due to environmental vibration and other reasons.

(3)Economy involves manufacturing costs, use-cost and benefits. The cost of manufacturing refers to the consumables and processing costs of the device. The use-cost refers to the power consumption of the equipment. The recycling efficiency refers to the value of the reused battery. Total amount of experimental equipment and processing costs is 1,500 yuan, taking into account the mass production can reduce costs, and manufacturing costs can be controlled within 500 yuan.

Summary

This paper mainly completed the following work:

(1)Mechanical design optimization of the product: for power, in order to ensure the precise transmission of the device, stepper motor was used as a power source. It could also eliminate the inertia of ordinary motor rotation; For transmission, using the belt drive and screw drive as a mechanical transmission program; For performance, timing belt and screw have characteristics of high efficiency, stability and high accuracy.

(2)Automatic control: Writing the power detection and motor control programs using 51 Single chip to realize the automatic control of the product.

(3)Physical model assembly of the product: After mechanical design, electrical control, drawing, three-dimensional modeling, physical processing, assembly and commissioning etc, we have finished prototype of the product;

(4)Test: The prototype was tested about its operation reliability and energy-saving effect. As for operational reliability, the correct device action rate was as high as 98.5%; for energy-saving effect detection, recycling a battery on average only needs 700J of electricity and it can recycle 1000J battery power, which saves up to 30% of the power and initially reached the expected design goals.

Improvement and Prospect

Product Improvement. (1)Extended Recycle Battery Type: The batteries can be further classified. For example, the battery can be divided into D size battery, AA battery, AAA battery and accumulator; it can also be divided into 30%, 30% to 50%, 50% to 80% according to its capacity. So as to facilitate the use of people on demand.

(2)Product noise reduction optimization: improve the sound of product action in the follow-up work.

(3)To improve product intelligence: Add power display or voice prompts to make it more intelligent and user-friendly.

(4)Environmental advocacy: use the main body of the recycling device for environmental protection and other aspects of publicity, thereby enhancing the use of dry battery recycling and product aesthetics.

Application Prospects. Using this device that can automatically sort dry batteries, the energy saving effect is obvious and the environmental protection efficiency is also high. In addition, the correct operation rate of the device is high, which can realize the automatic recovery of the dry battery. According to the experiment, this new device has a strong prospects for engineering practice and is environmentally friendly.

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