

Innovative Design based on TRIZ Evolution Route

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Abstract

Based on the laws of technical system evolution of TRIZ theory, we study on the evolution route of a kind of mechantronics product (plastic bottle recycling device), and conduct the innovation design of the device. Then, after the process of system scheme, working process and the overall structure design, we develop a new kind of environmental protection device which can set machinery, electronics, embedded system, wireless network and computer technology as a whole. The device is provided with the function of plastic bottle collecting, crushing, storage and reuse, also a reward system is equipped.

Keywords

TRIZ; Evolution Route; Plastic Bottle Recycling Device; Innovation Design.

1. Introduction

According to the China Packaging Federation, China produces about 3 million tons of plastic bottles every year and consumes about 18 million tons of oil. Polyethylene terephthalate used in plastic bottles is also the raw material of polyester staple fibers and filaments. The recycled waste plastic bottles can be made into chemical fibers and clothes after simple treatment. Discarded plastic bottles can also be treated as "plastic rice" for reuse. China has a large population, it consumes a lot of bottled water every day in cities, especially in densely populated areas and prosperous areas in cities, arbitrarily discarded plastic bottles can be seen everywhere. People with environmental awareness will throw waste plastic bottles into the dustbin, while people without this awareness will discard plastic bottles at will, polluting the surrounding environment and causing waste. Therefore, in order to reduce the environmental pollution caused by plastic bottles and encourage people to recycle plastic bottles, it is necessary to develop an environmental protection product with the function of recycling and processing plastic bottles, so as to benefit the society.

In this paper, the evolution route of plastic bottle recycling device is deeply studied by using the technical system evolution law in TRIZ theory, and an intelligent plastic bottle recycling environmental protection product with the functions of recycling, drying and incentive mechanism is successfully developed.

2. Product evolution law based on TRIZ

TRIZ theory (Theory of Inventive Problem Solving), that is, the theory of invention problem solving, is an invention and innovation method created by former Soviet inventor Genrich S. Altshuler and his invention team after decades of unremitting efforts on the basis of studying a large number of patented technologies. In TRIZ theory, product is regarded as a collection of things that can realize a certain function or function, that is, technical system; the technology system is constantly developing and changing. The development of products and technology always follows a certain objective law, at the same time, the technology system is also facing natural selection and the survival of the fittest. After long-term research, Altshuler and his partners summarized and abstracted the development law of technology system, put forward

the evolution theory of technology system, abstracted the evolution law into some axioms and expressed it in the form of evolution law, forming the famous eight evolution laws of technology system, which constitutes one of the core contents of TRIZ theory. In the classical TRIZ theory, the eight evolution rules of technology system are: the completeness law of technology system; Energy transfer law of technical system; Dynamic law of technical system; The law of improving ideality of technical system; Unbalanced evolution law of technical system subsystem; The law of evolution from technical system to supersystem; The evolution law of technology system to micro level; Coordinated evolution law of technical system.

In the product innovation design involved in this paper, the principle of improving ideality of technical system is used to study the evolution route of environmental protection product - plastic bottle recycling device. The law of improving the ideality of technical system refers to the evolution of technical system in the direction of improving the ideality of system. While a technical system realizes its functions, it must have two functions, namely useful functions and harmful functions. The ideality of a system is defined as the ratio of all useful functions to the sum of harmful functions and costs. The general direction of technical system improvement is to maximize the ideality ratio, which reflects the approximation of an actual technical system to an ideal system. In fact, the most ideal product or technology system (also known as ideal system) does not exist in practice. However, the final result of idealization is an effort direction of product design and a process of technological system evolution to the most ideal system. After continuous development, the technical system has experienced the continuous expansion of the system and the increasing number of subsystems. Then its technical system, subsystem and super system have entered the period of spiral development (expansion) and contraction (pruning). The final result is that the "new technology system" replaces the "old technology system" and completes a round of evolution process to improve the ideality. Applying this rule to the innovative design of plastic bottle recycling device can get a satisfactory solution. The evolution process of technology system is shown in Figure 1.

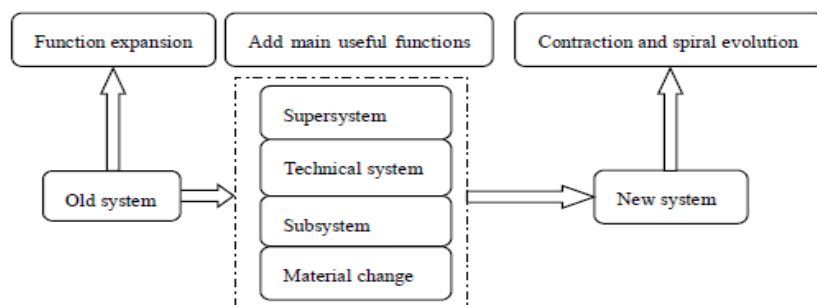


Fig. 1 Technological system evolution process

3. Evolution route of plastic bottle recycling device based on TRIZ evolution law

Since the emergence of plastic bottled water, at first, ordinary dustbins were mainly used to collect empty bottles. Plastic bottles were mixed with other garbage, which was not convenient for classification and recycling. People generally did not establish the concept of reuse; Later, an independent dustbin for collecting plastic bottles appeared. Its function is single and its structure is very simple, which is conducive to classified treatment. After plastic recycling, it is mainly landfill, which pollutes the environment; In recent years, some people began to study the special and multifunctional plastic bottle recycling box. This kind of recycling box not only has the function of recycling, but also has the function of directly treating plastic bottles into "plastic rice", which is convenient for the secondary utilization of plastics, and the ideal degree

of plastic bottle recycling box has been greatly improved. The plastic bottle recycling device studied in this paper is based on TRIZ evolution law, which further improves the recycling ideal, extends and optimizes the recycling and processing functions.

As shown in Figure 2, the evolution route to improve the ideality of the recycling box is to cut, divide and expand the system functions according to the principle of improving the ideality of the technical system, so as to expand it from single system to dual system, and then develop it into multi-system and multi-functional environmental protection products. The new generation of plastic bottle recycling box includes recycling, processing, online distribution information, reward and other functions, which can well encourage people to actively recycle plastic bottles and establish a good awareness of environmental protection.

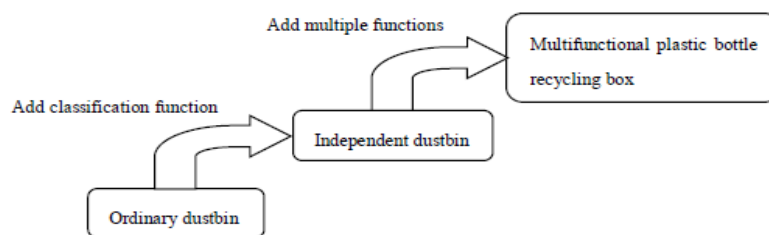


Fig. 2 Evolution route for improving the ideality of plastic bottle recycling device

4. Innovative design of plastic bottle recycling device

According to the above evolution route, the ideality of the designed products is improved, so that people are willing to put the used plastic bottles into the recycling box, which not only solves the recycling problem, but also achieves the purpose of on-site treatment. Based on this, by studying the original recycling devices such as garbage cans, this paper designs a multifunctional new environmental protection equipment with reward mechanism, which integrates machinery, electronics, embedded system, wireless network and computer server technology. The device is composed of mechanical crushing system, automatic control system and wireless network control system. The system design block diagram is shown in Figure 3 and the work flow is shown in Figure 4. After the used plastic bottles are put into the plastic bottle slide of the recycler, the arm control system is excited by the sensor, and the controller sends a signal to turn on the motor to drive the mechanical system. The tool components in the system crush, clean and dry the plastic bottles to achieve the purpose of collection, storage and reuse. At the same time, the user can get a certain reward through the automatic reward system on the recycler after putting in the plastic bottle. After the user inserts a special IC card into the recycler, the number of bottles and the amount of reward will be displayed on the touch screen of the recycler. The user only needs to follow the prompt, and the reward can be used later or donated. All submitted data is sent to the remote server for processing through the wireless network.

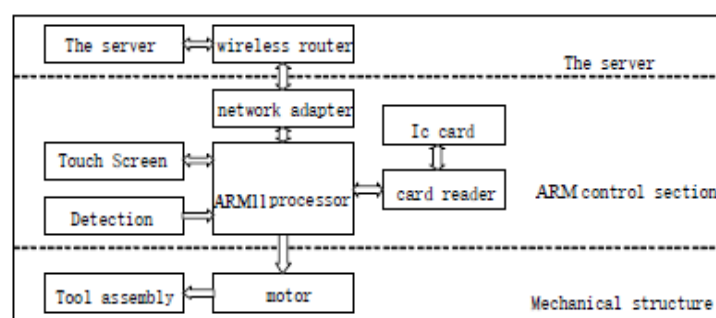


Fig. 3 System design block diagram of plastic bottle recycling device

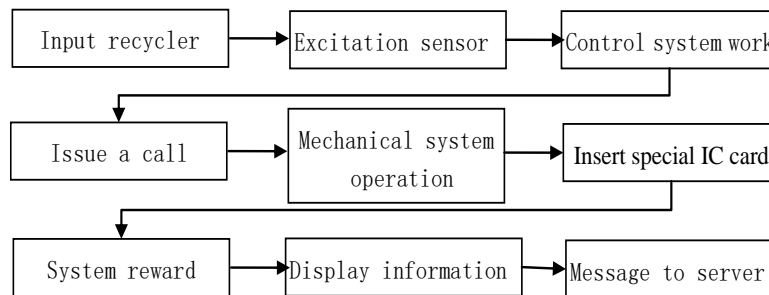
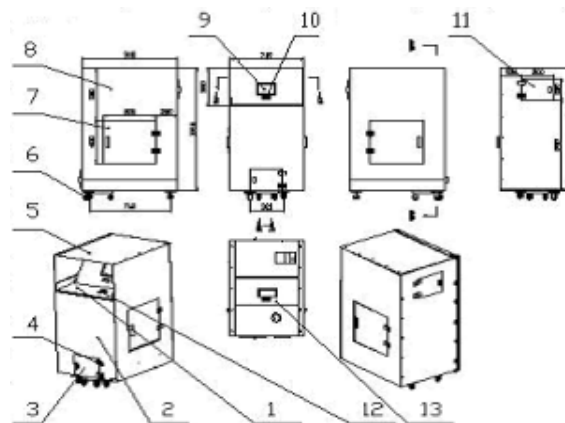


Fig. 4 Working flow of plastic bottle recycling device

5. Overall structure of plastic bottle recycling device

The mechanical structure of the recovery device is composed of motor, V-belt and cutting tool assembly. The motor is powered on to drive the V-belt to move, and then drive the belt pulley in the tool cutting assembly. The belt pulley drives the three high-speed steel sheet knife groups connected to the rotating shaft to rotate. The plastic bottle is broken through the shear force between the sheet knife and the fixed knife. The plastic bottle is processed into small pieces of plastic like scissors, and then cleaned and dried. Figure 5 shows the overall structure of the collector.



1. Upper roof 2. Front panel 3. Drawer door 4. Hinge 5. Upper panel 6. Wheel 7. Side door 8. Side panel 9. Touch screen 10. Card reading slot 11. Back door 12. Plastic bottle pipe 13. Waste bin

Fig. 5 Overall structure of plastic bottle recycling device

The appearance and internal basic structure of the plastic bottle intelligent recycling device are expressed through the view and three-dimensional diagram. The main parts are composed of 19 parts: upper roof, front panel, drawer door, hinge, upper panel, wheel, side door, side panel, touch screen, card reading slot, back door, plastic bottle pipe, waste bin, crushing cleaning and drying device, plastic bottle channel, V-belt, motor, electromagnetic relay and support bottom plate.

6. Conclusion

Following the technical system evolution law of TRIZ theory, this paper discusses the evolution route of the plastic bottle recycling device, and puts forward the design scheme of the recycling device. The prototype developed by this scheme has a good effect of on-site recycling and treatment of plastic bottles, and the treated plastic particles are very small, which is not only convenient for transportation, but also conducive to subsequent plastic recycling. In addition,

the recycling device strengthens user participation, autonomy and interest through the airborne reward interactive interface; Automatic processing of network information is used to realize the integration of recycling management and greatly reduce labor costs. At the same time, the recycling device equipped with reward mechanism strengthens the idea of waste classification, strengthens people's awareness of environmental protection, encourages people who consciously use the device, and provides new ideas for promoting waste recycling and designing and developing more corresponding innovative environmental protection products.

References

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