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Design of a new water-saving intelligent floor cleaner based on water circulation filtration system

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Abstract

In our life, mopping the floor and sweeping the floor are generally separate, we usually go to the first broom to clean up some sundries on the ground, and then through the mop for the second step of cleaning, which brings a lot of inconvenience to people, and will increase some corresponding costs. Based on an innovative water circulation system, this paper proposes a new water-saving floor cleaner design scheme. This cleaner can separate garbage when cleaning the ground. Liquid garbage goes into the sewage tank. At the same time, it also has the functions of self-cleaning and dust removal, which solves the problem of time-consuming and laborious traditional cleaning methods.

Keywords

Water recycling, Water-saving, Solid-liquid separation, Self-cleaning.

1. Introduction

With the development of the country and society, the living standard of modern people is constantly improving. Many young people have higher and higher requirements for the quality of the living environment. Healthy and energy-saving household appliances have become the focus of attention of many young people. This paper proposes a design scheme of a new water-saving intelligent floor cleaner based on the water circulation filtration system, which has several functions such as dust removal, mopping, cleaning, drying and garbage separation. Improve the cleaning efficiency and realize the maximum water saving. At the same time with a beautiful shape, more in line with the needs of modern life and social development needs.

The cleaning drum of the floor cleaner has a diameter of 60mm and a length of 280mm. The volume of the sewage tank and the cleaning tank is about 1100ml. The overall height of the cleaner is about 1.2m. The cleaner uses a mixture of diatomaceous earth and activated carbon to filter sewage to maximize the purification and reuse of sewage. In the experiment, the floor cleaner used 11mL clean water to clean the floor. The laboratory area was about 100m^2. During the mopping process, water circulation and sewage filtration were carried out at the same time. In contrast, it takes about 10L of water to clean the laboratory with the traditional mop, reducing the water consumption by about 10 times, which greatly improves the utilization efficiency of water and can effectively save water.

2. Product design

2.1. Design philosophy

The floor cleaner is based on the water circulation filtration system, through the operation of the driving wheel to drive the cleaning cylinder to wipe the ground, at the same time equipped with water supply system and water tank, cleaning the cleaning cylinder, and the use of diatomaceous earth and activated carbon mixture to filter sewage, can maximize the realization of sewage purification and reuse, can do "a clean to the end" when cleaning the floor. At the

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same time with the corresponding function of the vacuum cleaner, to realize the dry and wet garbage cleaning, from and perfect to clean the ground.

Through the water circulation filtration system, each filling of water can clean the floor of about 100 square meters, the water utilization rate is ten times that of the ordinary mop, greatly improving the household clean water use efficiency, promote the ecological environment protection. The floor cleaner designed in this paper adopts man-machine interaction, and sends signals to each device through the control unit to coordinate with each other to complete the floor cleaning work.

(1) Through three-dimensional modeling, a small water circulation filtration system is designed, and a water-saving intelligent floor cleaner with self-cleaning, solid-liquid waste separation, dust removal and other functions is designed.

(2) Intelligent control is adopted to design man-machine interaction function. The water yield is adjusted according to the dry humidity and the amount of stains on the ground, and the minimum water consumption is used to achieve the purpose of cleaning the ground.

(3) Send signals to each device through the control unit to coordinate and cooperate with each other to complete the cleaning work. The mechanical design of the floor cleaner includes the exterior shell, the wiping device, the transmission device, the cleaning device, the filtering device and the garbage collection device.

(4) The floor cleaner uses the mixture of diatomaceous earth and activated carbon to filter the sewage, which can maximize the purification and reuse of sewage, and can achieve "a clean to the end" when cleaning the floor; When cleaning the floor, the cleaner can separate the garbage, liquid garbage into the sewage tank, brush roller adhesion hair, dry garbage tank to collect other solid garbage, convenient for garbage classification, solid liquid separation, will not produce odor, and not easy to breed bacteria.

2.2. Shape design

The cleaning drum of the designed ground cleaner has a diameter of 60mm and a length of 280mm. The volume of the sewage tank and the cleaning tank is about 900ml. The overall height of the cleaner is about 1.2m.

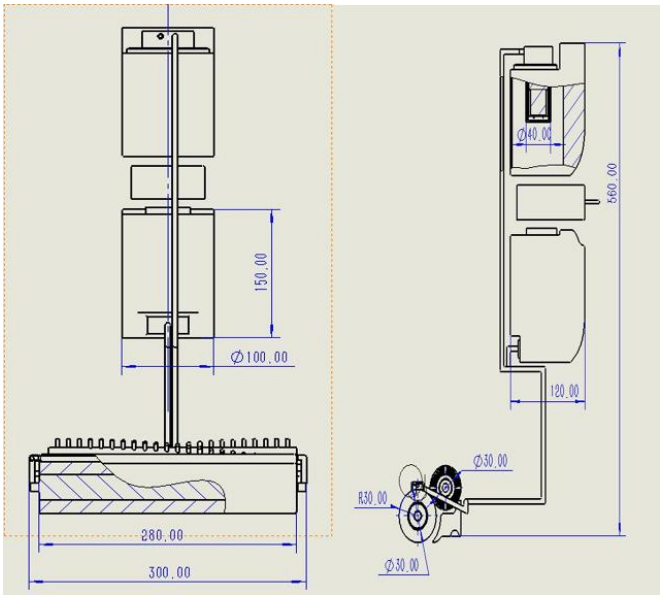

Figure 1 : Two-dimensional design drawing (left main view, right side view)

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Figure 2: Three-dimensional model

2.3. Parameter design

The main design parameters of cleaner are shown in Table 1:

Table 1: Cleaner main design parameters table

Parameter name	Cleaner height	Cleaning drum diameter	Cleaning drum length	Volume of sewage tank and cleaning tank	Cleaning water consumption	Screen size/mesh number
Parameter values	1.2m	60mm	280mm	1100ml each	100/m2	45um/325

2.4. Introduction by modules

2.4.1. Mechanical structure

The mechanical part is divided into the appearance shell, the wiping device, the cleaning device, the transmission device and the garbage collection device.

The overall mechanical structure composition of the cleaner is shown in FIG. 4, where the right picture is the explosion view.

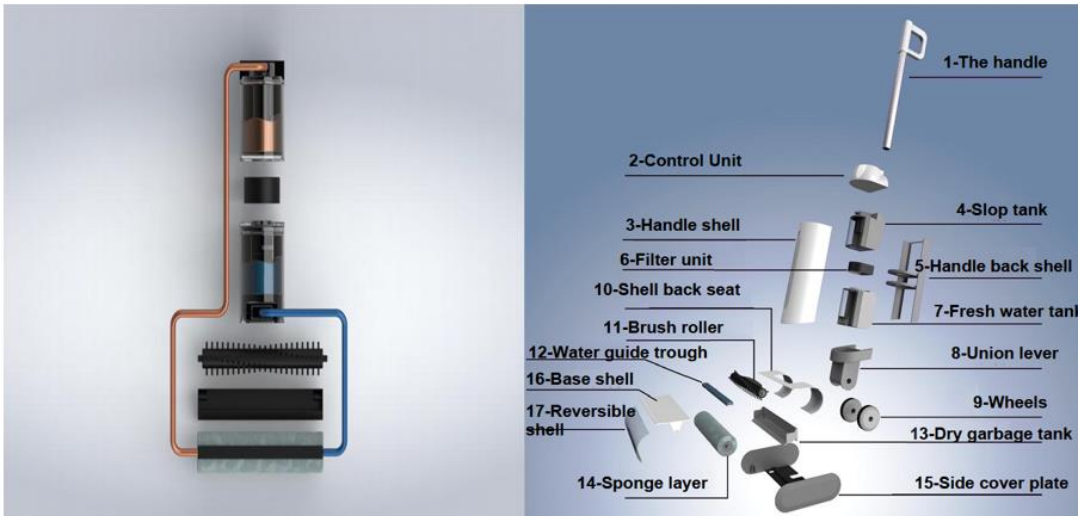

Figure 3: Mechanical structure disassembly drawing

(1) Exterior shell

The exterior shell of the cleaner is divided into two parts, the base and the handle, which can be connected by an adapter mechanism. The base includes a reversible shell, a base shell, a side cover plate and a base rear shell. The reversible shell is installed above the base shell and can be flipped open relative to the base shell. The rear shell of the base is installed on the rear

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underside of the base shell, and the side cover plate is covered on both sides of the base shell. The handle includes a handle part and a body part. The handle part comprises a handle shell and a handle rear shell, and the fuselage part comprises an upper fuselage shell and a rear fuselage shell. Among them, the handle part is installed on the fuselage part, and the fuselage part is connected with the base through the adapter mechanism, so as to realize the connection between the handle and the base.

(2) Wiping device

The wiping device is composed of a rotating shaft and a sponge layer coated on the rotating shaft. The composition of sponge layer and water absorption will be introduced in the third part of the innovation. The 3D model of the wiping device is shown in Figure 4.

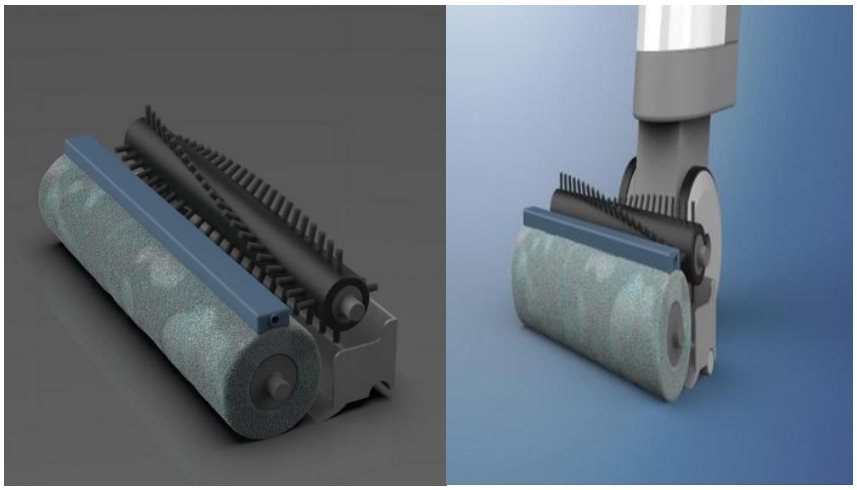

Figure 5: The 3D model of the wiping device

(3) Cleaning device

The cleaning device is composed of two parts: a water circulation guide tank and a brush roller. The brush roller comprises a rotating body and a cleaning piece arranged in a spiral shape on the rotating body. The cleaning piece is a brush or a tooth, which will rotate with the rotating body, and the gap between adjacent cleaning pieces has a smaller size than the dry garbage, so that the dry garbage on the sponge layer can be cleaned out at the same time, so as to ensure that there is no dry garbage residue in the water circulation guide tank after use. The water circulation guide tank includes a covering drum cover parallel to the axial direction of the sponge layer and an internal water extrusion device. The cover of the covering drum is inverted on the sponge layer, and the place where the cover is in direct contact with the sponge layer is kept sealed. In order to achieve sealing, the device adopts a seal that is locked by a screw, and the seal is placed behind the water extrusion, that is, the sponge tube first moves to the seal, and then moves to the water extrusion. The sealing part and the water extrusion part are respectively used as the sealing structure of the sink and the sponge tube. Figure 7 shows the structure diagram of the cleaning device:

(4) Transmission device

The transmission device is composed of two sets of motors inside the sponge cylinder and the brush drum, a water pump with the function of pumping sewage, a water pump with the function of pumping clean water and a slender pipe connected between them.

(5) Garbage collection device

The garbage collection device comprises a dry garbage tank and a sewage tank. A dry garbage tank is designed at the rotating shaft of the wiping device. The garbage collection device includes a guiding surface that can be close to the ground and close to the sponge layer of the wiping device. The rotating sponge layer of the wiping device drives the garbage into the garbage collection device along the guiding surface through friction. The sewage tank is

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connected with a water pump through a water pipe, and the water pump pumps the sewage in the sponge layer into the sewage tank.

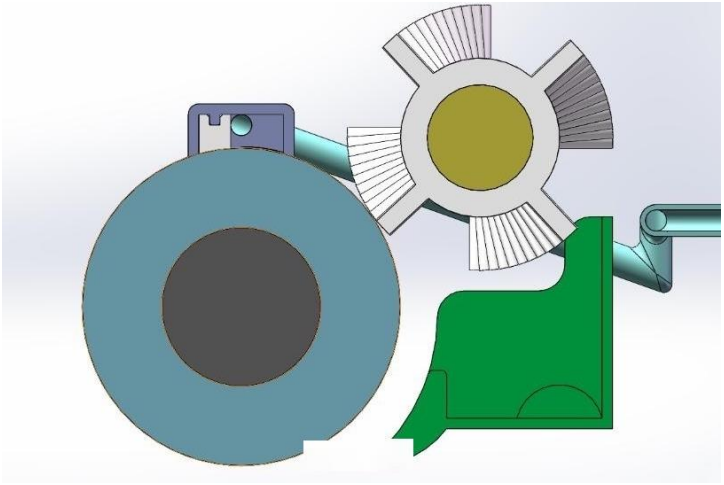

Figure 6: The structure of the cleaning device

2.4.2. Control system

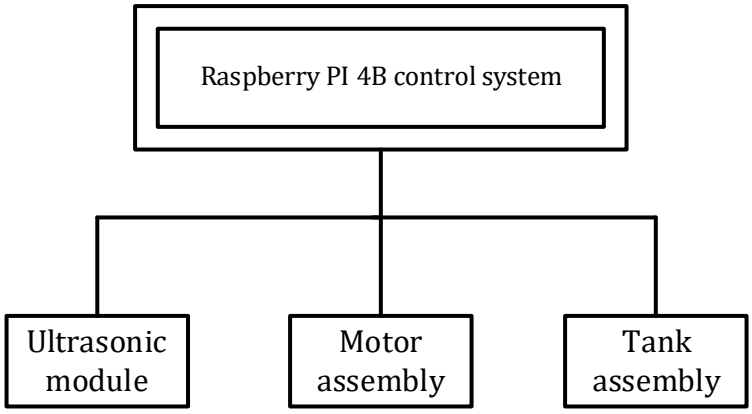

Figure 7: Control system composition

(1) Control unit: Raspberry PI 4B is used as the main control chip to output corresponding control signals according to ultrasonic detection signals, such as the operation and stop of cleaning mechanism and the start and stop of water supply mechanism, so as to realize human-computer interaction.

(2) The ultrasonic detection component is used to detect the degree of dryness and wetness of the ground in the environment around the floor cleaner, the amount of stains, etc., and form ultrasonic detection signals.

(3) Drive wheel drive assembly, used for control signals according to the control signal to drive the left wheel and right wheel of the floor cleaner to work, so as to make the floor cleaner move, and the floor cleaner travel speed is sent to the main control chip for the main control chip to adjust the control signal.

(4) Tank control assembly for water supply according to the control signal to carry out the washing mode of the floor cleaner.

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3. Innovation points

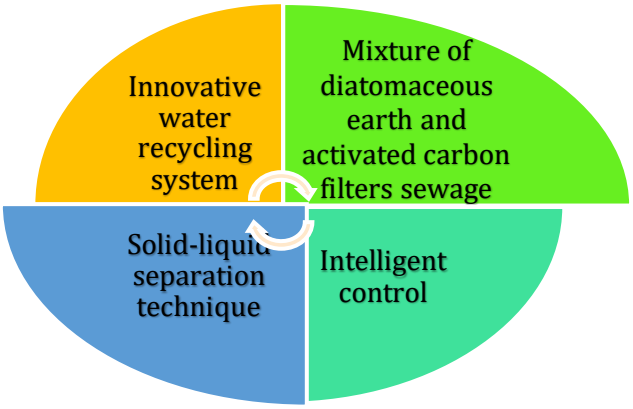

Figure 8 : Innovation points

(1) Innovative water recycling system

This design adopts an innovative water recycling system to improve the efficiency of water utilization. Sewage from one end of the water circulation guide tank into the sewage tank, through the filter device into reusable water, and then injected into the other end of the guide tank, flow into the clean water tank, composed of a complete water circulation system, when cleaning the floor to achieve the secondary use of water, so as to achieve "clean to the end".

(2) Mixture of diatomaceous earth and activated carbon filters sewage

This design uses the mixture of diatomaceous earth and activated carbon to filter sewage and make secondary utilization of sewage wastewater, improve the utilization efficiency of water, provide some possible references for the reuse of water resources, and step on a new journey on the road of sustainable development.

(3) Solid-liquid separation technique

This design can separate garbage when cleaning the ground, liquid garbage into the sewage tank, brush roller adhesion hair, dry garbage tank to collect other solid garbage.

The sponge cylinder used in this design includes an inner sponge layer and an outer sponge layer. The inner sponge layer is made of non-absorbent sponge, and the outer sponge layer is made of absorbent sponge. This kind of sponge cylinder can be increased to a great thickness, so as to improve the cleaning capacity of the cleaner, but its absorbent part is mainly the outer sponge layer, so it does not need to apply too much extrusion water to complete the water squeezing, will not cause too much resistance to the sponge cylinder, to avoid excess energy loss.

(4)Intelligent control

The cleaner can intelligently detect the dryness of the environment around the ground cleaner, generate the corresponding signal into the Raspberry PI 4B master control chip, and output the corresponding control signal, control the operation and stop of the cleaning mechanism, open and stop of the water supply mechanism, and control the water supply of the water tank according to the control signal, and control the water output according to the remaining water in the water tank to form a closed-loop control.

4. Conclusion

This water-saving floor cleaner greatly reduces the time needed to clean the floor each time with the integration of washing and dragging. At the same time, through the innovative water circulation system and special cleaning mechanism, it realizes the maximum water saving and

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ensures the cleaning effect. Taking 8.2 million households in Beijing as an example, the average household needs about 100 liters of water to clean the floor every week. If the cleaner is used, the water consumption can be saved by 90%, that is, 738,000 tons of water can be saved by households in Beijing every week. The average household uses about 430 liters of water a day, so it can be seen that using this cleaner can save a lot of water resources, which is of great significance for ecological environmental protection and sustainable development.

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