System Design of Solar Maglev Smart Home Flowerpot

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Abstract—Aiming at the disadvantages of artificial culture and potted plants in traditional home life, the maintenance of scientific intelligence is realized, and a solar magnetic levitation intelligent home flowerpot system is designed. STC89C52 single chip microcomputer as the main core hardware, through the alarm module to provide alarm information, through the device design and program control, to achieve automatic watering and provide light, in addition, the magnetic levitation device to control the inner pot of the flower pot in the state of suspension balance. By experiment, the simulation of smart home flowerpot system based on single chip microcomputer STC89C52 single chip microcomputer is running well, and the intelligent home flowerpot can realize the effect of replenishing water, light and magnetic levitation through system setting.

1. INTRODUCTION

In the new era environment, with the rapid development of science and technology, the concept of smart home is gradually becoming a reality, smart home products are also coming into people's lives [1]. With the continuous improvement of people's quality of life, people have higher and higher requirements for the living environment and indoor air quality. Many people will optimize the environment and improve the indoor decoration effect by raising potted plants indoors. However, due to the accelerated pace of life, people often have no time to take care of and take care of these indoor potted plants, which often cause plants to wither due to lack of nutrients [2]. In addition, the shape, structure and function of flowerpots of cultured green plants in existing home life are relatively simple, the decorative effect is poor, and it is easy to be corroded for a long time. Therefore, it is very necessary to develop an intelligent flowerpot which can facilitate people's home life and achieve scientific maintenance of green plants. The concept of smart home flowerpot arises at the historic moment.

In recent years, there has been an upsurge of research on smart home flowerpots at home and abroad, and there are many smart home flowerpots with different control principles and functions on the market, all of which are for scientific breeding of green plants and more convenient for people's home life. In foreign countries, Pret a Pousser, a French R & D team, has developed a smart flowerpot called "Lilo". When in use, the flowerpot is electrified, and the upper part of the flowerpot is equipped with LED lights to provide plants with the best spectrum to adapt to growth by adjusting light intensity [3]. In China, Beijing Tongda Technology Company has designed a smart flowerpot called "JUST GROW", which is equipped with red and green lights. When the red light is always on, it indicates that it needs watering. In this regard, this paper mainly aims at the system implementation research and design of solar magnetic levitation intelligent home flowerpot, adhering to the concept of green environmental
protection, not only can beautify the indoor environment and purify the air, but also achieve the purpose of scientific and intelligent maintenance.

2. SYSTEM OVERALL DESIGN
The solar magnetic levitation intelligent home flowerpot system mainly includes five modules, which are solar power storage module, detection module, control module, execution module and alarm module [4]. The solar energy storage module is composed of crystal silicon, and the detection module includes SHT10 temperature and humidity sensor, BH1750FVI light sensor and YZC-161B weighing sensor; the control module is mainly controlled by single-chip microcomputer, the specific type is STC89C52 single-chip microcomputer; the execution module includes water replenishment device, lighting device and magnetic levitation device; the alarm module is essentially a buzzer, the main function is to provide alarm information, convenient control of water replenishment and lighting and so on. This makes the design more convenient, reasonable and intelligent, as shown in figure 1.

![System Design of Solar Magnetic Intelligent Home Flowerpot System](image)

**Figure 1 Distribution of modules**

3. HARDWARE DESIGN

3.1 Solar energy storage modules
In this system, the solar energy storage module mainly absorbs sunlight and converts it into electricity through the solar panel, and then supplies power through the power supply circuit, but the components used in the system need a stable power supply with a voltage of 12V. The flyback switching power supply is used to convert the voltage from 220V to 12V.

3.2 Detection module
The temperature and humidity sensor used in the detection module of the system is the SHT10 temperature and humidity sensor through COMS micromachining technology. It is a kind of temperature and humidity compound sensor with calibrated digital signal output. This kind of sensor has long stability and high reliability [5]. In the process of use, we need to put the temperature and humidity sensor in the airbag for a long time, so the humidity may be very high, which requires good performance and excellent stability, ultra-low energy consumption and long-time monitoring. High energy consumption may lead to damage to the whole system. After careful selection, the SHT10 type temperature and humidity sensor meets the required conditions, with small size, low power consumption, strong anti-interference ability and high performance-to-price ratio, so it is one of the most suitable sensors to be used in more complex environments [6].

The detection of light intensity mainly takes the BH1750FVI light sensor as the sensing component. In the process of working, by setting the normal solar light intensity, that is, 1000Lux as the minimum
light intensity, and feedback the detected light intensity value to the single-chip microcomputer STC89C52, and then through the relay to control the lighting device, that is, the LED lamp is turned off, so as to provide light for plants.

In the process of planting potted plants, it is necessary to measure the total weight of the outer pot and the potted plants to ensure that the maglev device can achieve the levitation effect. When in use, through the input connection with the buzzer, when the weight limit is exceeded, the alarm will sound.

Here we choose the strain gauge type YZC-161B E-type weighing sensor, this kind of sensor is very convenient to use and install, and has the advantages of low power, large detection range, small error and so on [7]. The inner part of the sensor is 1000 European half-bridge strain gauge, and its measuring range is 50kg, which is mainly installed at the bottom of the flowerpot base to achieve uniform force.

3.3 Control module
In the design of the system, the control module mainly uses the STC89C52 single chip microcomputer as the key component of the whole system operation of the solar electromagnetic levitation intelligent home flowerpot. The whole system is based on the solar energy storage module to obtain electric energy. If the solar energy storage module is difficult to meet the power needs of the flowerpot, the flowerpot needs to obtain electricity through external USB holes. And the water replenishment device and lighting device in the working process mainly through the corresponding design and software system to replenish water and light the plants in the flowerpot. In addition, the design of solar magnetic levitation intelligent home flowerpot effectively introduces the mechanical structure design and control circuit design, gives full play to the advantages of modern science and technology, uses the internal STC89C52 single-chip microcomputer to effectively coordinate each branch module, and realizes the automatic control and adjustment of flowerpot moisture and environmental lighting.

3.4 Execution module
The water replenishing device included in the executive module of the system design is mainly composed of motor, water ring, wave wheel and water pipe, etc. The water filling process is mainly through the water pipe interface to store water in the water ring, and the starting motor will automatically replenish the flowerpot through the outlet pipe, as shown in figure 2 below.

In addition, the lighting device is essentially the use of plant growth lights to replace the role of sunlight [8], by installing LED lights suitable for the spectrum of plants, on the one hand, it can promote its growth and prevent long-term exposure to plants, on the other hand, it can also carry out any household layout to facilitate maintenance.

In order to realize the suspension function of the intelligent home flowerpot, the magnetic levitation technology is mainly applied, that is, the corresponding magnetic levitation device is designed. the specific arrangement is that the corresponding annular magnet layer is arranged in the edge area of the outer basin, and this part is the upper annular magnet layer. there is also a lower annular magnet layer, which is mainly arranged on the base, and the bottom magnet layer is arranged in the bottom area of the flowerpot in a cross shape, and there are four electromagnets.

Each electromagnet will set the Hall sensor inside, and its specific working principle is that the position signal of the magnetic levitation will be transmitted to the Hall sensor, and the circuit inside the flowerpot will be adjusted based on the change of the signal. If the internal electromagnet drive circuit is triggered, the external magnetic field can be effectively adjusted to ensure that the flowerpot will not be disturbed and balanced in the maglev state.

4. Software design
The software design of the system is realized on the basis of hardware design. In the working process, the temperature and humidity sensor, the light sensor and the weighing sensor in the detection module feed back the information to the buzzer, and then the alarm information is fed back to the single-chip microcomputer control module [9] through the buzzer. Thus the single-chip microcomputer control module can control the lighting device to supplement the light, and the water replenishment device can
automatically replenish water and so on. In essence, it is the automatic replenishment of nutrients, and the main control process of the system is shown in figure 3.

Figure 1. System flowchart

5. STRUCTURE DESIGN AND MATERIAL SELECTION OF SMART HOME FLOWERPOTS

5.1 Structural design of smart home flowerpots
The smart home flowerpot is mainly composed of three parts, namely, the base, the outer basin and the inner pot [10]. The specific structure is shown in figures 3 and 4. The magnetic levitation technology is fully applied in the three parts, so as to ensure that the plant can be suspended in the air, at the same time, the solar energy storage module is connected to provide electricity for the intelligent flowerpot, and an intelligent system is set up in the flowerpot to complete the watering and lighting functions of the plant in the flowerpot.

Figure 3. Main view                       Figure 4. Overview

(1- Plug; 2- Solar panels; 3- Base; 4- Outer basin; 5- The inner basin; 6- Illumination devices; 7- Replenishment plant; 8- Leakage holes; 9- Upper ring magnet layer; 10- Drain; 11- Display screen; 12- USB interface; 13- Lower ring magnet layer; 14- Sealing rings)
5.2 Selection of pots for smart home flowerpots
The body of the smart home flowerpot needs to be isolated with the corresponding material. When selecting the material, the selection should be made according to the application function of the intelligent home flowerpot. First of all, the flowerpot needs to be in contact with water, so it needs certain anti-aging ability and waterproof ability. PVC material [11] can be used for this. This material can effectively meet the material requirements of various functions of the intelligent flowerpot. First of all, PVC material itself has a certain anti-pressure ability. Compared with conventional materials, its compressive strength can be far more than several times. The specific material properties are shown in the table below:

TABLE I. PVC MATERIAL PERFORMANCE ANALYSIS TABLE

| Parameters            | Units   | Value  |
|-----------------------|---------|--------|
| ρ density             | kg/m³   | 1380   |
| E of elastic modulus  | MPa     | 2900-3400 |
| σ tensile strength    | MPa     | 50-80  |
| mp of melting point   | K       | 212    |
| λ thermal conductivity| W/m·K   | 0.16   |
| a of thermal expansion coefficient | 10-5/K | 8 |

5.3 Pot bottom selection for smart home flowerpots
The bottom of the solar electromagnetic levitation intelligent home flowerpot should have the following properties, which are non-toxic, superior mechanical properties and environmental protection. Based on these three requirements, this design chooses polypropylene material to make the basin bottom, which is a colorless and translucent solid material, which is non-toxic and tasteless. From the point of view of material structure, it has effective corrosion resistance and heat resistance. At the same time, when using steam to disinfect, the material did not have any adverse performance reaction. Its own excellent performance in scratch resistance and strength, will not appear the conventional stress cracking phenomenon. At the same time, polypropylene material has excellent bending resistance in practical application, can reach hundreds of bends at room temperature and will not be damaged, and has very excellent chemical properties. In addition to being difficult to resist the erosion of concentrated nitric acid and concentrated sulfuric acid, other related chemical reagents are difficult to cause damage to it, so it can give full play to the advantages and functions of polypropylene materials when designing the bottom of flowerpots.

6. CONCLUSIONS
To sum up, the design of solar magnetic levitation intelligent home flowerpot fully introduces magnetic levitation technology, solar power generation technology and intelligent technology, through the combination of the three technologies, ensure that the flowerpot can achieve intelligent operation, air levitation and solar charging functions. The design flowerpot should be set up for attention in practical application [12]. First, it is necessary to ensure the power connection between the solar energy storage module and the flowerpot. The maglev flowerpot mainly relies on solar energy to provide electric energy, so as to float and rotate. Second, the base of the flowerpot must be placed in a flat place to avoid the offset of the potted plants suspended in the air, resulting in reduced suspension effect. Third, avoid placing electronic devices with magnetic interference next to the magnetic levitation intelligent flowerpot as far as possible to ensure the stability of the magnetic levitation function of the flowerpot. At the same time, based on the functional requirements of solar electromagnetic levitation intelligent home flowerpots, appropriate materials are selected to ensure corrosion resistance and wear resistance in the practical application of solar electromagnetic levitation intelligent home flowerpots. And based on the intelligent system to achieve the automatic operation of various functions, and through the
appearance of the beautification design to add a touch of beautiful scenery to people's indoor environment to meet people's needs for living environment. In the process of future development, the design of solar magnetic levitation intelligent home flowerpot will have a good market application prospect through continuous optimization and improvement.

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