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Multi-functional AI Rental Plant Keeper

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Abstract *— There has been a drip irrigation automatic watering system on the market.However, it is impossible to control the illumination, temperature and humidity of plants at the same time, and it is not suitable for modern small-sized homes.The purpose of the device is to overcome the defects of high cost and low intelligence of the prior art, and is a public rental flower cabinet capable of personalizing the flower growing environment and satisfying people's individual requirements.The device is not only highly automated and intelligent, requires no supervision, low cost, wide applicability, easy to use, and uses public rental for all users who need temporary care flowers, and has profound and lasting application prospects.Moreover, large data processing can be performed based on the cultivation parameters uploaded by the user, and various types of flower planting schemes are continuously improved. Data can also be provided to the development of plant health status recognition functions based on artificial intelligence.*

Keywords — *Home automation；Flower intelligent management；Intelligent temperature&humidity control ；Artificial intelligence interface call；Machine leaning；Recognition and classification*

I. INTRODUCTION

With the improvement of the lives of contemporary people, raising a variety of potted plants has become a hobby of urban residents. Potted plants are welcomed by urban people because they can add color to the home, purify the air and other advantages. However, urban people need to face heavy work pressure, do not have the time and energy to manage potted plants, expensive from extremely fragile plants are easy to die, and from time to time often fertilization is also prone to yellowing, plant appearance and many other problems. Therefore, how to reduce the trouble of urban residents growing flowers has become the focus of this study. In addition, plant phenotypes are diverse, which can identify plant species by identifying leaves and petals, and analyze the effects of genotypes and environmental factors on interaction (genotype-by-environment interactions) and stress resistance of plants of the same species. With the deepening of the project, as a container for plant cultivation, it can provide a source of data sets for plant phenotypic research based on deep learning.

After searching the literature and market research, it is found that at present, the intelligent breeding machines for flowers and plants are mainly divided into three types: drip irrigation automatic flower watering machine in figure 1, figure 2 and figure 3, "greenhouse" and cabinet home intelligent planting machine. Drip irrigation automatic flower watering system can not control the light, temperature and humidity of plants, but is only used for the water supply of flowers. "greenhouse" can plant seasonal plants in a large area. However, it is lack of electronic control system and can not adjust the wet temperature. And the "greenhouse" covers a large area, which is suitable for the integrated planting of vegetables in a large area, but not suitable for small families. The existing cabinet-type family intelligent planting machine for managing small vegetables has a narrow internal space, which is only suitable for small plants, can only keep vegetables fresh or can be used for ornamental for a short time by controlling light and humidity, and can not really cultivate plants. and its price is high, the cost is high, the degree of intelligence is not high, it still needs human intervention.

Therefore, it is of great practical significance to develop a kind of public rental flower cabinet with low cost, high intelligence and can breed different kinds of flowers.

Fig. 1 Epiphyllum

Fig. 2 Dying flower

Fig. 3 High-temperature dying Dendrobium candidum

The rental cabinet scheme is adopted, the cost of the device is originally borne by the user and transferred to the business, and the user only needs to pay the cost of flower care; the flower cabinet is placed in the community and the campus does not need to occupy family and indoor space. The image information obtained by RaspiBerry wide-angle camera is sent to Baidu artificial intelligence server through the Internet for identification, the information of flower varieties is sent back and the breeding scheme is matched through the server. Get the real-time image information of flowers, which is used to send back to the client for users to know the flowers in real time. Using non-heating blue LED lamp and red LED lamp as lighting

tools, the safety is good, the light intensity is stable, and it is easy to adjust. The device can not only control the switch of LED lights, but also adjust the light and shade of red and blue LED lights to modulate the most suitable spectral color for flowers. Blue LED light and red LED light are selected because the absorption peak of plant chlorophyll, mainly in the range of 400~520nm and 610~720nm, the use of red and blue light can significantly reduce energy consumption and improve efficiency. Through the cooperation of the camera and the control module, we can intelligently adjust the distance between the lighting lamp and the flowers, and at the same time, we can also adjust the light intensity of the bright lamp to maximize the utilization of light. A soil moisture sensor is used to control the amount of water in drip irrigation in real time to avoid rotting roots of plants and waste of water resources.

II. SYSTEMS COMPOSITION

A. General structure

The principle of the intelligent leased universal planting cabinet is shown in figure 5, including the flower cabinet frame and the photo identification module installed on the flower cabinet frame, lighting module, watering module, data acquisition module, humidity control module, temperature control module and control module.

The cloud includes a database module for storing the optimal growth conditions of various flowers, including light intensity, environmental humidity, soil moisture and ambient temperature, and the database module is connected with the control module; the photo identification module is used to identify the varieties of flowers to be supervised after taking pictures of flowers to be supervised. The data acquisition module is used to collect the growth data of flowers to be regulated in the flower cabinet, including light intensity, environmental humidity, soil moisture and environmental temperature. The control module is used to obtain the best growth conditions of the flower in the database module according to the flower variety identified by the photo identification module, and according to this condition, the lighting module, watering module, humidity control module and temperature control module are controlled to make the flowers to be supervised in the best growth condition; the lighting module is used to receive the lighting instructions issued by the control module to illuminate the supervised flowers. The watering module is used to accept the watering instructions issued by the control module to water the soil; the humidity control module is used to accept the humidification instructions issued by the control module to humidify the environment in the flower cabinet; the temperature control module is used to accept the temperature control instructions issued by the control module to control the environment temperature in the flower cabinet.

The device uses AI photo recognition technology to identify the flower species after taking photos, and then transfers the best growth conditions of the flowers from the server. The control module controls the lighting module, watering module, humidity control module and temperature control module according to the optimal growth conditions to make the flowers to be supervised in the best growth conditions.

B. Mechanical structure

The opening and closing door of the electromagnet is composed of 1 for the door handle, 2 for the electromagnet matching metal sheet, and 3 for the electromagnet. The opening and closing door of the electromagnet is always powered on without any operation. The user can send the open door signal to the processor of the flower cabinet through the intelligent terminal, and the signal is transmitted to the processor through the HC-05 Bluetooth sensor. After receiving the open door signal, the processor sends a power break signal to the electromagnet. After receiving the signal, the electromagnet is cut off for a short time, and the electromagnet loses its magnetism, thus completing the operation of opening the cabinet door. On the contrary, when the user sends out the signal of closing the cabinet door, the electromagnet generates magnetic force when the electromagnet is electrified, and when the metal sheet is close to the electromagnet, the electromagnet firmly absorbs it, thus completing the operation of closing the cabinet door.

4 is the driving structure of the screw stepper motor, which is located in the background part at the back of each flower box, and the power supply is placed in the background part above the flower box to be connected with the screw stepper motor. The screw stepper motor is fixed with the platform through the screw support so that the platform moves only in the vertical direction. The screw part of the screw stepper motor is covered with a screw protection cover to achieve the role of anti-rust. Among them, the platform can be adjusted by the user. After the user puts the flower into the flower cabinet, the lifting platform is adjusted by APP to achieve the best light absorption, and the signal of the lifting platform is transmitted to the ATMEGA328 processor through the HC-05 Bluetooth sensor. After receiving the signal, the ATMEGA328 processor sends a forward / reverse signal to the stepper motor, and the stepper motor receives the signal and drives the screw to rotate through the dynamic coupling, so that the lighting platform can complete the lifting operation.

The lighting platform is composed of 5-year light platform, 6 red LED lights and 7 blue LED lights. Using RaspiBerry wide-angle camera to obtain flower image information through the Internet sent to Baidu artificial intelligence server for identification, send back the information of flower varieties and match the lighting scheme through the server. The most suitable absorption spectrum of flowers is modulated by the basic principle of pulse width modulation ((PWM)), and the signal of the color scheme is transmitted to the processor through the HC-05 Bluetooth sensor. after receiving the light, the processor sends signals to the red LED light and the blue LED light respectively, and the lamp illuminates the light of the specified spectrum.

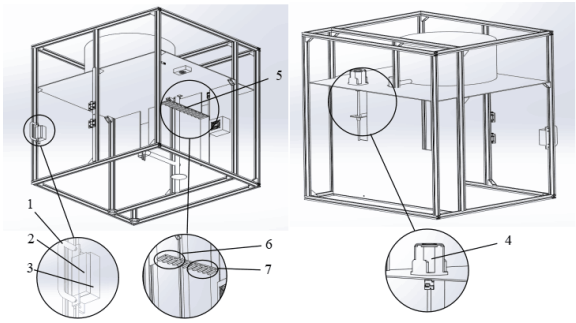
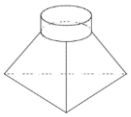


Fig. 4 Device schematic diagram

As the device is designed as a box, it can be designed in the shape of the following lampshade (material aluminum).

(a) Circular shape **(b) Moment shape**



(c) Triangular shape

Fig. 5 various schemes for the shape of the mask

In order to expand the range of light as much as possible, choose a circular lampshade.

The angle between the horizontal plane is confirmed:

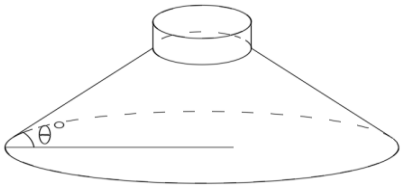


Fig. 6 Angle intuitive diagram

The side plate and the horizontal plane have the same inclination angle θ (0 °~ 90 °).

Then the light coverage S = Ω × [(1 / tan θ) + 0.1] 2m2.

Suppose the lamp source is at the height of 1.0m at the highest position, and the area of the bottom space is 1.44m2. If the illumination range is limited to the interior of the box, the value range of θ is 60 °~ 90 °according to the formula.

In the course of the experiment, we looked up the data and found that the larger the tilt angle θ, the more obvious the focusing effect. When the tilt angle of the side plate is 60 °lampshade, it has 40% focusing effect. The effect of lampshade is obvious.

Therefore, the side plate tilt angle is 60 °circular lampshade.

Assuming that the lamp strip is installed at the height of 0.8 to 1.0m, it is now calculated whether it is reasonable:
Illuminance of lamps and lanterns (lux lx) = luminous flux (lumen lm) / area (square meters).

According to the formula, when calculating the average illuminance of the floor surface of the ecological box, in the case of the overall lighting fixture, the following formula can be used to calculate.

Average illuminance (Eav) = luminous flux of a single luminaire × number of lamps and lanterns (N) x space utilization factor (CU) × maintenance factor (K) / floor area (length × width).

a) Downlight lamps and lanterns are used in a space of about 2 meters, and the space utilization coefficient CU is 0.4-0.55, then we can take 0.4.

b) generally cleaner places, such as living rooms, bedrooms and other maintenance factor K is 0.8, then we can take 0.8.

c) if the bottom of the device is 1.8m / 1.6m, the bottom area is 2.88m2.

Calculation formula: average illuminance = total light flux of light source × CU × K / area.
= (2500 × 3 × 16) × 0.4 × 0.8 / 2.88.
= 13333.33Lux.

At the same time, the lampshade is added, and the lampshade has a 40% focusing effect.
Actual illuminance = average illuminance × 40%.
= 13333.33 × 40%.
= 18666.67Lux.

Conclusion: the average illumination is above 18000Lux, which is enough to meet the light needs of common potted plants. Therefore, the position of the lamp strip is reasonable.

C. Electronic control component structure

The temperature control part includes a semiconductor chip, a radiator and an H bridge. Both sides of the semiconductor sheet are connected with a radiator. The H-bridge drive circuit can change the current direction of the circuit to control the cooling or heating of the semiconductor wafer. The semiconductor sheet is connected with the control module. The advantages of using semiconductor chip to control temperature are low cost, simple structure and high temperature control precision.

The humidity adjustment module includes an atomizer for atomizing water, an exhaust fan and an exhaust pipe connected to the outside. The exhaust direction of the exhaust fan is from the inside to the outside, and the exhaust fan is connected with the control module. When the ambient humidity is small, the control module will open the atomizer assembly and begin to humidify; when the ambient humidity is high, the control module will turn on the exhaust fan to reduce the ambient humidity.

The lighting device and the stepper motor are connected with the control module. Controlling the stepper motor can accurately adjust the lifting stroke of the lighting platform to achieve the optimal distance of plant absorption efficiency.

When the soil moisture sensor detects that the humidity is less than the preset value, the pump begins to pump water from the tank and the water intake is controlled by the preset value. Therefore, this real-time controlled drip irrigation

method can avoid plant root rot and waste of water resources.

The main controller is an important part of flower cultivation. It can collect all the information about flowers and flower cabinets and establish communication with users. The design of the electronic control module allows users to input data on the mobile phone to adjust the management of flowers. Therefore, according to the planned functional requirements, the processor selected in the electronic control system is ATMEGA328. It can be used as a communication module to communicate with clouds and intelligent terminals. Smart terminals are mobile phones or computers, through which the actual growing environment of flowers can be adjusted in real time. Through the intelligent terminal, users can not only observe the growth of flowers in real time, but also set the actual growth environment of flowers.

III. WORKING PRINCIPLE

The device has the advantages of simple structure and convenient operation, and can be operated according to the workflow shown in the figure: after the flower plant is placed, the user first confirms the flower variety information or fills in the information by himself through APP, then sets the culture parameters (including temperature and humidity environment in different periods, sunshine duration, watering water and interval parameters), then confirms the filling status of each parameter twice, and finally sets the foster care time. After completing each parameter, enter the payment interface and finish the payment.

IV. A RESEARCH SCHEME OF PLANT PHENOTYOE BASED ON DEEP LEARNING IS PROPOSED

A. Introduction to Deep Learning

The deep learning method is that a large number of neurons in the analogy human brain connect and work with each other in a special way, by learning the inherent law and representation level of the sample data, the information obtained in the learning process is of great help to the interpretation of text, image, sound and other data. Its ultimate goal is to enable the machine to have the same analytical and learning ability as human beings, so that the robot can recognize text, image, sound and other data.

B. Mainstream algorithms for deep learning

Generally speaking, the deep learning network structures that have been used in plant phenotypic analysis mainly include convolution neural network (Convolutional Neural Network,CNN), restricted Boltzmann machine (Restricted Boltzmann Machines,RBM), automatic encoder (Auto Encoder,AE) and cyclic neural network (Recurrent Neural Network,RNN). Convolution neural network (CNN) is one of the most common deep learning methods.

Since the late 1980s, CNN convolution neural network has been applied to visual recognition and classification tasks. Especially in 1998, the related research of Le Net-5, based on CNN has become a research hotspot. With the development of computing power of graphics processor (Graphical Processing Unit,GPU) and the emergence of a large number of tagged data sets, CNN has continuously improved its algorithm and architecture, and made a breakthrough in various application scenarios. Image classification is a basic problem in computer vision. the technical framework of feature extraction and classifier discrimination is usually used to solve the problem of image classification. The accuracy of traditional image classification methods depends to a large extent on the extracted features. there are often some disadvantages, such as the difficulty of feature design, the limitation of facing complex tasks, the difficulty of designing the hierarchical relationship between features, which leads to the weak generalization performance of the algorithm. Recent studies have shown that with the simplification of data acquisition methods and the emergence of large data sets, with the rapid development of chip technologies such as GPU, deep learning can effectively solve the above bottleneck problems. In 2012, Krizhevsky achieved the best classification results in the Image Net large-scale visual recognition challenge competition by using the extended depth CNN architecture, then CNN was paid attention to by researchers, and a series of network models were proposed to further promote the in-depth research and wide application of CNN. At present, CNN has become the leading architecture for most image recognition, classification and detection tasks. At the same time, with the rapid development of gradient descent, parameter optimization strategy, weight sharing and neural network architecture optimization (Neural Architecture Optimization,NAO) and meta-learning (meta-learning), the advantages of CNN in complex application scenarios become more obvious. The new CNN neural network architecture shows a new situation of cascaded application of multiple networks or multiple networks. The rapid evolution of neural network form provides intelligent and efficient data analysis means for numerous and complex scientific research fields.

C. How does the device provide data sets

The device will upload the flower growth situation to the cloud in real time with pictures and environmental temperature and humidity data and send feedback to the user, who will judge according to the plants in the picture and adjust the breeding parameters. This process is in line with the calibration process of the data set of the deep learning algorithm. High-definition plant pictures and real-time parameters (red-blue light intensity ratio of LED breeding lamp, ambient temperature and humidity, soil moisture) are stored in the database through computer vision combined with depth learning algorithm. Through the extraction and classification of color, geometric shape, texture and a variety of phenotypic coupling features, such as the response mechanism of leaf stomatal size, density and conductance to environmental changes, we can study the response mechanism of plants to environmental changes through the extraction and classification of color, geometric shape, texture and a variety of phenotypic coupling features. It affects the photosynthesis and respiration of plants, and analyzes the effects of external environment on

plant physiological health from the surface color and vein lines of flower leaves. Thus, in order to quickly predict the demand of plant water and photosynthesis, and better cultivate flowers.

V. PROTOTYPE DISPLAY

VI. CONCLUSION

The main idea of this design is to reduce the use cost of intelligent furniture and make flower planting more intelligent through the shared economic concept of leasing. This product combines camera with artificial intelligence to realize real-time monitoring of flowers, and displays temperature and humidity sensors on the Internet, so that users can view their flowers anytime and anywhere. The data collected are helpful to develop the function of plant health recognition based on deep learning algorithm and serve for better flower cultivation. In addition, LED adjusts different light intensity according to the demand of flowers and automatically controls the amount of watering without human Intervention. Finally, it has a broad application prospect in improving people's quality of life.

[9]

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