Design of Daylily Agricultural Picking Robot

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Abstract

Agricultural picking activities occupy an important role in daily life, and the research and development of agricultural picking robots play a more crucial role and increasingly become an advantageous tool to improve agricultural productivity. Daylily, as a crop for daily consumption, can significantly reduce serum cholesterol and has extremely high nutritional value. However, the picking conditions of daylily are harsh, and long-term picking is likely to cause extremely serious harm to the human body, especially the hands. This paper designs an agricultural picking robot that can pick daylily automatically, which can greatly free hands and improve labor productivity. Especially in health, it can significantly reduce the harm to the human body.

Keywords: Picking Robot, Daylily, Agricultural, Robot Design

1. Introduction

Daylily, also known as Golden Needle, has been cultivated in China since ancient times. The flower of daylily has high ornamental value, and its buds are picked and dried to become vegetables with high nutritional value. Daylily usually grows buds at dusk every day, the flowers bloom the next morning and wither around noon.

According to daylily's physiological characteristic, during the flower picking season, a special person must be fixed at 5～8 a.m. for picking activities. Otherwise, nutrients will be lost after blooming, and both the quality and the price will be low. The harsh picking conditions have greatly affected the picking efficiency of daylily, and long-term picking activities will cause certain harm to the human body. Therefore, agricultural robots that automatically pick daylily have become an important and urgent need.

Regarding the research of automated daylily picking, in 2012, Shanxi Province, China, developed a riding style daylily picker. The production efficiency of this picking device is 1.45 times higher than the traditional production method, and the production cost is reduced by 25.2%. This effectively solves the problem that daylily pickers are soaked by dew and harms their bodies, significantly improves the working conditions of daylily pickers, reduces labor intensity, and has obvious economic and social benefits.

This paper designs a daylily picking robot [1]. The robot uses a camera to collect images, determines the position of the daylily, and uses a parallel robotic arm with cutting and grabbing functions to pick the daylily and put it into the designated position. The equipment will have a set of image processing algorithms based on machine learning neural networks to determine the horizontal and vertical positions of daylily [2, 3]. The algorithm can autonomously learn the characteristics of a daylily, such as color, contour shape, size, etc., and then judge whether the photographed object is a daylily based on the above features [4]. If it is daylily, then execute the picking

procedure, if not, then ignore and continue to identify the next one.

Fig.1. Pick daylily

2. Robot Design

The agricultural robot designed in this paper includes a vision system, picking structure, mobile structure, microcontroller, and power system. The functional structure of the robot is shown in Fig.2.

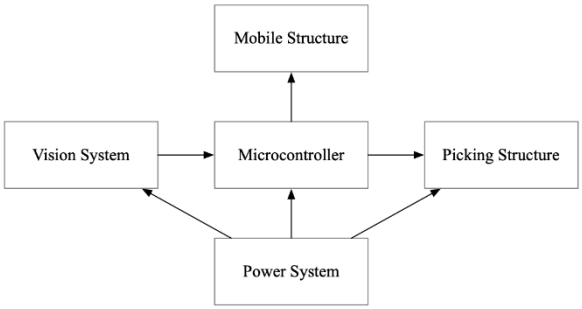

Fig.2. The functional structure of the robot

Through the vision system to identify the maturity of daylilies and the location information on the branches, the picking structure uses the recognized image information to separate the ripe daylilies from the branches. The mobile structure is responsible for the movement of the robot. The microcontroller is used to process the information sent back by the recognition module, and issue the instruction whether the picking structure picks, and how the driving mechanism moves. The power system is responsible for powering the entire robot.

2.1. Vision System

In this design, the vision system needs to meet the following requirements: 1) Can effectively identify the maturity of daylily, selective picking, to ensure the quality of picked daylily; 2) Identify the position coordinates of daylily in space, including horizontal and vertical coordinates and the distance between the camera module and daylily, assist the picking of the manipulator; 3) It can judge whether the robot is still in the field by identifying the environment, and assist the robot in walking to a certain extent.

Therefore, we choose the RGB-D binocular camera with depth function as our visual system [5].

Fig.3. The main global currents

The camera module has the following characteristics:

- Depth range: 0.6-8m
- Depth map resolution: 1280*1024 max
- Depth filed angle: 58.4*45.5cm
- Time delay: 30-45ms
- RGB: 1080P
- Connection type: USB

2.2. Picking Structure

When using a manipulator to pick daylily, it is important to ensure that it will not cause secondary damage to the crop, thus the common rigid manipulator cannot be used. Here we use an under-actuated flexible manipulator to perform the picking work. When picking, the manipulator relies on the cylinder to provide pressure to drive the fingers to close. This manipulator adopts a pneumatic drive. Compared with an electric drive, it can further adjust the gripping force of the manipulator by adjusting the pneumatic pressure to protect the daylily from being damaged [6]. The manipulator is shown in Fig.4.

Fig.4. The manipulator

2.3. Mobile Structure

As is shown in Fig.5, the planting base of daylily is sandy land, which has a high requirement for the tire of the picking robot. If the wheel drive, it is easy for the tire to slip. And if it is cloudy and rainy, the ground will become muddy, and wheeled robots will be unable to move at all.

Fig.5. Daylily planting base

We use a crawler drive. The contact area between the crawler and the ground is large, the conflict force grip is strong, and it is not easy to sink. The crawler type can walk on any messy terrain without any influence, and can also walk normally in any muddy and soft ground. Whether it is the rainy southern part of China or the monotonous north, whether it is a mountain or a plain, whether it is sandy or muddy, the crawler drive can make the robot seem to walk on flat ground.

2.4. Microcontroller

The microcontroller adopts the design scheme of dual controller STM32-Raspberry Pi. The two controllers are shown in Fig.6 and Fig.7 respectively.

Fig.6. STM32 main global currents

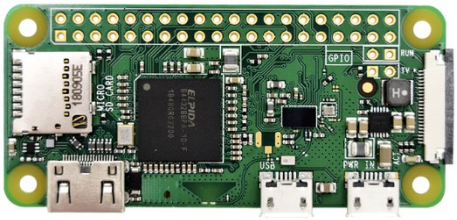

Fig.7. Raspberry Pi main global currents

STM32 microcontroller is the first choice for embedded control chips. This microcontroller has the characteristics of strong real-time, low power consumption, high integration, and a rich peripheral library, which is convenient for development. Here we use it to connect the mobile structure that drives the robot and the picking structure.

Raspberry PI internally runs a customized version of the Linux system, can be installed rich processing software, software features rich, to capture video and images can be arbitrarily modified. We use the Raspberry PI to connect to the vision system to process video information.

2.5. Power System

The power system is the power source of the whole system and is responsible for providing power for STM32, Raspberry PI, vision system, etc. The L78 series of three-terminal positive regulators (Fig.8) is available in TO-220, TO-220FP, D²PAK, and DPAK packages and several fixed output voltages, making it useful in a wide range of applications [7].

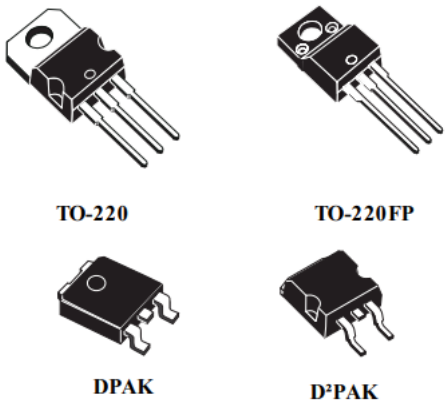

Fig.8. The L78 serial package

Different systems require different voltages, this requires the power system to be able to output different voltages stably. Therefore, L78 meets our power demand, so the L78 series is adopted as our power chip.

3. Conclusion

In this paper, we designed an agricultural picking robot of daylily according to its growth characteristics. The robot recognizes the maturity of daylily and analyzes the spatial coordinates through image recognition, and then drives the manipulator to pick. The robot can effectively improve people's labor production efficiency, and more importantly, avoid the harm caused to the human body by the daylily picking.

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