SUGISAKA MASANORI

Journal of Robotics, Networking and Artificial Life
Vol. 9(1); June (2022), pp. 20–24
ISSN (Online): 2352-6386; ISSN (Print): 2405-9021
https://alife-robotics.org/jrnal.html

Research Article

System Design of Daylily Picking Robot

Jichao Zhao, Fengzhi Dai, Tianyi Zhang
College of Electronic Information and Automation, Tianjin University of Science and Technology, Tianjin, China

ARTICLE INFO

Article History
Received 20 November 2020
Accepted 10 August 2021

Keywords
Picking Robot
Daylily
Agricultural
Robot Design

ABSTRACT

Agricultural picking is a key part of agricultural production activities. In recent years, people are committed to improving picking efficiency and freeing labor, and agricultural picking robots have emerged and are widely used. Daylily, as a crop for daily consumption, can significantly reduce serum cholesterol and has extremely high nutritional value. However, Daylily picking time and picking standards are relatively strict, long-term picking daylily will also damage the health of the work. The daylily picking robot designed in this paper can effectively solve the current picking problems, such as: improving picking efficiency, standardizing picking, and reducing physical hazards to laborers

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. Daylilies usually grow buds at dusk each summer, bloom the next morning from 5-8 am and wither around noon.

According to the physiological characteristics of daylily, its harvesting season is usually from June to August every year, which lasts more than 40 days. During that time, the picking staff must pick at 5-8 am every day to ensure the best quality of daylily, which is shown in Fig.1. 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 mainly completes four tasks. 1) Using the camera to collect the image, then using the image processing algorithm based on machine vision deep learning in the device to learn the characteristics of daylilies independently. such as color, contour shape, size, etc. 2) According to the above characteristics to determine whether the object being photographed is the pickable daylily. 3) Through the

Corresponding author's E-mail: daifz@tust.edu.cn, www.tust.edu.cn

camera to determine the location of the pickable daylily, after the coordinate conversion algorithm to determine the horizontal and vertical position of the daylily[2, 3]. 4) Finally using the parallel robotic arm with cutting and grabbing functions to pick the daylily and put it into the designated position[4].

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.

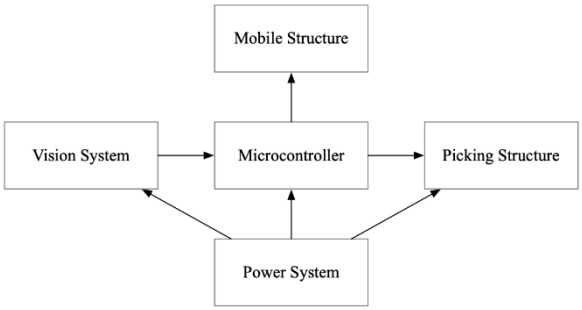


Fig.2. The functional structure of the robot

The functions of each part of this robot are described as follows. 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 is an important part responsible for obtaining picture information and feeding it back to the robot arm, and its recognition accuracy and speed have a great impact on the picking speed of the robot. 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], which is shown in Fig.3.

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

In the picking part, we use an under-actuated flexible manipulator instead of the common rigid manipulator to complete the Daylily picking work to ensure no secondary damage to the crop. 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.

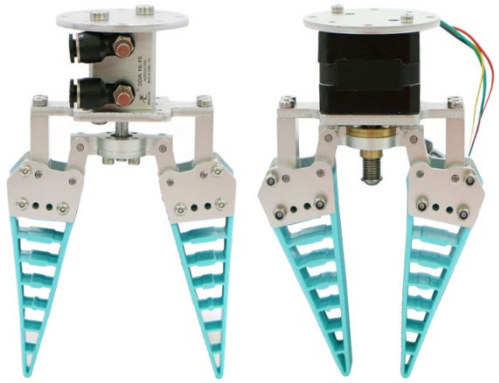


Fig.4. The manipulator

2.3. *Mobile Structure*

The movement of the picking robot should be adapted to the growing environment of Daylily. According to the growing environment of daylily, we adopt the crawler drive instead of the conventional wheel drive.

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

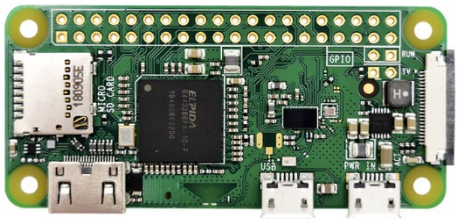


Fig.7. Raspberry Pi main global currents

STM32 microcontroller is general-purpose embedded microcontrollers based on the ARM Cortex-M3 core. It 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 runs a customized version of Linux internally, which allows for a rich set of processing software to be installed within the system for different

processing functions. It can process the captured video and images can be processed multiple times and 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].

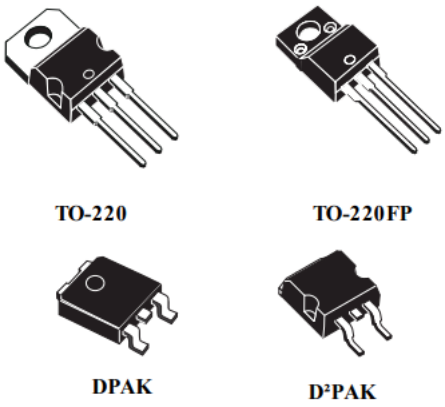


Fig.8. The L78 serial package

Different systems require different voltages, this requires the power system to be able to output different voltages stably., 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

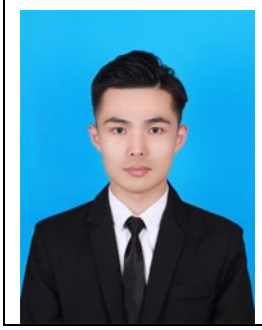
In this paper, we designed an agricultural picking robot of daylily according to its physiological characteristics, growth environment, and growth traits. The robot obtains the spatial coordinates of daylily through image recognition, then analyzes its data information and passes it to the controller to drive the robot arm for picking. 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.

References

1. Zhao JC, Dai FZ, et al. Device Design Based on TDS Water Quality Detection, *International Conference on Artificial Life and Robotics*, Oita, Japan, 2020, 1: P620-623.
2. J. B. Han, K. M. Yang, et al. A Modeling and Simulation based on the Multi body Dynamics for an Autonomous Agricultural Robot. *7th International Conference on Control, Mechatronics and Automation*, Delft, Netherlands, 2019, pp. 137-143.
3. U. Rao. Design of automatic cottonpicking robot with Machine vision using Image Processing algorithms. *International Conference on Control, Automation, Robotics and Embedded Systems*, Jabalpur, 2013, pp. 1-5.
4. Y. Yu, K. Zhang, et al. Real-Time Visual Localization of the Picking Points for a Ridge-Planting Strawberry Harvesting Robot. *IEEE Access*, 2020, 8: pp. 116556-116568.
5. Z. Xu, R. Jia, Y. Liu, et al. Fast Method of Detecting Tomatoes in a Complex Scene for Picking Robots. *IEEE Access*, 2020, 8: pp. 55289-55299.
6. G. Bao, P. Yao, et al. Flexible pneumatic end-effector for agricultural robot: Design & experiment. *IEEE International Conference on Robotics and Biomimetics*, Zhuhai, 2015, pp. 2175-2180.
7. A. J. Scarfe, R. C. Flemmer, et al. Development of an autonomous kiwifruit picking robot. *4th International Conference on Autonomous Robots and Agents*, Wellington, 2009, pp. 380-384.

Authors Introduction

Mr. Jichao Zhao



He is a third-year master candidate in Tianjin University of Science and Technology. His research is about multi-agent system, control system and reinforcement learning

Dr. Fengzhi Dai

He eceived an M.E. and Doctor of Engineering (PhD) from the Beijing Institute of Technology, China in 1998 and Oita University, Japan in 2004 respectively. His main research interests are artificial intelligence, pattern recognition and robotics. He worked in National Institute of Technology, Matsue College, Japan from 2003 to 2009. Since October 2009, he has been the staff in Tianjin University of Science and Technology, China, where he is currently an associate Professor of the College of Electronic Information and Automation.

Ms. Tianyi Zhang

She is a second-year master candidate in Tianjin University of Science and Technology. Her major is image processing, machine learn and deep learning.