# Design of strawberry picking robot based on motion controller

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**Abstract.** Picking strawberry by man has been unable to meet the needs of the development of the industry, automation device has become the development trend of picking. In order to realize the automation of strawberry picking, in this paper, a strawberry picking robot is designed based on motion controller. Respectively, the hardware and the software are introduced. The image processing system can detect the accurate position of strawberry, and improve the success rate, the strawberry picking robot can replace manual labor, improve production efficiency, and reduce production cost. It has a certain practical significance.

**Keywords:** Strawberry picking robot; Control system; Motion controller.

## 1. Introduction

Strawberry is a kind of fruit having high nutritional value and health care value, it has the advantages of bright color, abundant juice, and delicious taste [1]. In recent years, with the continuous promotion of strawberry breeding and cultivation technology of technology, and the development of plant diseases and insect pests control technology and processing technology of strawberry, the promotion of strawberry has been worldwide [2]. Strawberry begins to mature after blossom in general about 30 days, and picking period is relatively long, in greenhouse strawberry, picking is up to a maximum of 6 months, in the strawberry harvest period, every day at least need to harvest two times, labor intensity is very large, a kind of automatic machine is needed to change the current state [3]. From the development of strawberry industry, processing of strawberry production has been growing trend of strawberry products, and not just to eat. Strawberry product processing will increase the number of strawberry, it will expand the planting area correspondingly [4]. Requirement of appearance of processing strawberry is not very high, these conditions facilitate the automation of picking strawberry. Therefore, strawberry picking machinery is a problem to be solved in the industry. This paper describes the design of a strawberry picking robot based on motion controller, motion controller has high control accuracy, good reliability and many other advantages [5]. Strawberry picking robot can realize the automation of picking, instead of manual labor, improve production efficiency, and reduce production cost. It has a certain practical significance.

## 2. Hardware design

### 1.1 Robot mechanical part design

In order to facilitate the realization of strawberry picking, the robot body adopts the structure of three vertical degrees of freedom, three degree of freedom control robot can move in each position of the freedom, there is an actuator at the end, the actuator to complete the strawberry picking. As shown in Figure 1, the robot has three linear motions in main vertical direction, respectively they are X, Y, Z three directions. With this structure, the robot has the advantages of convenient operation, and simple control, at the same time, it has high positioning accuracy, and operating range is larger. Actuator imitates human picking strawberries manner. When picking strawberries artificially, man hold the fruit stem and cut off. The end of the robot's actuators is a picking claw, as shown in Figure 2, when it works, picking claw clamping mechanism will clamp the strawberry fruit stem, and then fruit stem will be cut off through a shearing mechanism. The strawberry picking is done.
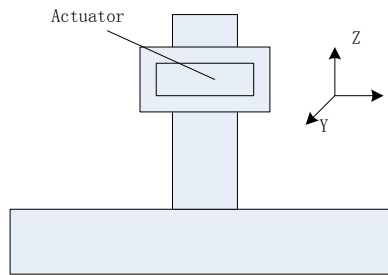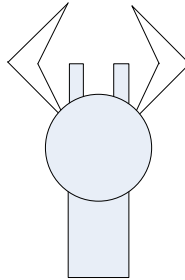
Figure 1.The structure of robot

Figure 2.The picking claw

## 1.2 Robot control system design

The core of the picking robot control system is motion controller, it is equivalent to the robot's brain, and it is used to control the normal work of robot. Fig. 3 is the design of control system of robot. All hardware is built based on motion controller. In working, the robot needs to know the location of strawberry, which requires image acquisition and processing device, the camera is used on strawberry image acquisition in this paper, strawberry position is determined by the processing image. Servo driver receives command motion controller, and control servo motor to do the corresponding action, servo motor controls motions of robot in every direction.
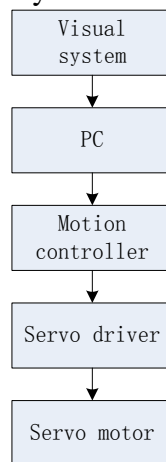
Figure 3.The control system

## 3. Software design

## 2.1 Software overall design

Motion controller is the core of the robot control system. Figure 4 is the overall design scheme of the software, the robot control system is using the double CPU structure of "PC+ motion controller", and it can improve the response speed of the system and improve the control precision. The motion controller only has operation nuclear, no developing nuclear, so it does not have the program development environment, it needs PC as the host machine of controller to program, the communication between the motion controller and PC uses Ethernet, program is debugging online. Modern robot control system mostly adopts distributed structure [6], the robot control system program design uses the modular design, as shown in Figure 5, and it includes management module, detection module, motion control module, logical control module, display module and I/O module.
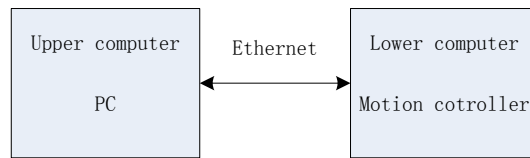
| Upper computer PC | Ethernet | Lower computer Motion cotroller |
|---|---|---|

Figure4. The overall design scheme of the software

Control system
- Management module
- Detection module
- Motion control module
- Logical control module
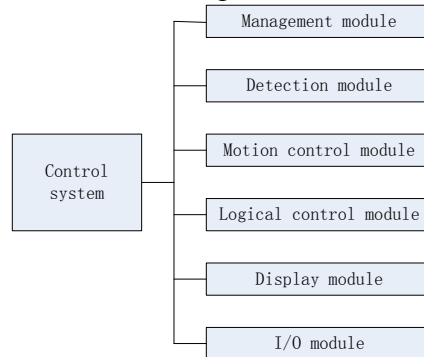- Display module
- I/O module

Figure5. The modular design

## 2.2 Image acquisition system

The image acquisition system is the detection device of the robot, it is equivalent of robot eyes, and the robot determines the position of strawberry through the image acquisition system to determine the next action. The image acquisition device comprises cameras and image acquisition card, cameras are fixed on the robot body, together with the movement of the robot body. Data acquisition card is installed on the computer, it supports the hardware drivers, it provides the standard interface, when it works, and it can directly use the standard function library provided by the acquisition card. Figure 6 is the work flow of acquisition system, acquisition system work does not use the host CPU time, and it can carry out the real-time processing of image.
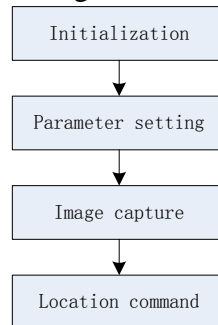
Initialization
↓
Parameter setting
↓
Image capture
↓
Location command

Figure6. The work flow of acquisition system

## 2.3 Work flow

Initialization
↓
Camera 1 working
↓
X and Y axis moving
↓
Camera 2 working
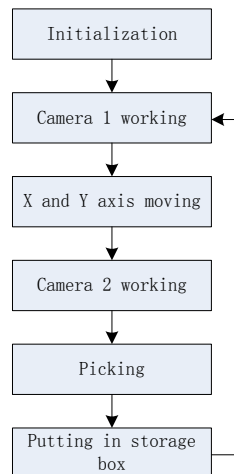↓
Picking
↓
Putting in storage box

Figure7. The work flow of robot

The essence of strawberry picking is to grab and cut off the strawberry by robot composition in the X axis and Y axis, and then put strawberry into the storage box. As shown in Figure 7, strawberry robot work flow is: first the system does initialization, and detects system state, if the system is working properly, it begins to do strawberry picking. Camera 1 acquires strawberry image, X axis and Y axis of robot start moving, so that the camera 1 arrives at the location of strawberry. After the arrival of the camera 1, camera 2 continues to acquire the image of strawberry, strawberry picking position is determined. Z axis control end actuator move to the position, sensor detects a strawberry, the movement stops, actuator will grab and cut off the strawberry. After cutting, the robot will put strawberry into the storage box, and system starts the next round of picking.

## 2.4 I/O design

The system exchanges information with the outside world through the I/O interface of the controller, once every input interface has signal input, the system will perform the corresponding instruction to ensure the normal operation of the robot, the I/O design of the system is shown in table 1.

Table 1. System I/O design

| Input | | Output | |
|---|---|---|---|
| IN0 | Limit switch 1 | OUT0 | The indicator light 1 |
| IN1 | Limit switch 2 | OUT1 | The indicator light 2 |
| IN2 | Limit switch 3 | OUT2 | The indicator light 3 |
| IN3 | Limit switch 4 | OUT3 | The indicator light 4 |
| IN4 | Position signal 1 | | |
| IN5 | Position signal 2 | | |

## 4. Conclusion

In this paper, aiming at the present situation and requirements of strawberry picking, a strawberry picking robot is designed based on motion controller. The robot integrates motion control, image acquisition and processing, mechanical design, electrical and electronic and many other advanced technologies. The three degree of freedom manipulator can improve the robot working range, and ensure the control precision. Using the visual system makes it possible for the robot to identify the strawberry accurately. The robot can carry out strawberry picking work instead of human, improve labor efficiency, and reduce production cost. It has a certain practical significance to the development of strawberry industry.

## Reference

[1] Lei Jun. China's strawberry production situation and prospects [J]. China fruit, 2001, (1): 49-51.
[2] Yang Hui. Strawberry picking and storage [J]. Hebei agriculture, 2005, (4): 27-27.
[3] Pan Jilan. Strawberry picking management [J]. Shandong agricultural mechanization, 2008, (1): 29-29.
[4] Ye Zhengwen. Chinese and foreign development trend of strawberry industry [J]. Chinese fruit industry information, 2005, 21 (4): 5-7.
[5] Xi Zhigang, Zhou Hongfu. Development and status of motion controller [J]. Electric transmission automation, 2005, 32 (4): 5-10.
[6] Deng Zunyi, Ning Yi, Liu Baoguo. Distributed robot control system design based on the CAN bus [J]. Micro computer information, 2006, 22:255-257.