Design of an Artificial Assisted Fruit Picking Device

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Abstract *— Because of high cost and low efficiency of fruit picking, a kind of artificial assistant fruit picking device is designed in this paper. The device can automatically distinguish the fruit entering the head of the structure through image processing and infrared induction, and then drive the blades to pick fruit intelligently. The experimental result shows that the device can achieve the expected function. It is not only safe and reliable, but also significantly improves the picking efficiency. Meanwhile, the product price is low and easy to produce so that it would be widely spread in future.*

Keywords *— assisted picking, image processing, infrared induction*

I. INTRODUCTION

With the improvement of people's consumption capacity in China, market demand of the fruit is stronger and stronger. According to the official statistics from relevant state departments, the orchard was about 11.136 million hectares in extent in 2017, while the orchard increased to 11.168 million hectares in 2018[1]. Facing up the increasing competition of the fruit industry, the picking efficiency is undoubtedly one of the key factors to the industrial competition.

In the whole production process of fruit industry, the quality and efficiency of fruit picking process will affect the interests of the later stage such as fresh-keeping, storage, transportation and marketing and so on, except the loss caused by natural disasters. High intensity and long-term picking work during fruit picking and harvesting has a significant impact on the health of fruit farmers. So far, fruit picking in China basically depends on manual operation. With the rapid urbanization progress and the rise of prices, the cost of labor has been greatly increased. Considering difficult picking of high branch fruit, the auxiliary picking devices are put forwards and can obviously improve the picking efficiency [2-5].

Taken account of the cost the mature devices for auxiliary picking in the market and the purchase quantity of fruit farmers, the efficiency of fruit picking is much lower than high altitude manual picking, and easy to miss some fruits. Therefore, a manual auxiliary picking device for automatic identification of fruit is proposed in this paper, which can transform the torque into the cutting force of the device by steering gear [6]. The voice prompt system and keystroke operation mode additional enhance the security and reliability of the device, to prevent people from the possible damage caused by picking device. The semi-automatic and intelligent fruit picker will fill the gap in fruit picking market, improves the picking efficiency, and achieves the mutual benefit and win-win outcome of fruit agriculture and manufacturing.

II. THE STRUCTURAL DESIGN OF THE NEW INTELLIGENT BED

A. Overall Structure

The picking device can judge whether the fruit enters the head of the picking device shown in Fig.1 through recognition algorithm for color block with a camera and infrared induction. When the main control board recognizes that the fruit enters the head of the device, the steering gear drives the blade to cut the root of the fruit.

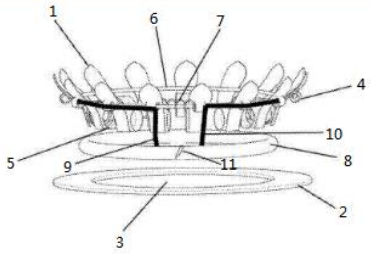

Fig.1 Structure of Picking Device

1-Cutting Blade; 2-Platform; 3-Through hole; 4-Outer Ring; 5-Inner Ring; 6-First Iron Ring; 7-Spring; 8-Second Iron Ring; 9-Traction Coil 1; 10-Traction Coil 2; 11-Infrared Sensor

B. Mechanical Structural

Based on the current environment of over-reliance on hand-picking, this project designs a kind of picking device convenient for fruit farmers to pick fruits. The device is composed of three main parts: cutting device, fruit discrimination module and voice prompt module.

C. Main Support Frame

The cutting device of the picker is mainly made up of S-type stainless steel blade and supporting structure as Fig.2 and Fig.3 shown. Two through holes of irregular ring are fixed on the back of the cutting blade 1, that the inner diameter of the outer ring 4 is 3 mm, while the inner ring 5 is 4 mm. The diameter of first iron ring 6 is 150mm with cross sections of 3mm, while second iron ring 8 is 105m with cross sections of 2mm, respectively. The rope is fastened through the outer ring 4 of each cutting blade in turn. Springs are set up in the middle of each cutting blade in Fig.3. In practice, use the device to

catch the target fruit, and adjust the head to let the root of the fruit be stuck in the gap of adjacent cutting blades naturally due to the gravity.

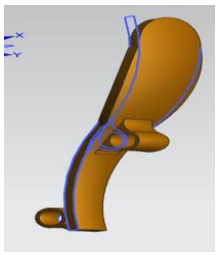

Fig.2 Cutting Blade Body

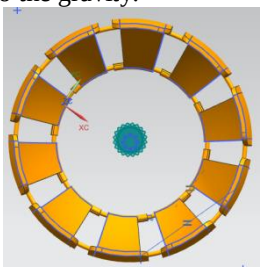

Fig.3 Overhead View of Main

D. Fruit Discrimination Module

Fruit discrimination includes recognition from camera and infrared induction. The camera is used to recognize the axial color of the annular device, while the infrared sensor is set up arranged between the blade tip clearances pointing to the blade. If the green area captured by the camera occupies more than 15% of the total image, the brownish black area distributes on the edge of the image, and the corresponding color area of the fruit in the head accounts for 60%, the fruit is regarded as entering the picking region [7]. When infrared induction and color block identification conditions are achieved at the same time, the main control board sends a signal to the steering gear, to pull the rope fixed behind the blade so that the blades are closed cutting off the fruits.

E. Voice Prompt Module

The voice prompt device is controlled by the buzzer to send the corresponding signal through a fixed vocal program written in advance in the main control board. When the main control board judges the fruits have entered the picking region via the fruit discrimination module, the operator is asked whether to cut off the fruits. If confirmed, press the capacitive touch key on the operating rod, to complete a whole process.

III.HARDWARE AND CONTROL PRINCIPLE

The hardware structure of the device is shown in Fig.1. The cutting blades 1 are placed on the through hole 3 of the platform 2, equally around the circumference. The outer ring 4 is set up at the upper part of each blade back toward outside of the circumference, while the inner ring 5 at the lower part of the front side is toward the inside. All outer rings 4 are connected by first iron ring 6, with spring 7 arranged between adjacent outer rings and also passed through by the ring 6. All inner rings 5 are connected by second iron ring 7. The second iron ring 8 crosses the through hole 3. One blade set as the starting point, the odd outer rings are connected by traction coil 9, while the even outer rings by traction coil 10. The traction coil 9 and 10 are made of wear-resistant materials and connected with the steering gear. Driven by the motor, the blades connected with the coil 9 move in the opposite direction to the blades connected with the coil 10.

Fig.4 Structure of the fruit picking device

The main control board selects the low priced STM32 F103C8T6, used to control the infrared induction device HC-SR501 and the steering gear SG90S. Because the requirement of image processing in this system is not high, the ov7670 camera is used to sample and process the graphics [8-9]. In the course, the first step of picking is to sample by image recognition with a camera and infrared induction. When the fruits are found entering the picking region, the main control board sends a start signal through the pre-compiled instructions to the corresponding sound conversion module, and then the loudspeaker sends a cut permission request. At this time, the potential change of the capacitance button is processed by the main control board, and the steering gear drives the blades to achieve cutting. The flow chart of control system is shown in figure 5.

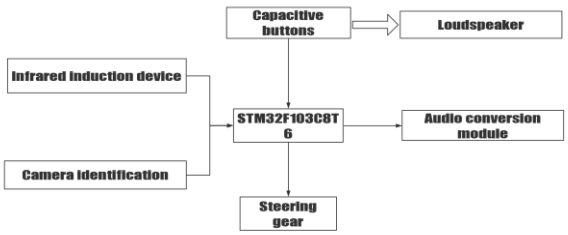

Fig.5 Picking Control System

IV.EXPERIMENTAL RESULTS

The device can easily identify the fruit entering the picking range and harvest the fruits.

When the worker wears a green dress and putting hands into the picking device, there are no voice prompts given by the loudspeaker. The experimental results show that the algorithm is stable to guarantee the safety of picking process. The capacitive key provides a second layer of protection to reduce the incidence of unforeseen accidents.

The whole system worked successfully during the test of picking.

V. CONCLUSION

The structure and control principle of the artificial assistant picking device are introduced in detail in this paper. It is proved by experiments that it can accurately complete the picking process, and shows

the characteristics of stability, intelligence and efficiency in the test process.

With the progress of science and technology, the planting cycle of fruit is shortened while the production capacity is increased. Related to the variety of picking device needs to improve in the market with single function and inefficiency, the device proposed is suitable for the current situation of fruit picking for low cost, safety and efficiency. It has a very broad application and research prospects.

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