Design of the shuttle-type picking and storage device for cherry fruit

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Abstract

A shuttle-type cherry fruit picking and storage device is designed for cherry fruits to quickly assist manual picking. In this paper, the structure, parameters and motion transformation of this picking and storage device are introduced in detail. It has been proved to pick cherry fruits quickly and efficiently by experiments.

Key words: Fruit picking, Shuttle-type tool, Fruit storage

1 Introduction

In the vast rural areas, agricultural production is widely diversified, and large quantities of economic crops, especially fruits, are produced and placed on the market, enriching the people's dietary varieties and improving the quality of life of the people. Fruit and vegetable picking is one of the most time-consuming and labor-intensive aspects of agricultural production, requiring a large amount of labor and high-intensity work. China's total fruit planting volume exceeds 330,000 acres, ranking first in the world. Cherries were introduced to China in the earliest, with many varieties, large cultivation areas, high yields, and high labor intensity. Therefore, the auxiliary fruit collecting device is indispensable. There are many problems of the existing auxiliary manual fruit collecting device.

At present, domestic fruit picking has the following problems: 1. Due to the fact

that the existing fruit-assisted manual collectors are mostly high- branch shears and mechanical grippers, it is easy to damage the fruit and cause “hollow fruit ". And it is easy to cause mechanical transmissions damage for long-term lifting work. 2. There are many inventions and patents in fruit picking today, each of which has its own characteristics, some of which are complex and not suitable for farmers who have not been trained with professional training. 3. Farmers cannot afford excessive economic burdens, and some mechanical aids cannot actually bring actual profits to fruit farmers (heavy machinery is too expensive, such as heavy picking machinery in German wine vineyards). 4. The orchard's terrain is complex, uneven, and unsatisfactory. Moreover, the structure of the fruit tree branches is complex and the fruit is unevenly distributed. It is difficult to capture the position of the fruit by the existing auxiliary manual device. To solve these problems, this "shuttle-type" fruit picking and storage device was designed.

2 Structural design of the picking and storage device

2.1 Overall structure

A "comb-shaped shuttle" blade is used. The cherry fruit stalks entering the comb-oriented can be cut off by the two double-edged blade which is fixed and movable, shuttled back and forth.[1].

The picked cherries will fall into the collection bag attached to them along the guiding mechanism placed behind the picking blade. When the cherries are full, just replace the rear collection bag and continue picking, as shown in Figure 1.

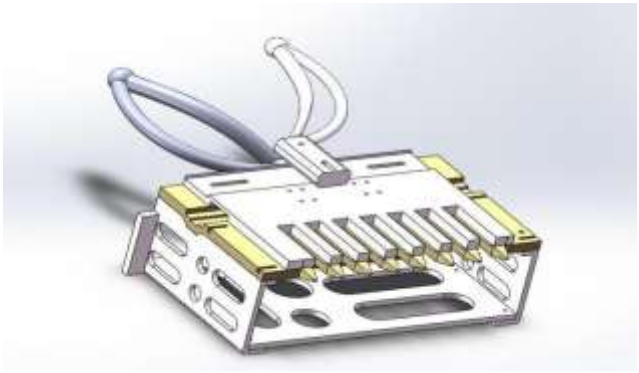

Figure 1 Overall structure

2.2 Structural design

2.2.1 Overall appearance

The main part of the device is a rectangular hollow box[2], plus a curved handle and a grip, and the bottom is a comb-shaped blade edge. The grip of the handle device is in the shape of a door handle, which is improved to have a certain curvature, and is more convenient to grip[3] , as shown in Figure 2.

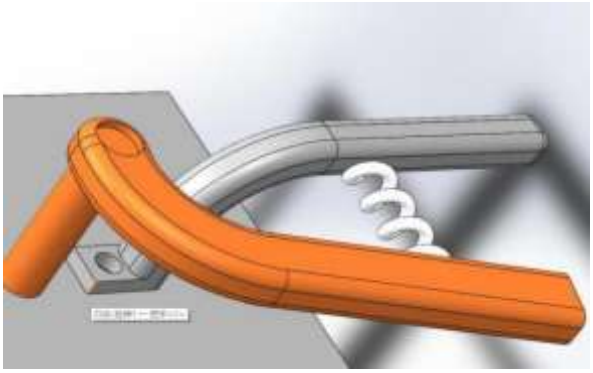

Figure 2 Handle device

2.2.2 Motion Transformation

The picking device, as shown in Figure 3, has a large sliding groove on the comb-shaped cutting edge. The sliding rotating shaft and the rocker are fixed by screws to drive the blade horizontally in the sliding groove, that is, the axial rotation is converted into a radial flat move[4].

The lower half of the comb-shaped blade at the front end of the picking device is provided with a sliding groove with a screw for restricting the moving range and direction of the lower half blade, so as to realize the left and right movement of the blade, that is, "shuttle". The upper half inside the box is fixed to the box, so that the gap between the two knife edges can cut the fruit rhizome.

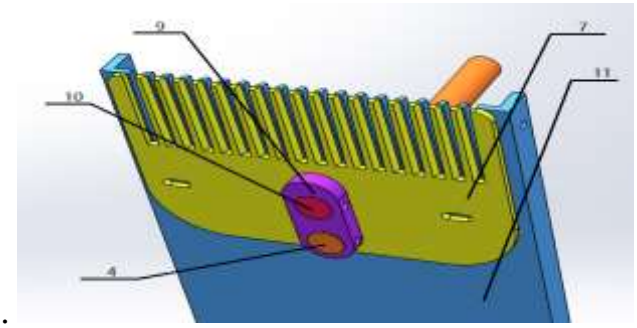

Figure 3 Picking device cutter head

2.2.3 Parameter analysis

1. The distance between the handle and the crank: the spring is connected between the handle and the crank. Considering the rotation angle of the slider below and the transitional distance of the blade, the optimal length of the spring is 4cm, and the spring compression is 2cm.

2. Spring parameters: According to the length of the spring, it is estimated that the full compression of the spring can generate a force of 20N, the inner diameter is about 3.0mm, and the length is 4cm, which is suitable for the needs of the device.

3. Crank rotation angle: According to the above calculation, the spring can generate a force of 20N, and then the torque formula can be used to calculate that the crank rotation angle is 13°. The rotation angle is small, which can save effort for the user [5].

4. Comb-shaped blade: There are 11 comb teeth in total with an interval of 3.1mm. Multiple rhizomes can be cut off at the same time.

5. Shear force: The acrylic (PMMA) is used as the blade material. According to the movement distance of the crank-link mechanism, it can be calculated that the blade can withstand a load of 5N, which is enough to cut off the cherry handle branches.

6. Collection device: A storage bag that can hold 500g fruit at one time is most suitable by testing.

3 Experimental results

The prepared fruit picking device, as shown in Figure 4, was taken under the cherry tree for picking experiments. Many fruit rhizomes can enter the gap between the blades during the picking process. And in one collecting, most of the rhizome can be cut off. The picked fruits can be safely dropped into the storage bag. This device greatly improves the picking efficiency compared to individual cherry picking.

Figure 4 Fruit picking device

4 Conclusions

Aiming at the problems such as labor-intensive, tedious process, low picking efficiency and easy damage to the fruit and "hollow fruit “caused by manual picking, a device was designed to quickly assist manual picking, and at the same time, it can reduce the problem of fruit damage. This product can simplify the fruit picking

process, increase labor efficiency, and reduce the current fruit damage rate during picking process. The picking and storage device is small, lightweight, inexpensive, and has broad application, research prospects and market value.

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