

# Structure Design of A Semi-Automatic Pineapple Picking Machine

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**Abstract.** As a result of the growth characteristics of pineapple, at present, mainly to pick pineapple by hand, time-consuming and laborious. The use of mechanical pineapple picking not only greatly liberates the labor force, but also is more economical and efficient. Aiming at the present situation of pineapple picking in China, this paper designs a new type of semi-automatic pineapple picking machine, which is simple in operation, has little damage to pineapple, realizes mechanization of pineapple picking, reduces the physical labor degree of pineapple pickers, and improves the production efficiency.

## 1. Introduction

Pineapple is an important tropical fruit, which is widely planted in Hainan, Guangdong and Guangxi. Pineapple fruit is of high quality and nutrient-rich, containing a large amount of fructose, glucose, vitamin B, C, citric acid, protease and various trace elements [1]. Pineapple leaves are rich in fiber and are a kind of textile material with excellent bactericidal properties [2-3], and have anti-tumor, hypoglycemic and blood lipid-lowering effects in the medicinal field [4-5].

At present, pineapple picking mainly faces three problems. First, due to the sharp teeth on the pineapple leaves, the peel is hard and convex and has sharp thorns. Manual picking is easy to cause injury, which seriously reduces the picking efficiency of pineapple; second, because pineapple is a perennial fruit with special structure, it is less likely to be mechanized for large-scale mechanization. At present, it is mostly targeted for batch picking. Third, in view of the value of using different parts of pineapple, it is studying how to realize pineapple. At the same time as automatic picking, it is necessary to consider how best to preserve the plant without destroying the potential economic value of the plant and avoiding the consequences of its next year.

In view of the above problems, the author combines pineapple planting evenly, with a large row spacing, and the distance between each row is basically the same; the fruit is larger, the pineapple fruit grows in the upper part of the pineapple tree, the fruit stalk is longer, and the pineapple fruit is connected with the fruit stalk when mature. At the brittle and other actual planting environment and its growth characteristics, a design scheme of integrated semi-automatic pineapple harvesting machine with high practical value is proposed to improve the mechanization level of pineapple picking and promote the development of pineapple planting industry. Taking advantage of the economic value of pineapples, it is hoped that in the future, it will be able to effectively cope with the labor shortage and the rapid growth of labor costs.



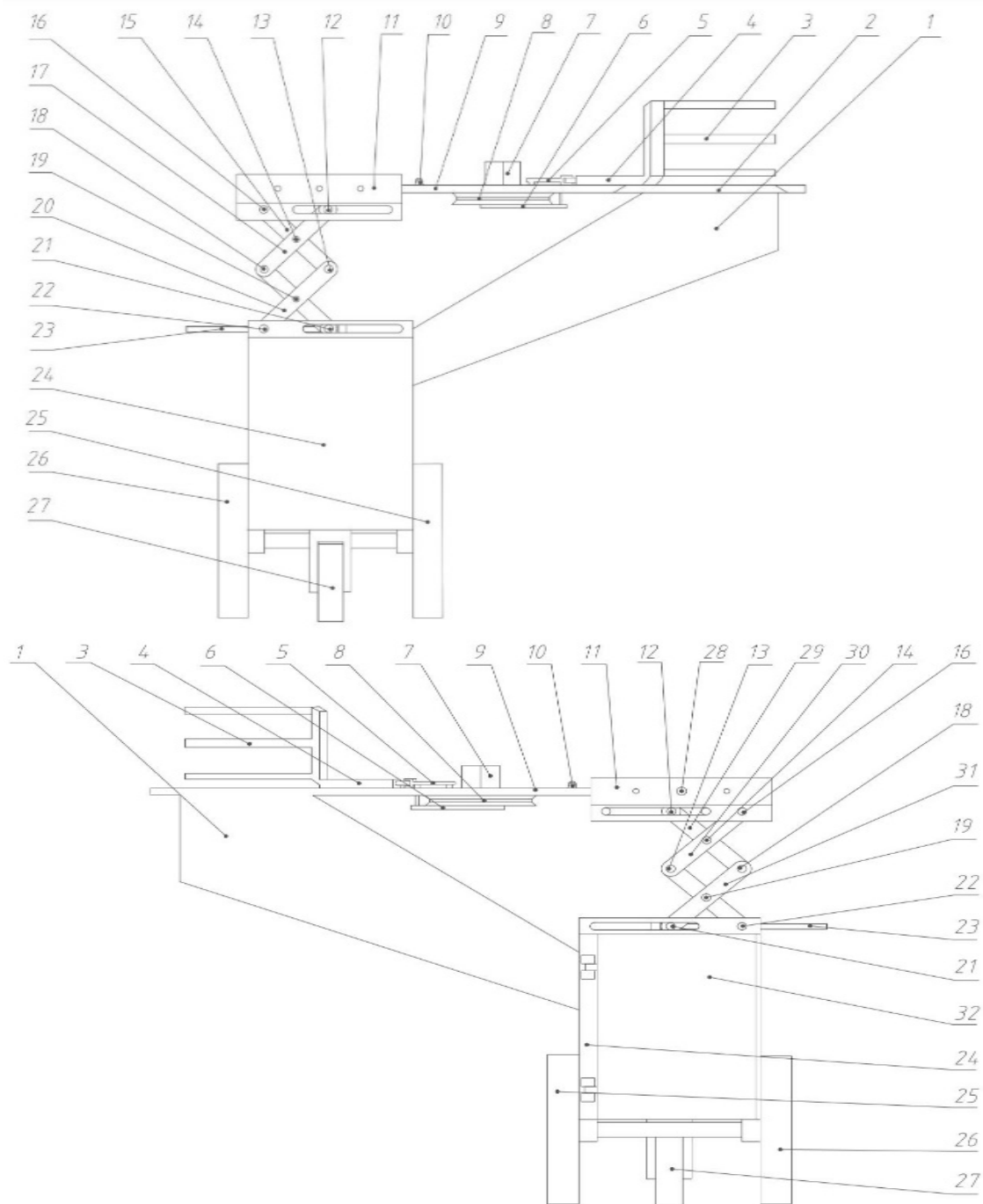
## **2. Design principles and structural solutions**

### *2.1. Design principle*

The pineapple operation is seasonal, the mechanization level is low, the manual harvesting is the main, the labor intensity is high, the cost is high, and it is easy to hurt people. At the same time, the pineapple planting interval is uniform, the row spacing is large, suitable for mechanical picking conditions, design A semi-automatic pineapple picking machine. The machine converts manual picking into manual control picking. The picker can control the switch on the switch frame to control different mechanical parts. By controlling the lifting device, the picking platform is moved back and forth, so that the cutting edge of the platform is aligned with the pineapple in the front and rear direction. The fruit and the handle are connected; by controlling the left and right movement of the picking platform, the edge of the platform is aligned with the pineapple handle in the left and right direction; the cutting edge of the platform is aligned with the edge of the pineapple in the up and down direction by controlling the lifting rail. After aligning the pineapple stalk, the stepping motor is controlled to rotate, the power is transmitted to the picking claw through the multi-bar mechanism, the claw is picked up, the pineapple is moved, and the knife edge on the lifting platform is matched to connect the pineapple fruit with the fruit stalk. Broken, part of the fruit stalk that cannot be cut off can be cut off by the edge of the knife to achieve the picking of the pineapple. The pineapple that has been picked has a certain inertia and continues to roll back into the pineapple transport pipe connected to the back side of the cutting platform, and finally enters the pineapple collection box. In the next picking process, the above operation is repeated, and after the collection box is full, the picked pineapple is taken out. In the subsequent pineapple picking process, the pineapples of the same variety are basically the same height, and the mechanical advancement process is basically straight so that the process of aligning the pineapple does not need to be adjusted frequently, which improves the efficiency of pineapple picking.

### *2.2. Structural plan*

The pineapple picking and collecting machine is composed of a picking part, a lifting part, a pineapple conveying part, a pineapple collecting part, and a moving part. While following the concept of integration, convenience, environmental protection, and saving design, pineapple can be harvested, collected and stored. The overall structural design is shown in Figure 1.



Note 1. Conveying pipe; 2. Cutting blade; 3. Dialing claw; 4. Guide groove; 5. Rocker; 6. Intermediate link; 7. Stepping motor; 8. Crank; 9. Cutting platform; Wheel; 11. Move the frame left and right; 12-22. Lifting device connecting rod; 23. Screw; 24. Pineapple collecting box; 25. Right rear wheel; 26. Left rear wheel; 27. Front wheel; 28. Cutting platform Lock; 29-31. Lifting device connecting rod; 32. Pineapple collecting box door

**Figure 1.** Overall structure

### 3. Main components structural design

#### 3.1. Picking section

The picking part of this work is done with the claws 3. The cutting blade 2 for cutting is mounted on the cutting platform 9, the power is provided by the stepping motor 7, the motor drives the crank to rotate, and the crank transmits the power to the shifting claw 3 through the connecting rod 6, the rocker 5 and the guiding groove 4, wherein The crank 8, the connecting rod 6, the rocker 5 and the shifting claw 3 constitute a crank-rocker mechanism. Each time the rotor of the stepping motor 7 rotates, the claw 3 is moved to complete the forward swinging of the pineapple once, and then the original position is restored. Move the claw 3 to move the pineapple forward. Because the mature pineapple handle is brittle with the fruit, the pineapple handle is easy to break at the edge of the cutting platform 9, so that the pineapple handle is broken, and some pineapples cannot be broken by themselves. The shank can be severed by the sharp cutting head 2 on the cutting platform 9.

#### 3.2. Lifting device

The lifting portion of the present work is composed of a left and right moving frame 11, a lifting device link and a lead screw 23, and the lifting platform is adjusted in the vertical and horizontal directions to realize the operation of aligning the cutting platform 9 with the pineapple. When operating, the cutting platform locking device 28 is opened on the sliding groove, so that the cutting platform 9 slides left and right in the sliding groove 11, and the cutting platform locking device 28 is locked when the groove of the cutting blade 2 is aligned with the pineapple handle; The lead screw 23 lifts and lowers the cutting platform 9 so that the connecting portion of the pineapple fruit and the fruit handle enters the cutting edge 2, and the positioning of the pineapple fruit by the cutting platform 9 is completed. Since most of the pineapple fields are of the same variety, the pineapple height is almost the same, and the width of the pineapple field is basically fixed. When the machine is basically straightforward, the left and right sides and the upper and lower sides do not need to be adjusted frequently due to the large opening of the knife edge.

#### 3.3. Pineapple conveying part and collecting part

The pineapple conveying portion is composed of a conveying pipe 1, and the collecting portion is composed of a pineapple collecting device 24 and a pineapple collecting device door 32. After the pineapple leaves the fruit stalk, it continues to slide forward due to inertia and falls into the conveying pipe 1. The inner wall of the conveying pipe 1 is smooth, and the friction resistance to the pineapple is small. The pineapple slides into the pineapple collecting device 24 by gravity and slides into the pineapple. When the device 24 is collected, since the pineapple peel is thick, the pineapple fruit is less damaged during the sliding into the pineapple collecting device 24. At this point, a pineapple picking collection is complete. In the next picking process, the above operation is repeated, and after the pineapple collecting device 24 is fully collected, the pineapple collecting device door 32 is opened to take out the picked pineapple.

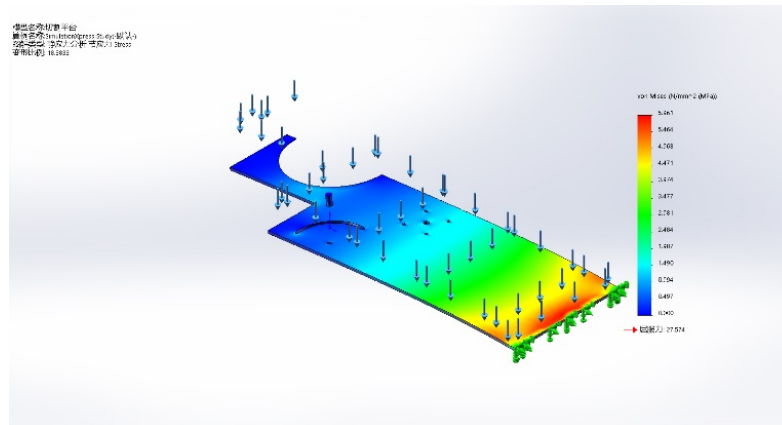
#### 3.4. Moving parts

The moving part is composed of a right rear wheel 25, a left rear wheel 26, and a front wheel 27, and the front wheel 27 is an in-wheel motor that powers the moving part to ensure the operation of the pineapple picking and collecting machine between the trenches.

#### 4. Cutting platform strength check and a three-dimensional model of the main body of the harvester

##### 4.1. Cutting platform strength check

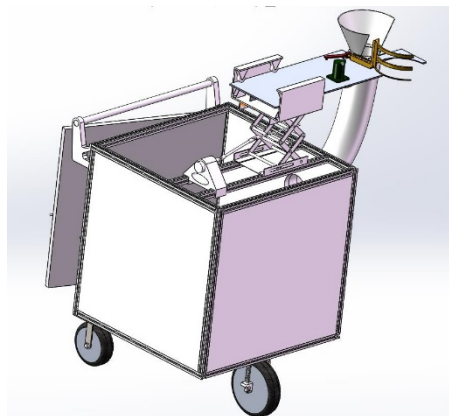
With SolidWorks, the strength of the cutting platform is checked. The maximum stress on the cutting platform is 5.961N/mm<sup>2</sup>, and the maximum displacement is 3.808mm, which meets the strength requirements of the materials used and meets the rationality of the design.



**Figure 2.** Cutting platform strength check chart

##### 4.2. Three-dimensional model of the main body of the harvester

In order to better carry out the structural interference check and dynamic characteristics research, the overall three-dimensional modeling of the pineapple harvesting machine was carried out by SolidWorks, which verified the rationality of the design.



**Figure 3.** A three-dimensional model of the main structure of pineapple harvester

#### 5. Conclusion

The semi-automatic pineapple harvester is designed according to the width between the two ridges of the pineapple. The body is narrow and can travel smoothly between the two ridge pine trees to prevent the harvester from causing damage to the pineapple ridge and pineapple plants. The picking part of the pineapple harvester extends out of the main part of the machine, and the pineapple is positioned and picked from above, and the pineapple fruit and branches are not damaged during the picking process. The lifting height of the pineapple harvester lifting device is sufficient to deal with pineapples of different heights. The length of the left and right moving devices can satisfy the positioning of the

pineapples in different positions of the harvesting machine between the ridges. When the harvester picks, the brittle fruit and the handle are brittle when the pineapple is ripe. The joint between the pineapple fruit and the fruit stalk is broken by the combination of the claw and the knife edge, and some pineapples that cannot be broken can also be cut. It is cut by the knife edge to achieve pineapple picking. The harvesting machine collects and collects in one body. The operator does not need to collect the picked pineapples by means of back and back and only needs to control the machinery to realize pineapple picking, which greatly reduces the physical labor of the pickers.

### References

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