Research and Design of Autonomous Snow Lotus Fruit Harvesting and Grading System

Ruizhe Peng[1, *], Dongyang Zhao[2], Xiaoyu Liu[2], Yongtai Zhuang[2]

[1]College of Automation, Wuhan University of Technology, Wuhan, China
[2]College of Mechanical and Electrical Engineering, Wuhan University of Technology, Wuhan, China
[*]Corresponding author

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Abstract: This device is a full -automatic snowdrop fruit picking classification device. This device can be realistic. Now automatically plan the path of the Snow Lotus Fruit Garden, pick the snow lotus fruit with the optimal way to solve the road, and benefit. Use visual recognition technology to achieve precise positioning snow lotus fruit. At the same time, the size of each module of the device is rigorously designed by market research. It can run in the snow lotus orchard, and can be picked to the tree. There are snow lotus fruit, realizing the automation of snow lotus fruit picking throughout the process, and avoiding a large number of labor costs.

1. Introduction

1.1 Background

Since the 1980s, Snow lotus fruit (chrysanthemum potato) [1] has been introduced into Japan, China, and Central and European countries from the Andes of South America [2].

As can be seen in Figure 1. According to the statistics of the yield of potato crops in my country from 2013 to 2020, the output of potato crops shows an annual upward trend. From this, the demand for consumer potato crops in the Chinese market is very strong. It has high economic value. In 2021, the potato output was 3043.54 tons.

After consulting information, the consumption of Snow lotus fruit has a long history. In addition to high nutritional value, the fruit water content is extremely high, the juice is crystal clear, the taste is crispy containing more than 20 essential amino acids, vitamins and minerals necessary for the human body [3]. The value of health care. It has a variety of effects such as stimulating the growth of beneficial bacteria in the body, reducing human blood sugar, and reducing tumor formation [4]. We can see the content of various basic nutritional ingredients in Snow Lotus Fruit Fresh Fruit in Table 1.

Table 1: The content of various basic nutritional ingredients in Snow Lotus Fruit Fresh Fruit [5]

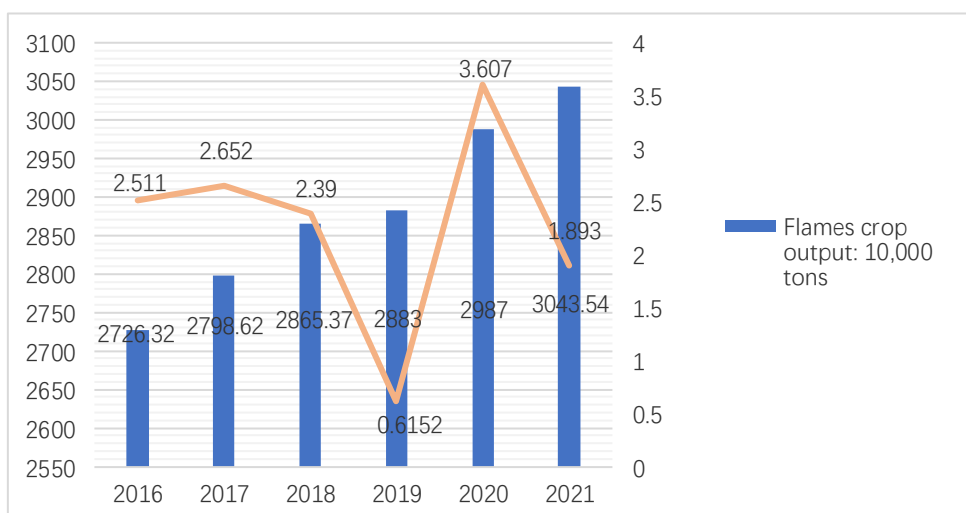| Element	Content
Water	85.6%
Fat	0.39%
Protein	0.91%
Cowardly	31.59mg/mL

Figure 1: 2016-2020 China Fragrance Statistics Map

The market's requirements for harvesting snow lotus fruit are increasing. Snow lotus fruit that has not been treated and shakes is randomly accumulated on the field and ridges. The morning and evening during the production process is related to its output, storage, retention, processing and utilization, and subsequent rotation. The accumulation causes the nutritional quality to be reduced, and it is difficult to sell the final decay. In Figure 2 the snow lotus fruit stacked on the field.

Figure 2: Snow lotus fruit stacked on the field

1.2 Project significance

When traditional artificial mining snow lotus fruit, when digging farmers digging, they usually hold their hoe with both hands, shaved the hoe down, and then outward the hoe [6]. Fixed the stems of Snow lotus stems to drag out the remaining snow lotus fruits on the stems. This method greatly consumes the physical strength of the excavator, and maintaining such a working posture will seriously affect the health and daily life. Therefore, it is not suitable for long -term excavation operations, and the efficiency is low. In Figure 3 the snow lotus fruit stacked on the field.
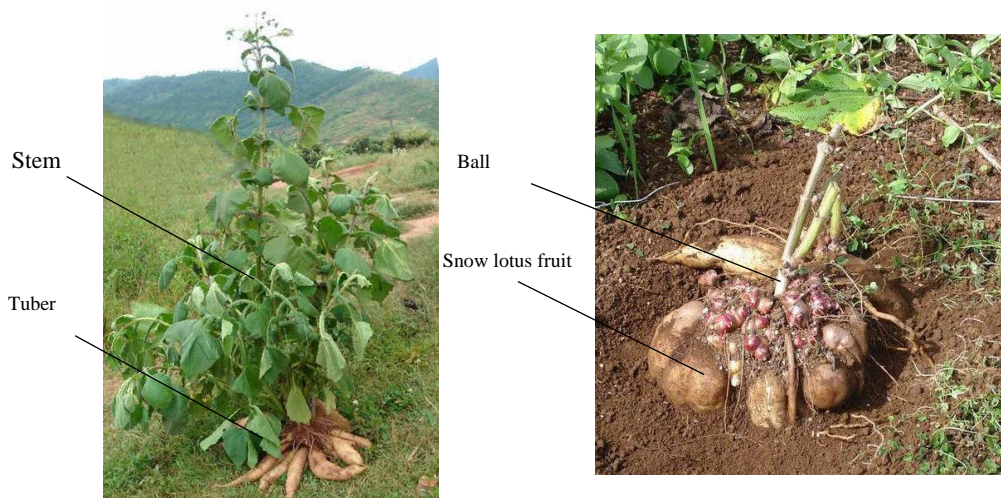
Figure 3: Snow lotus fruit parts

2. Project Design

After many investigations, China has increased year by year. Today's artificial picking is still its main picking method, but artificial picking is difficult, low efficiency, and high cost.

In order to improve the efficiency of picking, reduce the loss during picking, and reduce the cost of picking, and to improve market competitiveness, the increasing snow lotus fruit income has designed a fully automatic separation of tuber picking robots. This project is designed in accordance with the four fruits mechanical picking steps, including positioning, picking, departure, and recycling, and truly achieved the basic principles of "one accurate, three reliability, and no damage".

In order to adapt to the rugged terrain of the hills and mountains in the planting area of the snow lotus fruit [7], this device uses a deformable tire to reduce the comparison of the ground to increase the weight and protect the land [8].

In order to pick Snow lotus fruit without injury, the device simulates artificial picking. The design and use of adaptive robots can first capture the stem poles with a height of 15-20cm. Fruit branches are separated.

In order to improve the market applicability of the device, the design of this device has various institutions to regulate the height and complete the multi -angle steering from the steering mechanism to adapt to various terrain with a crawler [9]. Systems such as control make the machine intelligent. Implement the automatic positioning, picking, departure of branches, and recycling of the device. The overall design is shown in Figure 4.
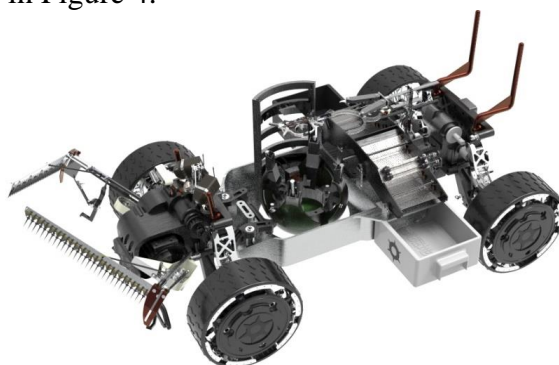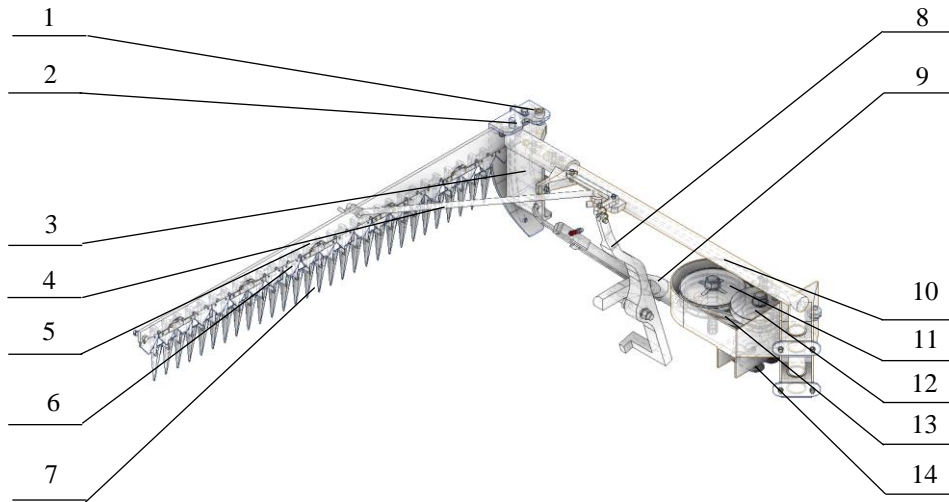

Figure 4: Snow lotus fruit picking device

3. Mechanism Design and Principle Description

3.1 Inclined stem cutting structure design

1-Fixed block; 2-front shelter fixed bolt; 3-shear support block; 4-shear support push rod; 5-shelter; 6-front triangle combed teeth; 7-can be cut with teeth; 8-dial; 9-front and rear flat push rods; 10-angle adjustment rods; 11- From the belt wheel; 12-active leather wheel; 13-multi-segment leather; 14-motor

Figure 5: The front -end angle adjustable cutting mechanism

Use appropriate concentration and content of urea, superphosphate and other fertilizers to irrigate, with a planting density of 1667 plants/667m3, a planting row spacing of 80cm $\times$ 50cm, sow 50g bulbs at the same time, and conduct inspections and records every 30 days. The results are as follows picture:
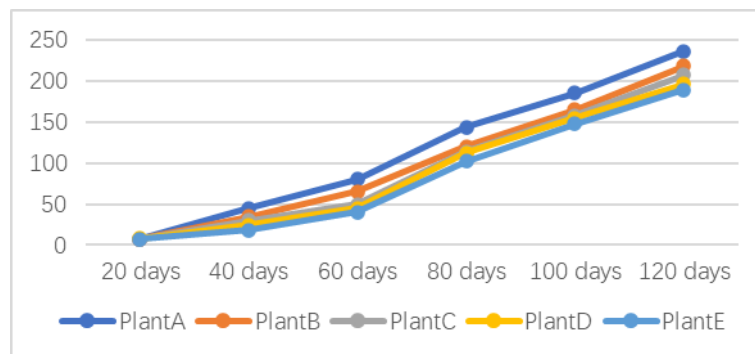

Figure 6: Different snow lotus plant plants in the same environment height

The above data and charts (this shown in Figure 8) can be seen that the height of the snow lotus fruit plants of different varieties in the same situation vary, and the height range is more than 100cm to 250cm fluctuations. Based on this situation, we have made it as shown in Figure 5 6.

The rotation of the motor drives the active leather wheel through the belt to transmission from the belt wheel, and the cam to be turned into a periodic flat. The horizontal movement of the sliding of the rack forms shearing with the forward triangular combing tooth that is pressed above the plant. It repeatedly acts on embedding the stems in the combing teeth, and the height of the plant is reduced

after cutting.

## 3.2 Transformed tire structure design

1-rubber track; 2-locked rotor; 3-friction tablets; 4-wheel spindle; 5-hydraulic cylinder; 6- Pushing rod link; 7-fixed limit connecting rod; 8-motor; 9-wheel deformation support; 10-gear box

Figure 7: Display diagram of deformation wheel device

During the wheel movement, the middle motor and the gear are directly meshing to directly drive the rotation of the wheels, and then the wheels move forward. When the snow lotus picking device encounters a continuous low -lying or difficult to pass the road, the main axis of the device is killed through a friction tablet. At this time, the planet wheel and the outer gear of the central part are relatively static. At the same time, the three hydraulic push rods of 120 °are present at the same speed to launch the same distance, the connecting rods on both sides, the rubber track close to the connecting rod deformation, etc. Become a triangle tracking motion mode. The overall design is shown in Figure 7.

3.3 Four -leaf fruit digging mechanism structure design
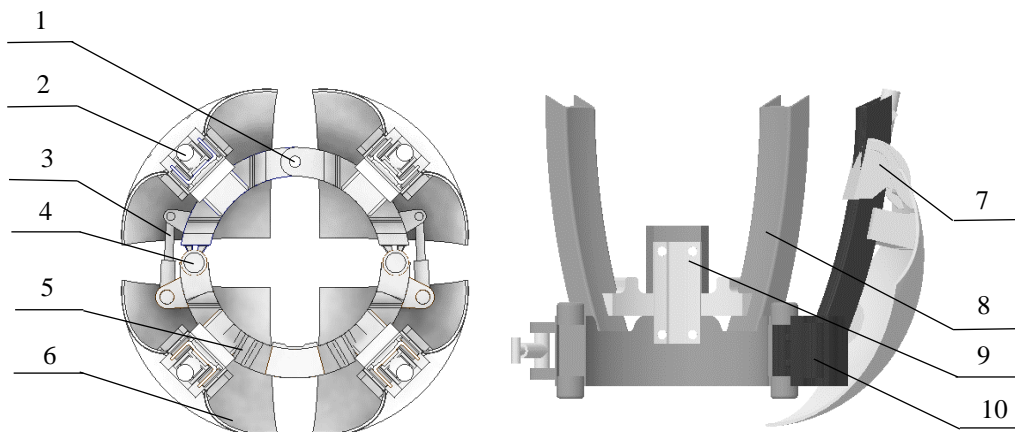
1-closed locking device; 2-shovel; 3-hydraulic manipulation valve; 4-opening and closing rotating shaft; 5-fixed bracket; 6-block shovel; 7-shovel slide rail; 8- raising fixed support; 9-lift fixed connector; 10-rotatable shovel support

Figure 8: Four -claw arc digging mechanism

The roots formed by the root can be more than 0.8m. It is distributed at 5-30cm of the farming layer. There are 13 branches of a single chrysanthemum potato, up to 36 branches. The front farming was 35 cm, forming the height of the Tianzhuang to 25 cm, and the line distance from 85 cm to 100 cm. Based on this situation, we have made it as shown in Figure 8 Four -claw arc digging mechanism. According to the volume of the sphere:

$$V = \frac{\pi}{3} * H^2 * (3R - H)$$

(5)

In the formula:
V is the size of the global body, the unit is cm3;
π is the peripheral rate, with the value of 3.1415;
R is the radius of the sphere, the unit is cm;
H is the distance from the top of the ball crown to the section, that is, the height of the ball crown, the unit is cm;

Therefore, during the process of digging the stems of the snow lotus fruit, the dug -of -soil block volume is about 220cm3, the depth of the soil of the arc -shaped four -claws of the lower part of the device is 60cm, and the curvature radius is 90cm. According to calculations, the device can be well excavated and completely digging the overall tuber part of the snow lotus fruit to reduce the damage in the process of extracting the tuber.

The tuber excavation mechanism consists of a tuber shovel, a shovel hydraulic cylinder, a shovel, and a frame support, and a closed locking device, an open and closing hydraulic cylinder. The shovel hydraulic cylinder is placed between the tap rails and the shovel. The shovel knife is dropped along the curved rail under the action of the hydraulic cylinder, and the tap of the four -claw arc -shaped round surface is inserted into the soil. The four curved surfaces behind the tuber are closed into an arc surface. By flattening the pad and flattening device, the four claws and claws containing soil lumps contain soil lumps are raised by raising the guide rail [10].

## 3.4 Adapt to the design of holding the stalk structure
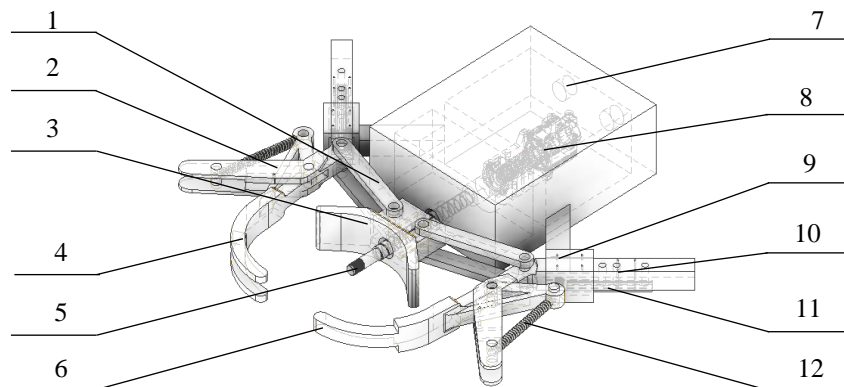
1-connecting rod; 2-claw connection bracket; 3- close the front paw; 4-two teeth close to the left paw; 5-front paw rotation shaft; 6-Single tooth close to the right paw; 7-motor in the blessing seat; 8-motor; 9-slider slide rail fixed support [11]; 10-mobile slide; 11-slide rails; 12 adaptive pull spring

Figure 9: Adaptive clamping mechanism [12]

The device rotates the roller screw -based motor through the motor to rotate the front paws forward. The four links on both sides are driven by the front paw connection with a mobile slide rail. The middle part of the blessing mechanism is locked, and the front paws of the left and right teeth are

gradually closed under the action of adaptability [13]. The flexible material with a large friction coefficient with a large friction coating is added to improve the reliability and stability of the grip. Based on this situation, we have made it as shown in Figure 9 Adaptive clamping mechanism.

3.5 Block stems extraction separation structure design
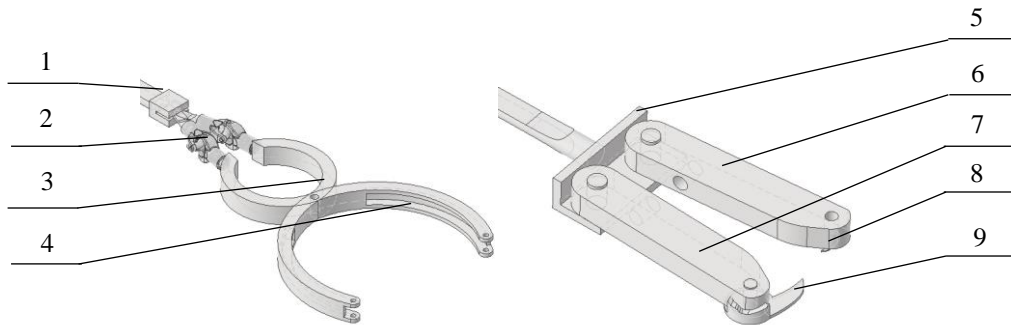
1-Blocking stem support; 2-turnable to the universal section; 3-right clamping mechanism; 4-left clip holding mechanism; 5-cutting mechanism support; 6-right shear; 7-left shelter; 8-right cut; 9-left cut;

Figure 10: Robotic arms diagram

The device drives the gear rotation through the motor to realize the adaptive flexible semi -curved picking device and one -way shear device to move the direction of the snow lotus fruit. The picking device will be locked by itself. At this time, the picking device cannot be moved. One -way cutting device will continue to move forward. When the stems are between left and right cuts, the gear of the parallel joystick will be separated separately, respectively. To mesh with the racks of the two devices to achieve synchronous motion. One -way shear device moves towards the negative direction of Xuelian fruit. Grasp the snow lotus fruit. Based on this situation, we have made it as shown in Figure 10 Robotic arms diagram.

4. Calculate the determination of the size and the strength of the intensity

4.1 Test of grinding fineness

4.1.1 Flexible package feasibility

According to the principle of the motion of the device, we can see that the rod and hydraulic device converted into triangular tracking motion during the motion of the device can simplify it into the following crank slider mechanism. This is shown in Figure 11:
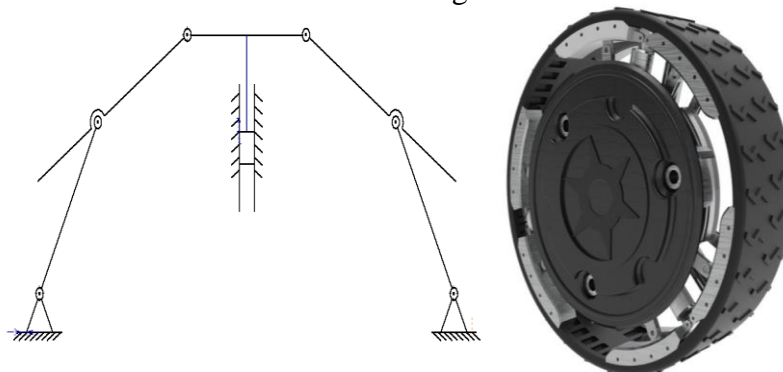

Figure 11: Simple diagram of variability tire mechanism

Analysis of institutional freedom of the device:

$$P = 3 \times n - 2 \times P_l - 1 \times P_h - k$$

(6)

In the formula:
P is the number of freedom of the device;
n build a number for institutions;
Ph The number of high sidelines;
Pl is the number of low sidelines;;
k is constrained by virtual.
In the mechanism, n is 5, pH is 0, PL is 7, and k is 0;
Therefore, the device has a stable and unique movement.

4.1.2 Institutional motion speed and acceleration

The crank length of the design device is 17.0cm long; the length of the link is 10.2cm in length; the eccentric distance E of the slider is 6.2cm. Installation speed map shown in Figure 12.
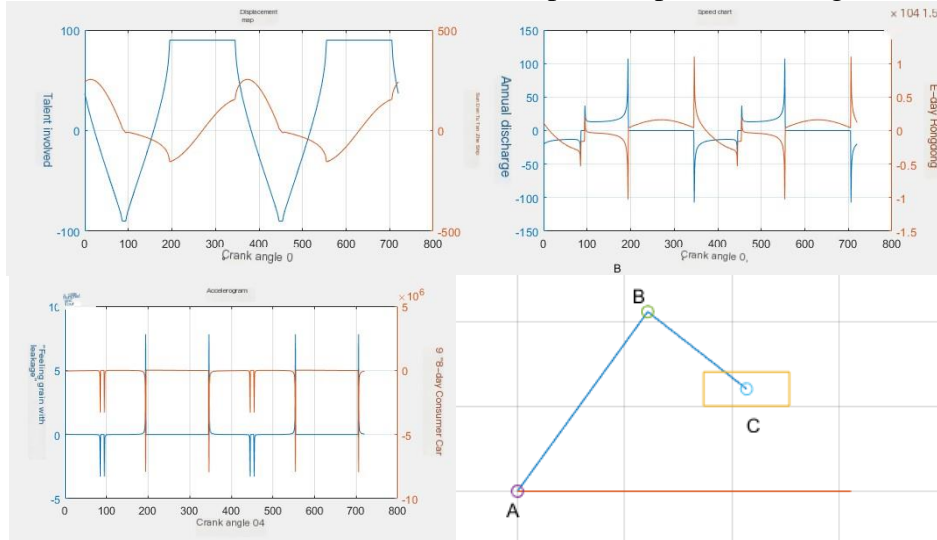

Figure 12: Installation speed map

4.1.3 Resistance and selection during the track movement process

In the process of tracking, the environment encountered is more difficult, and it determines the limits of the movement of the device.
When the Snow Lotus Fruit picking car is working

$$F_z = F_f + F_x = mgf + mgf_x$$

(7)

In the formula:
Fz is the total resistance of the device, the unit is N;
Ff is the external resistance during the installation movement. It is mainly rolling friction. The unit is N;
Fx is the internal resistance during the installation motion, the unit is N;
f is the coefficient of friction during the exercise;
fx is the internal friction coefficient during exercise.

Table 2: The rolling friction coefficient of the track wheel on different ground

Movement	Resistance
Pavement	0.05~0.06
Dry soil	0.06~0.07
Wet soil	0.08~0.10
Sandy ground	0.12~0.16
Swamp	0.12~0.18

The weight of the snow lotus fruit picking device is about 80kg (when it is full of snow lotus fruit); when facing the maximum roll coefficient on the ground, the speed is 0.7m/s, and the device FZ is about 1960N. This is shown in Table 2.

$$M_z = F_z \times r$$

(8)

The r is 0.18 ×0.7m = 0.126m, and the resistance is 245.96n • m.

Therefore, the torque selection of the motor should be greater than 61.74n • m.

5. Overall plan thinking and summary

5.1 Overall innovation point

1) Variable circular wheels can cope with the picking of mountains for adaptability.

2) The device designs the electromagnetic device controlled by the Zhan's segregation and the separation of the itinerary switch control.

3) Device frame and axis fixed parts, lightweight design, and improve the stability of the device to reduce the quality of the device.

4) The device design of the tuber digging, the snow lotus fruit recognition, the tremor and shaking soil, and the overall snow lotus fruit picking device.

5) Imitate artificial picking, cutting stems, and holding stems.

5.1 Promotion prospect

According to the requirements and technical parameters, the size of the snowdrop fruit picking car frame is CM ×CM. The mobile robot equipped with a reliable robotic arm is a hotspot of modern industrial research and life. Capture, shear separation and recycling, etc., the corresponding knife mouth can be replaced by the knife mouth of different fruits for cutting and positioning.

The device can have a good harvesting effect on the potato device. It has a good identification and separation of a cluster of multi-steming plants such as potato, etc., to achieve a reliable harvest of large underground plants, and to fruit species, and fruit species. Reserve to achieve the purpose of multi -angle collection and sustainable planting. Crossing the cut stems to achieve the utility of returning to the field. The rake of plowing the field in the parking space can be better for sustainable planting.

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