Design and exploration of an apple sorting baler

Zhun Luo1, Lihua Ma2,*, Zhonghua Zhou1, Senjun Jia3, Zongguo Fu1

1School of Marine and Mechanical Engineering, Zhejiang Ocean University, Zhoushan, Zhejiang, 316022, China
2School of Foreign Languages, Zhejiang Ocean University, Zhoushan, Zhejiang, 316022, China
3Zhoushan Knowledge & Innovation Technology Development Co., LTD., Zhoushan, Zhejiang, 316000 China

*Corresponding author e-mail: zsmalihua@126.com

Abstract. The packaging classification for the more vulnerable objects such as apple is only at the stage of manual classification, which is not only time-consuming and laborious, but also cannot accurately sort apples. Therefore, a design scheme of apple sorting and packaging machine is proposed. The structure of the machine and the functions of each part are systematically expounded. The functional modules of bad fruit removal, wax drying, intelligent classification and bagging are analyzed. The design scheme is to reduce the apples' surface damage, improve the degree of mechanization.

Keywords: Apple sorting; bagging; classification.

1. Introduction

Apple has the reputation of "smart fruit" and "memory fruit." People have long discovered that eating more apples has the effect of improving memory and improving intelligence. Apples are not only rich in essential nutrients such as sugar, vitamins and minerals, but more importantly, they are rich in zinc [1].

In recent years, along with the increase in fruit export volume, how to determine a fast, effective and efficient screening and sorting method is extremely urgent. At present, the more easily damaged package classifications such as apples only stay in the stage of manual classification, which is time-consuming and laborious, and it is not easy to sort apples more accurately [2]. Moreover, the effect of sorting is often not ideal, the manual error is large and the labor efficiency is low. Compared with the automated machine, the efficiency of manual execution and the execution effect are not strictly guaranteed. Therefore, the automatic sorting machine has been introduced in the market, which can accurately sort the size of fruits and vegetables by weight, and can distinguish according to the weight grade [3~5], which better meets the export standard, thus saving labor and labor. Time is a good thing to do both. However, it is rare to see manufacturers that develop fruit automatic sorters as the main industry in China. Even if there are manufacturers, the input costs are high, the cost of automatic production lines is high, and most sorting opportunities cause damage to apples. Therefore, these products should not be put into the market in large quantities.
This paper designs an apple sorting baler, which can realize fast sorting according to the size of apple, and fully package the sorted apples, which not only mechanizes, but also reduces the surface damage of apples and improves apples quality.

2. Apple sorting machine design
According to the working principle of sorting and summarizing, the sorting machine combines various mechanical components, mainly composed of screening dust removal, air drying, conveying classification and bagging packaging [6]. Each part cooperates with each other to complete the sorting work of the machine. The power source of each part is provided by an external motor to complete the normal operation of the system.

2.1. Machine body structure
The body design of the apple sorting machine is mainly divided into four parts: vibrating plate, conveying channel, double-roller indexing plate, bagging packaging; vibrating plate is mainly used for dust removal screening, conveying channel is mainly used for cleaning air-drying wax, double roller dial is mainly used for the classification of apples in large, medium and small. The last part is to carry out bagging classification of apples into their respective storage boxes. The four parts are combined with each other to complete the sorting and packaging classification work.

![Figure 1. Apple sorting device diagram](image)

2.2. Machine control composition
The control design of the apple sorting and packaging machine is mainly based on the motion characteristics between the mechanical mechanisms, supplemented by the external motor to provide the power source, relying on the hydraulic control system to complete the cutting and fusion of the packaging bag and the electromagnetic control system to achieve the sandwiching and relaxation of the apple. The sorting and packaging of the apple can be completed without using the detecting device, and the sorting efficiency is high.

3. Machine function module
The main purpose of the apple sorting machine is to complete the sorting and bagging of the apples. To accomplish this, the apples need to be cleaned to remove stains, sprayed with wax, sorted according to size, packaged and packaged. The specific implementation is as follows.

3.1. Vibration dust removal
The vibrating dust disk is tilted so that the apple rolls under the action of its own gravity toward the screen hole [7]. The outlet end of the vibrating plate is connected with a conveyor belt, and a sieve hole is opened at the outlet, and the apple passes through the sieve hole after vibrating and dusting. The size of the mesh hole is set to satisfy only one apple passing, preventing the apple from accumulating on the conveyor belt, causing the surface damage of the apple to affect the taste; the roller in the vibrating plate
is spirally scrolled as shown in FIG. 3, and the apple is rolled toward the middle, so that Order through the mesh.

3.2. Cleaning spray wax
After the dust-removed apple, some dirt remains on the surface, and it needs to be cleaned at this time. Therefore, a row of water spray cleaners is arranged at the starting position of the transfer channel, and the flow pipe is arranged in the bracket and communicates with the outside. When the apple of the hole came here, the sprinkler worked to clean the residual dust on the surface of the apple. At the same time, based on the special design of the conveying channel, the roller was embedded with a part of the roller exposed on the surface of the conveyor belt. The setting of the roller was effectively slowed down. The rolling speed of the apple prevents the apple from colliding with the two side walls of the conveying channel too quickly, causing damage to the surface of the apple. The distance between the rollers is preferably the diameter of an apple. This setting allows the apple to reach the first roller. By the rolling action of the drum, changing the behavior before rolling and moving forward, and then passing the second roller, this setting can send the apple to the indexing plate in a transfer manner, reducing the number of rolling circles of the apple and reducing the damage of the apple. The rotating shaft is fixedly connected to the conveying passage and perpendicular to the longitudinal direction of the conveyor belt, and the barrel wall of the drum is provided with a strip-shaped groove body, and a ball is embedded in the strip-shaped groove body for pushing the apple mobile. The apple rotates irregularly at any angle on the surface of the drum, and functions as a friction cleaning. The cleaned apple continues to move forward under the action of the drum. Since the front cleaning will cause some water droplets on the surface of the apple, the conveying passage needs to be The air drying device is installed, and the hot air blown by the air dryer removes the water droplets remaining on the surface of the apple. After the previous cleaning and air drying, the residual stain on the surface of the apple is extremely small, which meets the requirements of wax spraying [8]. Then, through the wax spraying part on the conveying passage, the setting of the wax spraying pipe is the same as that of the water sprayer, and is arranged in the bracket to communicate with the outside, and the spraying wax is separated from the water spraying device by a certain distance to prevent mutual doping and waxing substances. The use of pollution-free fruit glue, waste water and fruit glue after subsequent recycling and reuse, after spraying the apple, because the surface of the liquid has not fully cured, it is necessary to carry out subsequent air drying operations, so that the surface of the apple The pectin is completely solidified.
Figure 4. Shows the transmission channel

1-Air dried part; 2-Spraying wax part; 3- Air dried part; 4-Water spray

Figure 5. Transmission channel

5- fan; 6- roller; 7-Ball; 8- Nozzle

Figure 6. Transmission channel partial view

Figure 7. &8. water spray, spray head and air drying device
3.3. Classification
After the apple spray is air-dried, it continues to move to the next stage. At the discharge end of the conveying channel, there is an indexing plate [9] controlled by a belt roller mechanism. The indexing plate is evenly provided with a triangular opening slot, and the slot is inside. On the side, there is a three-stage grading plate which is arranged downwardly from the outside to the inside. The apple reaches the indexing plate through the conveyor belt, and the indexing plate is controlled by the belt roller mechanism. Four indexing grooves are arranged on the indexing plate to realize four The indexing mechanism can control the indexing plate to perform a one-way periodic rotation with a stop, and the grading plate in the notch on the indexing plate is reduced in size from the outside to the inside, so that the apple can be stuck on different grading boards according to different sizes. Between the indexing plate, the apple can be divided into three levels: large, medium and small. The movement coefficient of the belt roller mechanism is determined by the turnover frequency of the roller mechanism. The middle of the surface of the indexing plate is provided with a connecting rod supporting the double roller mechanism, and under the double roller mechanism. There are respectively a push-in board that can push the apple into the slot and an push-out board that can push the apple out of the slot, and the push-in board is rigidly connected with the roller, and can prevent the apple from being hit as the roller rotates. By having a double roller mechanism, it is possible to avoid device jamming during the push and push of the apple. The driving wheel axle of the indexing wheel mechanism is connected with the transmission mechanism of the speed regulating gear box, and the regularity rotation of the indexing plate is controlled by the speed regulating gear box, so that the apple is graded on the corresponding matching conveyor belt, which is beneficial to improve the classification efficiency of the apple. Moreover, the use of a speed-regulating gearbox eliminates manual operations, reduces labor, and automates.

A spring is connected between the grading plate and the indexing plate, and an electromagnet for repelling the grading plate is arranged on the indexing plate. The material of each grading plate is magnetic material, which is the same magnetic as the electromagnet, and the electromagnet can control each grading plate. The grading plate is rejected by the electromagnet to make the grading plate outward. The grading plate is provided with an anti-slip ring, and the anti-slip ring is composed of a plurality of curved rubber strips. When the apple moves to the end of the transport, the push-in plate pushes it between the corresponding graded plates, forcing the graded plate to squeeze inward, the spring contracts, and because the magnets are repulsive with the same sex [10], the graded plate is clamped Apple, then the indexing plate turns to the other end, at this time, the electromagnet is disconnected, the grading plate is restored to its original state, and the apple falls into the receiving funnel at the lower end. Since different sizes of apples are pushed into the plate and pushed into the three-level grading plate. Different positions, when going to the other side, will also be pushed out of the board and into the different sizes of the receiving funnel to complete the apple's large, medium and small classification.

![Figure 8. Classification device diagram](image-url)
3.4. Bagging

After the previous classification, the large, medium and small apples fall into their respective funnel pipes. The end of the pipe is connected with a plastic packaging bag. At the same time, three sets of resistance wires that can move in opposite directions are arranged on both sides of the pipe. The control of the resistance wire in the hydraulic system under the intermittent reciprocating movement to the middle [11], the temperature of the three sets of resistance wires is different, the temperature of the lowermost resistance wire is moderate, just enough to make the plastic bags stick together, the middle
layer resistance wire is high temperature, used to blow the plastic bag, the most The temperature of the upper resistance wire group is the same as that of the lowermost resistance wire group, and the functions are also the same. The three sets of resistance wires work together to realize the sealing-cutting-sealing of the plastic bag, and the apples that have been bagged fall into the conveyor belt and enter the respective belts with the conveyor belt. Complete all work in the storage box.

4. Conclusion
Compared with the prior art, the beneficial effects of the present invention are as follows: 1) apples can be stuck between different graded boards according to different sizes of apples, apples can be divided into large, medium and small grades for sorting; 2) set on conveyor belts Roller, reduce the number of rolling circles of apples, reduce apple damage; 3) can pack the fully-automatic bag of sorted apples. The adoption of this device will greatly shorten the sorting cycle, improve efficiency, reduce costs, and provide a strong guarantee for mechanized agriculture.

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