Design of Weighing Controller for Kiwi Fruit Grading Based on PLC and MCGS

Baijie Ma¹, Tianyu Zhang² and Ning Guo³*
¹College of Mechanical and Electronic Engineering Shandong Agricultural and Engineering University Jinan, Shandong,250100,China
²College of Mechanical and Electronic Engineering Shandong Agricultural and Engineering University Jinan, Shandong,250100,China
³College of Law Shandong Jianzhu University Jinan,Shandong,250100,China
*Corresponding author’s e-mail: mabaijie@163.com;ningguo2011@126.com

Abstract: At present, after picking kiwifruit in China, most areas have used machines to classify them, gradually replacing manual classification. However, machine classification is currently all large-scale machines, with an average of about 150kg, and the cost is high. It cannot be classified immediately after picking. Transportation is inconvenient, which may lead to inaccurate results, thereby affecting efficiency. Therefore, based on this situation, this article simplifies and improves the large-scale sorting machine. On this basis, the design consists of conveyor belt, pressure sensor N340, stepper motor, stepper driver, MCGS HMI touch screen, air cylinder, ID551, ISD1730 language A medium-sized kiwi fruit grading control system composed of broadcast module, photoelectric switch, aluminum alloy bracket, etc. After the system runs, the kiwi fruit senses the weight through the pressure sensor, and then enters the corresponding grade box according to the weight. The fruit quality is measured according to the fruit weight, and the effect is tested better.

1. Introduction
Kiwifruit has a unique flavor and is rich in minerals, which has a good effect on maintaining human health. At present, after kiwi fruit is ripe and picked, most places begin to grade kiwi fruit. There are three main methods for grading kiwi fruit: fruit size grading, appearance quality grading, and fruit weight grading. The fruit size grading method is based on the size characteristics of the kiwi fruit. According to the size characteristics of each kiwi fruit, the kiwi fruit with a larger cross-sectional area is of better quality, and the smaller grade is lower. This is the fruit size grading method [1]; The quality classification method is mainly based on the identification of the color of the kiwi fruit. The fruit of kiwi fruit has many different colors. From the color type of the fruit, there are mainly four types of green flesh, yellow flesh, red heart and all red. An overall value of the kiwi fruit market can be seen in the 9th World Trade Association. From the data provided by the association, the green pulp kiwi fruit currently has the highest sales volume in the global market. It is the first choice of customers, and it is usually what we said "Original kiwifruit", the second is the yellow fleshed kiwi, the sales volume is second only to the green fleshed kiwi, it is also the hottest type in recent years, the third is the red heart type kiwi, the last is the all red type Kiwifruit [2]; Fruit weight grading currently has the best prospects. This article will introduce grading by fruit weight.
There are currently two main methods for fruit weight classification, subjective factor classification and super-large mechanical classification. The subjective factor classification method is most commonly used, but the efficiency is too low and the labor is large, and the task is often not completed in a day. And this method is easily affected by subjective factors. For example, some people think that this kind of good is a high-level result, while some people do not agree with the result, so the accuracy rate is low. At present, most of the mechanical classification methods used are classified by large-scale weighing and sorting machines. However, large-scale weighing and sorting machines are expensive, complicated to operate, and inconvenient to transport, so it is currently difficult to promote.

2. Design Scheme of Kiwi Fruit Grading Controller
The three-dimensional design diagram of the kiwi fruit weighing and grading controller based on PLC and MCGS is shown in Figure 1. The grading system is mainly composed of pressure sensor N340, stepper motor, stepper driver, MCGS HMI touch screen, air cylinder, ID551, ISD1730 language. It is composed of broadcast module, photoelectric switch, aluminum alloy bracket and other parts. The conveyor belt is slightly skewed towards the slope. The resistance strain pressure sensor N340 is at the lowest part of the conveyor belt, close to the slope. The running speed of the belt is 0.4m/s. According to the approach time of the kiwi, the four slopes are "A grade fruit" Outflow Slope", "Class B Fruit Outflow Slope", "Class C Fruit Outflow Slope", "Class D Fruit Outflow Slope", and the final outflow directly from the end of the conveyor belt is the "Secondary Fruit Outflow Slope", also called "unqualified" Fruit flows out of the slope".

Each slope is covered with a conveyor belt that slowly drives from bottom to top. Because the volume of the medium controller is relatively small or slightly larger, the kiwi is still slightly higher when it slides to the box. If you use the slope directly, it may cause the next kiwi fruit to collide with the previous kiwi fruit, causing the quality of the kiwi fruit to decrease, causing unnecessary loss. The conveyor belt has a certain friction, and the operation from bottom to top will give the kiwi fruit a resistance and friction, making the kiwi ideal. The kiwi fruit can just stay slowly, ensuring the original quality of the kiwi fruit and better maintaining the income of the fruit grower.

The working principle of the system is: After the equipment is calibrated and run, the operator pours the kiwi fruit into the equipment, and the kiwi fruit runs slowly along the conveyor belt. Because the conveyor belt has a certain slope, the kiwi fruit runs in rows at the lowest end and reaches the sensor at the slope. When using the sensor’s anti-pressure principle, if the pressure sensor of the “A grade fruit outflow slope” cannot bear the weight of the kiwi, the sensor will deform, and the resistance value of the resistance strain gauge will increase or decrease with the deformation, and then be measured. The circuit converts the resistance into a current signal to make the stepper motor work. After the stepper motor runs, it transmits a pulse signal to the photoelectric switch. At this time, the photoelectric switch will control the solenoid valve to conduct, and the cylinder (the pressure setting range of the cylinder is from 0 to 1bar) ascending, pushing the baffle open, the kiwi fruit enters the conveyor belt slope and flows to the box. This kiwi fruit is a grade A fruit. Correspondingly, the remaining B-grade fruit, C-grade fruit, and D-grade fruit have the same principle. When all the pressure sensors can bear the weight of the kiwi fruit, the kiwi fruit flows out smoothly, and the secondary kiwi fruit is the secondary fruit, which means we say no Qualified kiwi fruit.
As shown in the system flow chart of Figure 2, the weight of kiwi fruit of type A is above 110g, the weight of type B fruit is 100-110g, the weight of type C fruit is 90-100g, and the weight of type D fruit is in the range 80-90g, and the weight of the secondary fruit is below 80g, every time the sensor cannot bear the weight of a kiwi, it will fall into the corresponding conveyor belt landslide, and the ID551 weighing display controller measures the real-time weight of the kiwi, and the ISD1730 voice broadcasts Types of kiwi fruit.

The above is the introduction of the equipment operation process. Based on these introductions, a simple I/O allocation table can be designed, as shown in the following table 1. Because the working principle of the conveyor belt slope is the same, this time only three conveyor belts are used to show the corresponding allocation. table [3].
3. Research application and debugging

After Siemens S7-200smart writes the program, it is input into the device, and the software and hardware are tested together, and finally the operation is completed. The main page is displayed on the MCGS display screen, which is divided into three sub-interfaces: operation, calibration, and debugging [4].

The running interface mainly records the number and total number of various varieties, real-time weight, belt running status and speed. In addition, you can see the buttons for program running and program stop, and you can control the start and end of the program at any time, which greatly saves production preparation time. To improve production efficiency, and there is also a back button to return to the main interface for viewing.

The calibration interface is the calibration interface after the device is restarted. The calibration is divided into zero point calibration and span calibration. You can only operate on this interface when the device is stationary. After the program is re-downloaded to the PLC, the weighing will be inaccurate, so every download The program needs to perform a weighing calibration. After entering the program, click the zero point calibration first, and see that the interface displays "0" to indicate that the calibration is successful; then click the span calibration button and see the screen display 1KG (calibration requires a standard weight weight), Indicates that the span calibration is successful, and the calibration process is officially completed at this point.

The debugging interface displays the different weights of the kiwi, the speed of the belt, the corresponding delay time and weighing time, and the cylinder start time. In addition, there are functions of resetting the count, re-debugging, and returning to the main interface.

A total of 100 kiwifruits of different weights were selected for this debugging. After inputting the program into the device and calibrating, the kiwifruits were transferred to the pressure sensor one by one for weight compression, and compared with the large scale weighing machine and manual classification results. The classification result of the system is better, the classification accuracy rate reaches the standard, and the ideal classification can be achieved.

4. Concluding remarks

This design scheme improves the complex structure and high cost of the large weighing and sorting machine, and also gets rid of the influence of subjective factors on manual classification. It has a high accuracy rate and has greater value meaning. It can be seen from the debugging results of the equipment that the equipment productivity is better, it can achieve more ideal classification, better promote the development of the kiwi fruit industry and maintain the interests of fruit farmers.

| address | Comment                      |
|---------|------------------------------|
| I0.0    | Photoelectric 0              |
| I0.1    | Photoelectric 1              |
| I0.2    | Photoelectric 2              |
| I0.3    | Photoelectric 3              |
| Q0.0    | Step 0 pulse input (belt 0)  |
| Q0.1    | Step 1 pulse input (belt 1)  |
| Q0.2    | Step 2 pulse input (belt 2)  |
| Q0.3    | Step 0 direction (belt 0 direction) |
| Q0.4    | Step 1 direction (belt 1 direction) |
| Q0.5    | Step 2 direction (belt 2 direction) |
| Q0.6    | Solenoid valve 1             |
| Q0.7    | Solenoid valve 2             |
| Q1.0    | Solenoid valve 3             |
| Q1.1    | Solenoid valve 4             |
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References
[1] Mo Y.Z, Duan J.H, Shen B, et al. (2014)Kiwi fruit size classification detection algorithm based on area[J]. Electronic World,168:257-258.
[2] Qi X.J, Xu S.K, Lin M.M, et al. (2015)Research progress on the coloring mechanism of red-fleshed kiwi fruit[J]. Journal of Fruit Science, 192: 1232-1240.
[3] Huang Y.L. Ying Y.B.(2002)Synchronous tracking automatic control device for apple real-time grading system [J]. Journal of Agricultural Engineering. 187:262-263.
[4] Ji N. (2019)Design of kiwi fruit weighing and grading controller based on PLC and MCGS[J]. Yangling Vocational and Technical College, 166:262-263.