Design for the Control System of Intelligent Fruit Picker

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Abstract

At present, apple picking in China mainly relies on manual labor, and there are some problems such as heavy workload, wide operation range, high requirement of contact strength control and selective picking. In order to improve the efficiency of apple picking, reduce labor intensity and cost, and guarantee the quality of fruit products, an electric automatic apple picking device based on the control of a single chip microcomputer is designed in this paper. The motion part is provided with kinetic energy by the motor, and the control part is controlled by the single-chip computer to collect. The fruit is inserted into the fruit picker through the person holding the fruit picker, and the fruit is sensed by the ultrasonic distance sensor to enter the fruit picker and extracted automatically. This product is easy to operate and maintain, with strong adaptability, low cost, easy to promote the advantages. It's a portable, affordable picking device that farmers can afford.

Keywords

efficient and safe, venous bionic cloth bag, acoustic distance sensor, microcontroller control.

1. Introduction

China is the world's largest fruit producing country. However, with the rapid development of science and technology, fruit picking in China is far behind the pace of the times. At present, the apple picking in China is still mainly artificial, the labor force is large, the labor intensity is big, the work efficiency is low, the labor cost is big, the high place Apple needs the high ladder assistant, the operation is inconvenient, the transportation process is easy to cause the fruit damage. It is found that although some achievements have been made in agricultural robots in China, the robot fruit picker with complex intelligence is mainly composed of manipulator and terminal actuator. However, because of the complexity and uncertainty of the actual working environment, its intelligent level is far from the level of agricultural production and its cost is high. The price is too high for the growers to afford.

In view of the above problems, a fruit picking device is designed, which uses a motor to control the cutting of the tool head and is not affected by the dense fruit branches. It can save time, ensure safety and improve picking efficiency and picking quality.

Figure 1. Artificial picking

Figure 2. Robot picking

2. Domestic and Foreign Research Overviews.

According to the investigation, the fruit picking robot developed in some developed countries is only suitable for large workspace, and is influenced by technology, price, market and so on. It has long

distance from practical and commercialized. In China, because of the limited cultural level of fruit farmers, it is difficult to operate, and the cost of fruit picking robots is higher. Agriculture is difficult to accept, so the generality is poor, in addition, there is little centralized modern orchard suitable for mechanization, and fruit picking robot can not be put into practical application for a long time.

3. Brief Introductions of the Principle of Work

The portable automatic grab fruit picking device is composed of a telescopic support rod, a single chip microcomputer a small electromotor and a vein bionic transmission cloth bag.The fruit picking motion part of the picker is provided with the kinetic energy by the small motor, which is controlled by the microcontroller to collect the process.The fruit was inserted into the fruit picker through a human hand picker, and the fruit was sensed by the ultrasonic distance sensor and picked automatically.

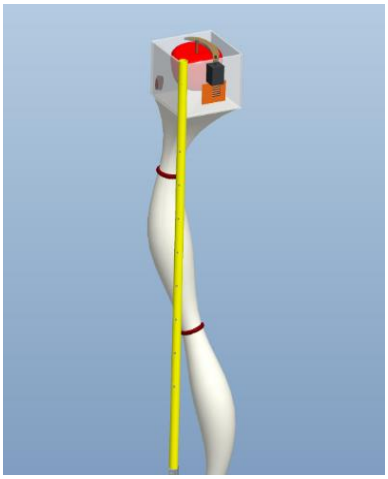

Figure 3. Electrodynamic fruit picker

3.1 Overall Design

The fruit picking device is high 180cm. The telescopic rod is made of non aluminum alloy. The strength is light and easy to handle. The telescopic rod can easily adjust the best fruit picking length according to the height of the fruit tree and improve the adaptation range of the fruit picking device. The transmission part of the apple, which uses a transmission bag with a vein like structure, can effectively slow down the decline of the apple and minimize the damage to the apple in the transmission process.

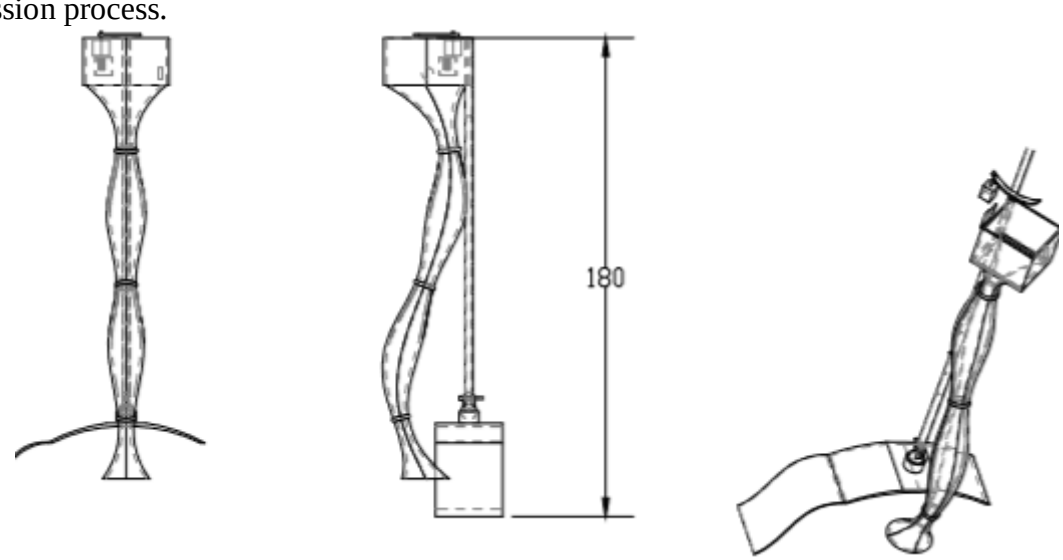

Figure 4. Overall design of fruit picker

3.2 Plucking Part

The picking part of the fruit picker is a sleeve composed of four cuboids surrounded by acrylic sheets, with side length of 14cm and height of 15cm.Acrylic board is light, light, high and transparent. It not only provides a place for the motor and so on, but also makes it easy to observe the apple position when picking fruit. The ultrasonic distance sensor is installed in the middle position of the picker, and the status of fruit in the picker is perceived. The steering gear is fixed on the side of the sleeve through the fishplate and the sharp blade. When the apple is detected at the right position, the steering gear rotates 180 degrees to cut the apple stem.

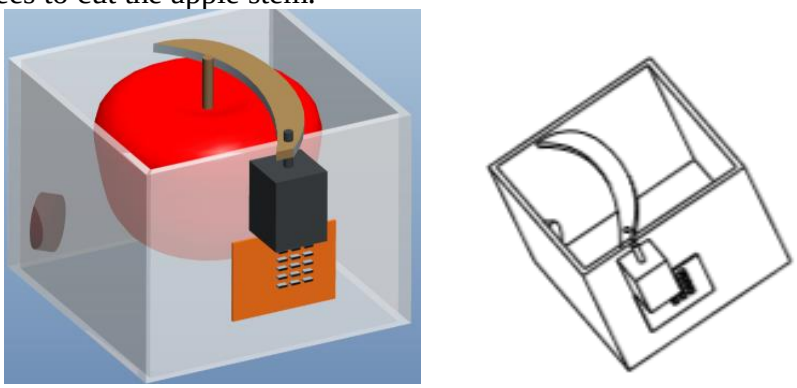

Figure 5. Picking part based on ultrasonic distance sensor

3.3 Vein Bionic Transmission Cloth Bag

The transmission bag is made of soft, smooth cloth and processed into cylindrical shape. In the middle of the cloth bag, there are several fruit falling buffer layers made of extensible knot material, like the human vein, using the adjustment point to adjust the size of the cross sections. In the process of apple falling, the adjustment section is slightly smaller and the apple is resistant to the apple, so that the apple has been at a steady and slow motion in the course of falling. The state reduces the speed of fruit dropping and reduces the collision.

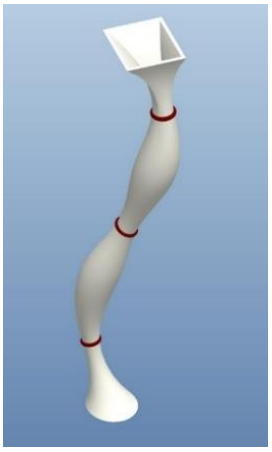

Figure 6. A lightweight vein bionic transmission bag

3.4 Retractable Transmission Rod

The telescopic rod is composed of two telescopic supporting rods to form the skeleton of the picking device, which plays an overall supporting role for the picking device. The fruit picking device can be retracked from 1.8 meters to 3 meters, thus achieving the picking of fruits with different heights. In the telescopic rod, the transmission lever can be adjusted with adjustable length through ingenious design. As shown in the Figure 7：

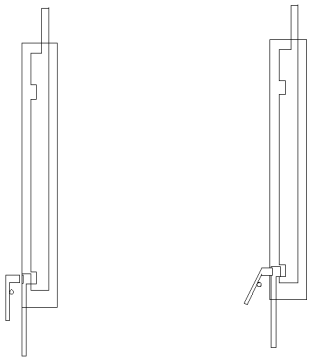

Figure 7. Retractable transmission rod

3.5 Distance Sensor and Control Chip

The principle of hc-sr04 ultrasonic sensor is: after the ultrasonic ranging module triggers the signal, it emits the ultrasonic wave. When the ultrasonic wave is projected onto the object and reflected back, it calculates whether the apple enters the picker by calculating the time difference between receiving information and sending information. The ultrasonic sensor has the advantages of acuteness, no visual blind area and no interference by obstacles.

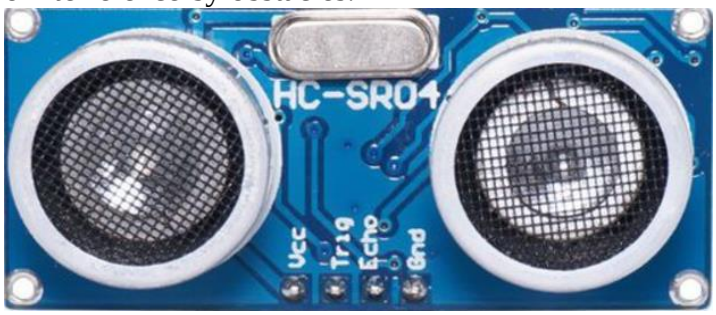

Figure 8. The Ultrasonic distance sensor

MK60FX512VLQ15 is the core controller of this system. The MK60 MCU USES 5V power supply, and the I/O port can be compatible with 5V input voltage. The low on-chip voltage makes CPU operation speed fast and power consumption low, so the MK60 MCU is especially suitable for low power consumption. In this design, 5V external power supply is used to power K60 microcontroller. By monitoring the ultrasonic distance sensor, it can determine whether there are apples in, and then decide whether to pick apples.

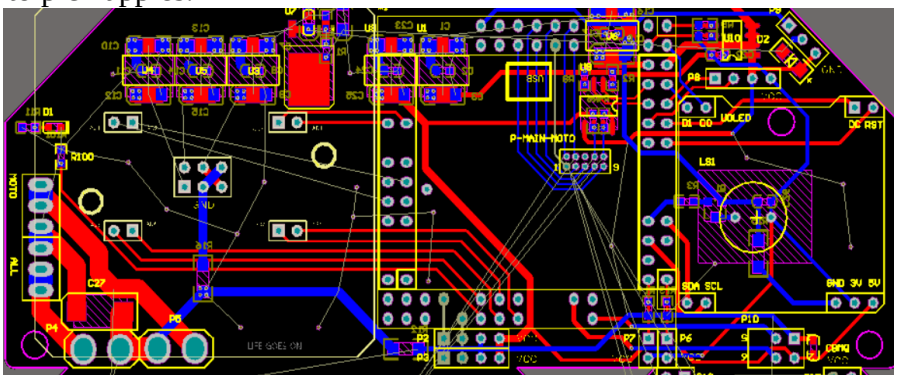

Figure 9. The Schematic diagram of PCB main board

3.6 The Power Part

In the design, in addition to the basic parameters such as voltage range and current capacity, it also needs to be optimized in terms of power conversion efficiency, noise reduction, interference prevention and circuit simplicity. Reliable power supply scheme is the foundation of the whole hardware circuit stable and reliable operation.

Power supply for all hardware circuits is provided by 7.2v 2000mAh ni-cd nickel cadmium charging. Since the operating voltage and current capacity required by different circuit modules in the circuit are different, the power module should contain multiple voltage stabilizing circuits to convert the charging battery voltage into the voltage required by each module.

To meet the needs, there are two supply voltages as shown in the figure:

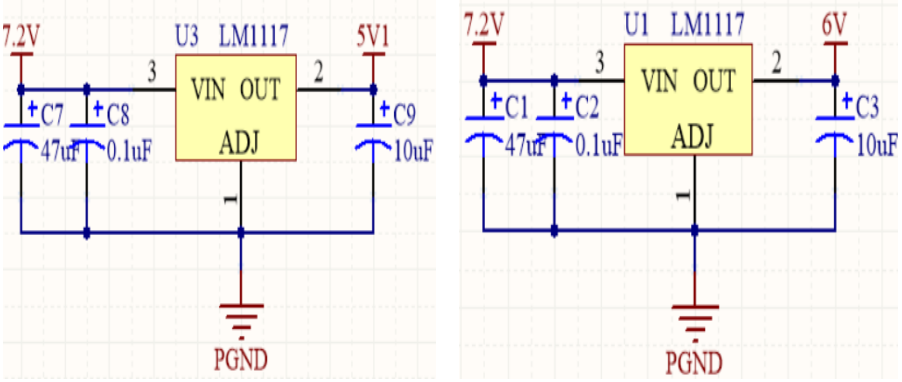

Figure 10. 5V and 6V power

4. Introduction to Control Strategy

Under the working mode of the fruit picker, the ultrasonic sensor is in the real-time monitoring mode. When the apple enters the fruit picker, the system detects the signal of apple entry, and then continues to wait for a second to detect again. If the apple enters without error, the single-chip computer will control the steering gear output, and the steering gear will drive the knife for fruit picking.

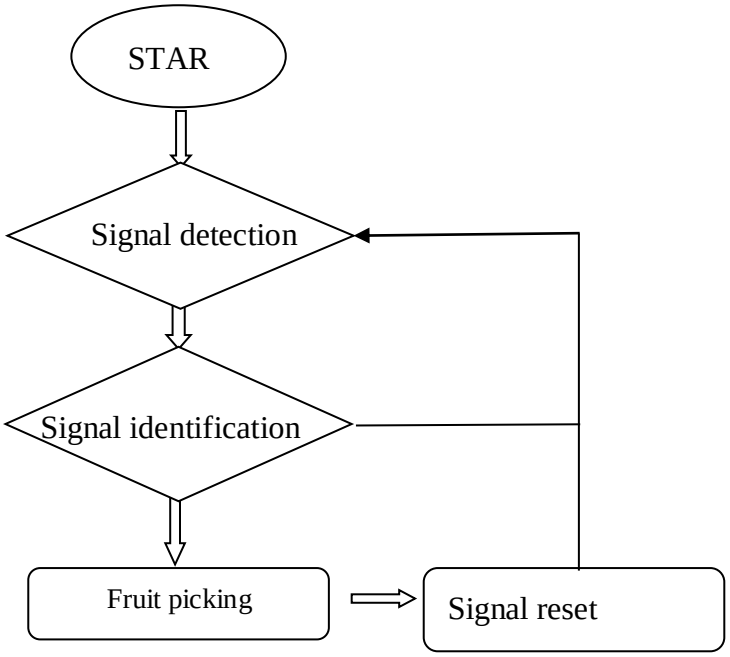

Figure 11. The work flow diagram

5. Innovative Points of the Works

1) the vein bionic transmission bag has the fruit drop buffer zone with a vein like flap, which effectively slows down the speed of the apple drop, reduces the high-speed bump damage caused by the falling apple, and makes the fruit picking independent of the picking and transmission, and improves the picking efficiency.

2) the light picking structure allows the harvester to be used flexibly in the scattered trunk. The telescopic supporting rod and the transmission part are skillfully combined with telescopic and transmission so as to realize the perfect combination of telescopic and transmission.

3) this product is low cost, simple structure, simple operation, no bump of fruit, easy to promote and maintenance, can greatly improve the efficiency of picking and ensure the safety of the fruit farmers.

6. Application Prospects

The fruit picking device has great development potential, flexible and portable, greatly improving the efficiency of fruit picking, liberating the labor force, ensuring the safety of the personnel and ensuring the quality of fruit picking. It is a light, simple and convenient fruit picking machine which meets the working conditions. It is easy to use in all kinds of conditions, and the product can be light at the same time which bring the gospel to fruit farmers.

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