

Design and Research of a New Type of Compound Automatic Cleaning Equipment for Vegetables

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Abstract: In order to adapt to different types of vegetable cleaning, improve the quality of cleaning work, this paper designs a home or small restaurant to use a new complex automatic cleaning equipment for vegetables. The equipment adopts the innovative structure of "Pipeline single-cavity multi-mode". The whole equipment adopts assembly line layout, which is convenient for structural layout and makes cleaning work in order. The cleaning chamber integrates various functions, and different types of vegetables are cleaned in a single multi-function cleaning chamber, so that the volume of the equipment is effectively reduced. The controller automatically adjusts the parameters of the cleaning execution module according to the category of vegetables, adopts different cleaning strategies, and meets the intelligent requirements. Vegetable temporary storage points are arranged on the left and right sides of the equipment, which can greatly improve the cleaning efficiency through reasonable scheduling of cleaning work.

Keywords: Compound; Vegetable; Automatic Cleaning; Integration

1. Introduction

The intake of vegetables is very important to human health. Vegetables can provide a variety of vitamins for the human body, supplement human needs, help the human body resist some diseases, etc., an essential step before people eat fruits and vegetables is to wash them. If the fruits and vegetables are not washed properly, they will face the risk of "Disease from the mouth"[1]. In recent years, domestic like fruit and vegetable washing not thoroughly lead to excessive pesticide residue news reports emerge one after another, household washing machine market can be said to be very chaotic. The scale of each household washing machine enterprise

varies, and the quality of its washing machine products is also uneven [2]. Many sellers even exaggerate the propaganda, making people more and more worried about the food safety of fruits and vegetables, therefore, the overall consumer confidence in household vegetable cleaning equipment is not high[3,4].

Although there has been a relatively complete development of industrial washing equipment for vegetables, but in the home market, the prevalence of low, single category, lack of function, most people feel that the washing machine is not simple enough to operate, long wait time and other defects [5]. At the same time, especially for leaves and other low-strength vegetables in the cleaning process is very easy to cause damage to the vegetable body. In addition, the vegetable washing machine design is not compact enough, its volume is usually large, and high power consumption [6]. Therefore, when designing a new type of vegetable cleaning equipment, it is very important to innovate the mechanical structure of the equipment to reduce the damage of the vegetable in the cleaning process, to reduce the power consumption and to improve the efficiency of the equipment. Based on the above problems, this paper designed a new type of complex vegetable automatic cleaning equipment, improve the problems of market washing machine, so that people can easily clean all kinds of vegetables at home[7-9].

2. Mechanical Structure Design

In a complete cleaning process, the nozzle, brush, ultrasonic, ultraviolet and other modules in a single cleaning chamber work in time sequence [10]. The tubers and leaves are washed twice. When cleaning different vegetables, whether the modules are enabled and operating parameters are controlled to achieve a variety of cleaning modes. A model of the device is shown in Figure 1. This innovative structure is called "Pipelined single-cavity multi-mode" structure[11].

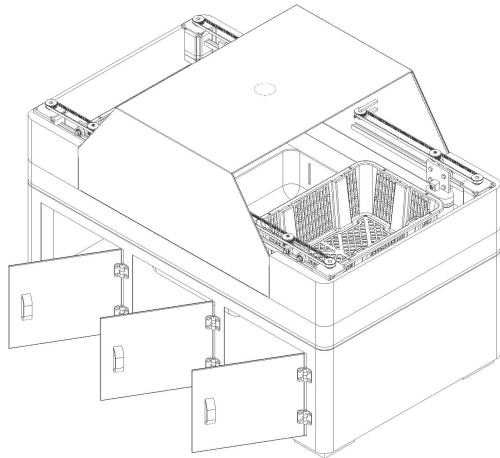


Figure 1. Model Drawing of Washing Machine

In order for the equipment to be able to clean different types of vegetables, will be divided into two categories, are tubers (potatoes, eggplant, fruit, etc.) and leaves (cabbage, cabbage, spinach, etc.) [12]. In the cleaning process, the two kinds of vegetables adopt different cleaning strategies, and the tubers are washed by brush and spray with water gun, to the blade class uses the ultrasonic, the submergence jet and so on the gentler cleaning method. The whole model of vegetable washing machine is shown in Figure 2.

1. basic framework
2. vertical moving mechanism
3. automatic brush module
4. the cabin
5. Vegetable Basket
6. electronic control module

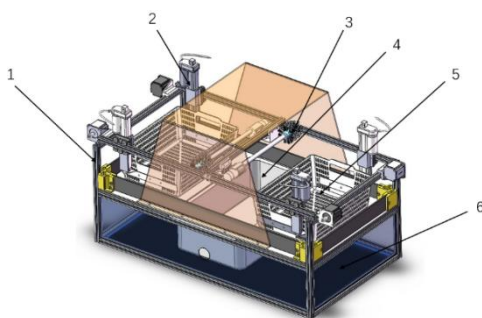


Figure 2. Three-Dimensional Model of a New Type of Compound Vegetable Automatic Cleaning Equipment

Before cleaning, manually sort into two different cleaning baskets. At the beginning of cleaning, the left basket is transported to the cleaning chamber, and the tuber vegetables in the basket are transported into the cleaning position for strong cleaning. After going through a series of washing processes (water flow washing, brush

cleaning, ultrasonic cleaning, sterilization, drainage), the washing basket is transported back to the left. Next, the leaf vegetables in the right basket are transported into the washing chamber for gentle cleaning. After a series of washing processes, the washing basket is transported back to the right.

The device adopts double-side synchronous belt drive to realize the horizontal movement of the vegetable basket. The transmission mode can ensure the stability and smooth movement of the vegetable basket, thereby achieving better cleaning effect. The stepping motor is the driving power source of this equipment, its high precision and high efficiency can ensure the accurate position control of the vegetable basket. In addition, the equipment is also equipped with a roller group and guide rail, these parts can make the vegetable basket in the cleaning process to maintain a stable trajectory. Through the drive of the bracket, the vegetable basket can accurately reach the upper part of the cleaning position, so as to carry out the efficient cleaning operation.

The vertical movement of the vegetable basket is realized by the electric push rod. The electric push rod is connected to the bracket of the vegetable basket. When the vegetable basket moves horizontally to the cleaning point, the electric push rod begins to stretch, causing the vegetable basket to sink and completely immerse in the cleaning chamber. In this way, each cleaning module in the equipment can completely clean the vegetables in the vegetable basket. When the washing is finished, the electric push rod begins to contract and the vegetable basket is slowly raised so as to drain the washed vegetables [13].

The cleaning device of the equipment consists of brush, jet inlet, ultrasonic generator and other modules, as shown in Figure 3. When the vegetable basket reaches the cleaning position, the jet water gun at the four corners of the cleaning chamber starts to work, spraying strong water at a specific angle to make the vegetables in the frame move in a spiral shape[14]. At the same time, the ultrasonic module began to work, relying on vegetables and vegetables, vegetables and brush, vegetables and water between the collision and friction will clean vegetables. The prototype of the whole machine is shown in Figure 3.

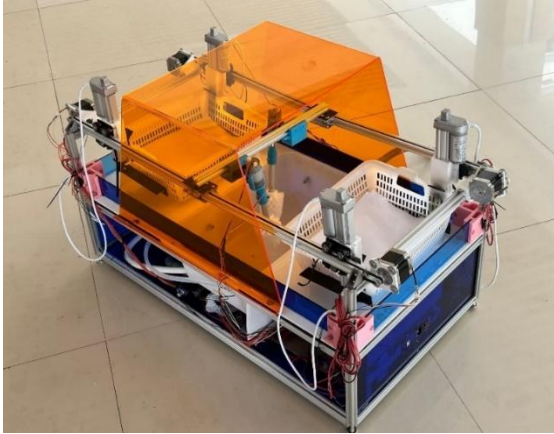


Figure 3. Physical Prototype of Equipment

3. Introduction of Control Scheme

The whole control principle of the equipment is the core part of the equipment, which realizes the accurate control and adjustment of various movements and movements of the equipment. In the device, the user can interact with the host computer screen to start, stop or adjust the device parameters. Through the serial communication, the host computer sends the instruction to the single-chip microcomputer, the single-chip microcomputer analyzes the instruction and transforms it into the corresponding control signal, finally controls each execution module to carry on the movement according to the preset. These control signals include the direction and speed of the drive motor, the cleaning module drive, the pump switch control and so on.

After placing the vegetables, the user selects the kinds of vegetables in the baskets on the left and right sides by interacting on the display screen of the PC. The controller automatically adjusts the cleaning strategy according to the type of vegetables on both sides.

When the cleaning procedure starts to run, the synchronous stepper motor starts to work, and moves the vegetable basket horizontally to the top of the cleaning chamber. Then, put the push rod under the cleaning chamber to extend, and put the vegetable basket into the cleaning chamber. The controller automatically adjusts the parameters of each module in the cleaning device according to the vegetables, including the speed of the brush motor, the speed of the water pump of the water jet gun, the working time of the ultrasonic wave and so on. After that, the drain valve closes and the cleaning modules begin to work according to the preset parameters. After cleaning, the drain valve is opened, and

the transportation transmission device transports the vegetable basket back to the starting point to drain, and at the same time carries on the ultraviolet ray disinfection. Transport the other side of the vegetable basket to the cleaning chamber and follow the same steps to clean.

4. Design Calculation and Finite Element Analysis

The horizontal movement of the vegetable basket is controlled by a motor and is a key element in the transmission part of the equipment. Because the movement distance of the vegetable basket needs to be controlled accurately, the stepper motor is selected for the motor. Working main parameters: the load mass m_0 is 5kg, including 3kg vegetables, 2kg parts (tray, basket, etc.). The movement speed of the vegetable basket is.

$$v = 0.15m/s.$$

$$\omega = \frac{v}{r_s} = \frac{0.15m/s}{14 \times 10^{-3}m} = 10.714rad/s \quad (1)$$

r_s —— Radius of indexing circle of belt pulley

Motor Speed:

$$n = \frac{\omega}{2\pi} = \frac{10.714rad/s}{2 \times 3.142} = 102.314r/min \quad (2)$$

Since a vegetable basket is driven by two motors,

the load weight is taken: $m = \frac{m_0}{2} = 2.5kg$, The

ideal power of the motor:

$$\begin{aligned} P_0 &= \frac{\mu mgv}{\eta} \\ &= \frac{0.3 \times 2.5kg \times 9.8N/kg \times 0.15m/s}{0.8} \\ &= 1.378W \end{aligned} \quad (3)$$

μ —— Coefficient of friction. Take rubber and stainless steel friction coefficient 0.3; η —— Power transfer efficiency, take 0.8. Since the mass distribution is not necessarily uniform, the Factor of safety $s = 2.5$, then the motor power:

$$P = SP_0 = 3.445W \quad (4)$$

$$T = 9550 \frac{P}{N}$$

$$\begin{aligned} \text{Motor torque:} &= \frac{9550 \times 3.445 \times 10^{-3}kW}{102.314r/min} \\ &= 0.322N \cdot m \end{aligned} \quad (5)$$

The connecting part of the vegetable basket is an important load part, which is the main part to fix the vegetable basket on the push rod and needs to carry the weight of the vegetable basket and the vegetables loaded by the vegetable basket, the results of the analysis are shown in Figure 4:

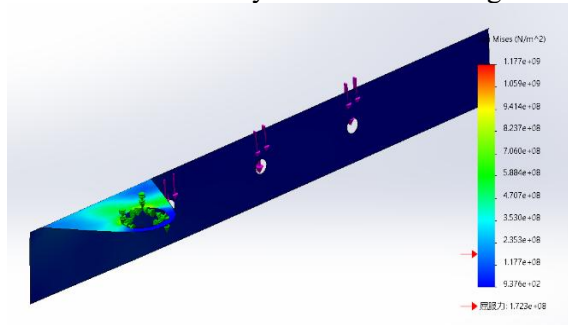


Figure 4. Finite Element Analysis of Vegetable Basket Connector

The rudder fixing block is used to install the rudder in the automatic brush module to ensure that the rudder drives the brush to fold. It needs to bear the weight of the brush to turn the motor and the brush, as well as the moment when the brush is folded, the results of the finite element analysis are shown in Figure 5:

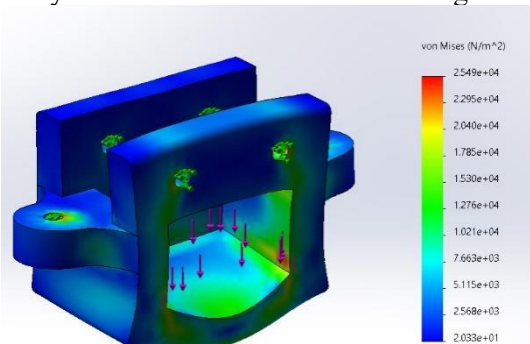


Figure 5. Finite Element Analysis of Rudder Fixing Block

5. Conclusions

To sum up, washing machine as a modern, high-efficiency kitchen appliances, and gradually become a home and commercial kitchen one of the necessary equipment. This article through carries on the analysis to the vegetable washing machine design essential factor and its to the user experience influence, draws the following conclusion:

(1)The design elements of vegetable washing machine include cleaning effect, cleaning method, cleaning capacity, appearance design and so on. Among them, cleaning effect and cleaning method is the core element of washing machine design, directly related to user

experience. Therefore, the washing effect and the Operability and intelligence of the washing method should be enhanced as far as possible in the design of the washing machine to enhance the satisfaction of users.

(2)The design of vegetable washing machine should pay attention to the principle of ergonomics, that is, to ensure the function of vegetable washing machine, as far as possible to simplify the operation process, reduce the user's operating difficulty and fatigue. At the same time, for the users of commercial kitchens, the washing capacity of the washing machine is also an important consideration, should be as much as possible to improve the efficiency of cleaning.

The advantage of this equipment is the "Single-cavity multi-mode pipeline" structure, the water flow washing, brush cleaning, ultrasonic cleaning, sterilization and other functions of the integration of the model, the utility model has the advantages of improved equipment integration, reduced volume, compact layout, full function and low cost. At the same time, according to different types of vegetables to take different cleaning decisions, strong adaptability, cleaning effect is remarkable, to make up for the existing washing machine is not simple enough to operate, wait for a longer time and other shortcomings, from a broader prospect, promote new washing equipment into the home appliance market. In short, as a new type of kitchen electrical appliances, its design of Operability, cleaning effect, cleaning capacity, etc., need to pay attention to user experience and ergonomics. This paper is expected to provide some reference for the design and research of washing machine.

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