Intelligent Automated Production System for Sour and Spicy Fish

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Abstract: As one of the traditional Chinese cuisines, Sour and Spicy Fish is difficult to ensure consistency in taste and quality with manual production due to its complex cooking process and different eating habits. With the continuous expansion of the takeaway market, Sure! Here's the translation: "More and more people are choosing to purchase food through food delivery, especially in recent years as the market for sour and spicy fish has continued to expand. This pre-made dish has received wider attention [1-3]. However, during peak hours, it is difficult for merchants to guarantee the taste and quality of dishes in limited time, while also satisfying the efficiency of delivering food. Therefore, this paper aims to propose an intelligent automated production system for Sour and Spicy Fish, which achieves automation through intelligent control system technology and special ingredient addition system, thus improving production efficiency, significantly reducing labor costs while maintaining the taste and quality, making it a more commercial and beneficial catering solution. Through analyzing system architecture, simulation experiments, social surveys, and experimental data analysis, this paper draws a final conclusion and explains the advantages and the wide application prospects of the system in the market.

1. Introduction

Cuisine can provide dishes that are aesthetically pleasing, delicious, and fulfill various dietary and physiological requirements for people [4]. Nowadays, Sour and Spicy Fish has become an important part of traditional Chinese cuisine, with the supply increasing in all settings, including households, restaurants, and takeout platforms. However, due to the cooking methods, the production of Sour and Spicy Fish involves significant manpower, unstable cooking results, and long cooking times. For restaurants, this not only increases labor costs and affects customer dining experience but also puts them at a disadvantage in market competition with other dishes [5]. To solve these problems, an intelligent automated production system for Sour and Spicy Fish has emerged. The development trend of relevant technology depends on the demands of society and the market. Kitchen automation and intelligence have become a hot topic in food processing technology in recent years. Currently, there are some similar research projects in the market, such as automated stir-fry pots, automated hot pot machines, and automated grilled fish machines, but they all have their limitations and drawbacks, including single functions, complex operations, and high costs. Based on this, our system utilizes advanced devices and technologies, such as intelligent control systems, special ingredient addition systems, and food safety monitoring systems, to achieve automated cooking of Sour and Spicy Fish, overcoming the disadvantages of traditional cooking methods and improving production efficiency and product quality.1

2. Due to Design of the Mechanical Body Structure

This chapter designs the mechanical body structure of the intelligent automated production system for Sour and Spicy Fish, proposes the overall design scheme of the system, and focuses on the design of the system's inspection, transportation, and weighing of side dishes. By simulating the overall operation of the intelligent automated production system for Sour and Spicy Fish, the design

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parameters that meet the requirements are obtained. The mechanical body structure design will achieve the following functions:

(1) Real-time inspection and warning of dishes - The camera module at the top of the machine serves as machine vision, which monitors the safety indicators of the dishes and ingredients during the seasoning process through neural networks and deep learning algorithms to ensure food safety. The feeding function is implemented through the hopper and feeder.

(2) Accurate weighing and control of dishes - Using a pressure sensor, a device that controls the feeding amount of the division mouth, and an electronic controller, the machine can accurately allocate dishes based on the customer's input of operational system instructions.

(3) On-demand pouring of soup - All required condiments are made into liquid form, and by presetting the amount of soup, the machine uses a condiment pipe to deliver soup to the bowl.

(4) Smooth transportation of prepared dishes through the conveyor belt - After the machine has finished seasoning the dishes, the dishes are transported out through the conveyor belt.

(5) The internal hopper and the feeding mouth are detachable structures, and are installed by simple embedding to facilitate disassembly, installation, regular cleaning to achieve a higher level of food safety. Moreover, it facilitates periodic inspection and replacement of internal machine parts [6].

In the design of this paper, the goal is to liberate the manual labor required for adding side dishes, serving dishes, and washing dishes. The operator only needs to put the processed side dishes into the feeding hopper and wait for the Sour and Spicy Fish to be cooked and served. Therefore, the Sour and Spicy Fish intelligent automated production system is designed as a highly intelligent integrated system. In addition, the system is combined with the control functions of an intelligent stir-fry machine [7], resulting in a design for the Sour and Spicy Fish intelligent automated production system, as shown in the overall design concept in Figure 1.

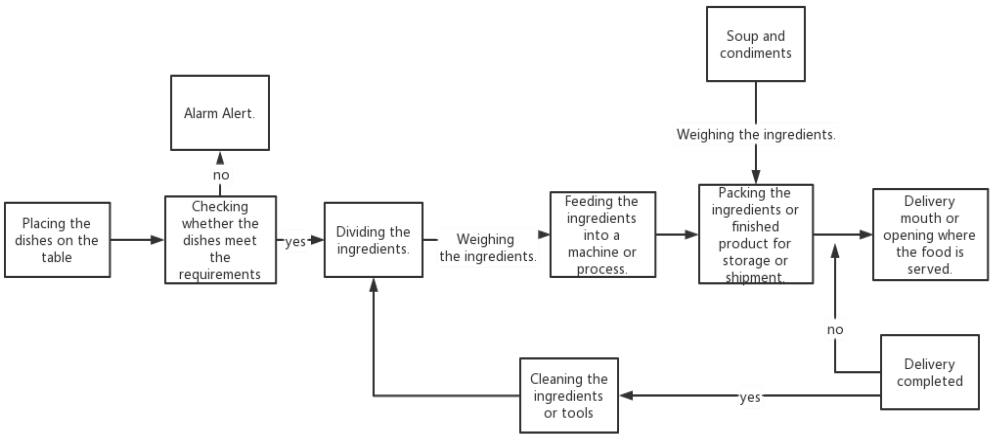

Figure 1 Overall Design Concept of the Sour and Spicy Fish Intelligent Automated Production System

3. Structure

3.1. Overall Structural Design

In order to achieve an efficient and convenient working mode, the Sour and Spicy Fish intelligent automated production system adopts a combination of a class flow line process and an integrated machine model to build a practical production system. In terms of structural design, multiple independent hoppers are installed for storing pre-prepared dishes, and a camera is installed above the machine to monitor whether the dishes meet food safety standards in real time. The dishes are transported to the weighing section through the rotating feeding structure and stop running after reaching the set weight distribution port [8]. Then, the packed boxes are transported to the weighing section below through the conveyor belt, the pre-prepared dishes are sent to the packed boxes, and the soup and condiments are sent to the packed boxes as well. After completing all operations, the system delivers the packed boxes to the food delivery port [9]. The overall structural design of the

Sour and Spicy Fish intelligent automated production system is shown in Figure 2.

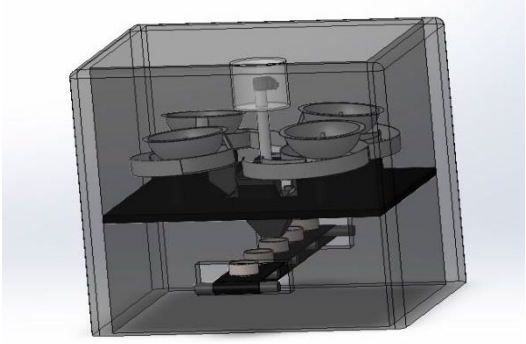

Figure 2 Overall Structural Diagram of the Sour and Spicy Fish Intelligent Automated Production System

Based on the principles of overallity, functionality, reliability, and practicality in mechanical structure design, the design specifications of the Sour and Spicy Fish intelligent automated production system are shown in Table 1:

Table 1 Design Specifications of the Sour and Spicy Fish Intelligent Automated Production System

Design Specifications	Parameter Description
Overall Length	170cm
Overall Width	170cm
Overall Height	180cm
Function	Ingredient Distribution, Feeding, Weighing, and Food Delivery

3.2. Ingredient Distribution Structure

The main function of the ingredient distribution structure in the Sour and Spicy Fish intelligent automated production system is to deliver the main ingredients for the preparation of Sour and Spicy Fish [10]. Vegetables are added manually in advance and the ingredient distribution structure is designed as a rotating centrifugal structure. It consists of a circular disc with multiple feed slots. Raw materials are transported one by one from the center of the disc to the periphery through the slot. The disc is made of wear-resistant and corrosion-resistant materials and is driven by a motor to rotate. The raw materials are transported along the feed slots by the centrifugal force and are discharged at the end. Since the rotation speed of the disk is adjustable, precise control and adjustment of the raw materials can be achieved. After starting the system, the distribution structure rotates, and the vegetables pass through the feeding structure to the weighing port under the action of gravity. When the preset weight signal is reached, the distribution structure stops running. The structure of the ingredient distribution is shown in Figure 3:

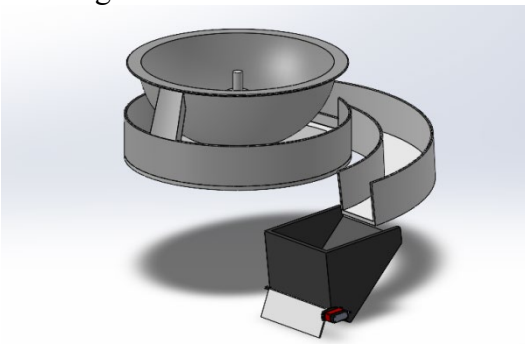

Figure 3: Ingredient Distribution Structure

3.3. Weighing Port Structure

In order to control the amount and ensure the uniformity of the ingredients, a weighing delivery structure is used to achieve this goal. The weighing port mainly achieves accurate control over the

weight of the ingredients. The vegetables enter the feeding device through the ingredient distribution structure, and the weight of the vegetables is accurately grasped through the gravity sensor at the bottom of the weighing port. After reaching the preset weight, the vegetables are transported by the conveying device to the packaging box below. The structure of the weighing port is shown in Figure 4:

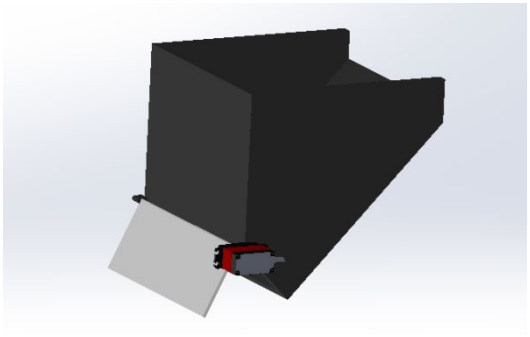

Figure 4 Weighing Port Structure Diagram

3.4. Transportation Structure

In order to better save labor and achieve convenient and fast packaging of Sour and Spicy Fish, a transmission mechanism with wheels is used to realize automation, unmanned, and intelligence in the packaging process [11]. Under the action of the limit structure, the packaging box moves with the conveyor belt to the vegetable delivery port. The vegetables are transported from the delivery port to the packaging box, and soup and other ingredients are added from the liquid output port, and then transported to the food delivery port. This assembly line structure enables accurate and efficient delivery. The transportation structure is shown in Figure 5:

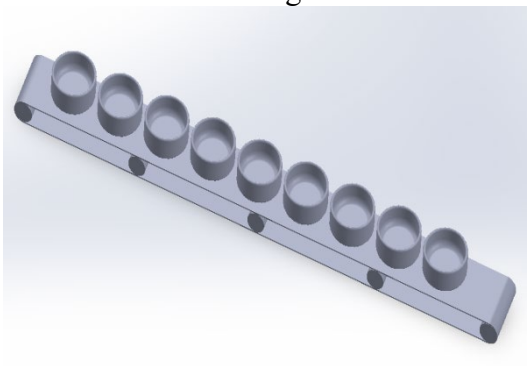

Figure 5 Transportation Structure

3.5. Liquid Auxiliary Material Delivery Structure

Liquid auxiliary materials not only improve the flavor of the dish, but also enhance its color, making them indispensable condiments in the kitchen [12]. When selecting ingredients for Sour and Spicy Fish, it is necessary to consider the small amount of auxiliary materials, which include both solid and liquid auxiliary materials. To achieve precise control of the auxiliary materials, sophisticated instruments must be used, which significantly increases the development cost of the intelligent automated system and is not suitable for most users. Therefore, when preparing the soup and auxiliary materials, the solid particles are first dissolved in water. When the soup and auxiliary materials need to be added, they are delivered to the packaging box through a liquid delivery port. The liquid auxiliary delivery structure consists of a food-grade auxiliary material barrel and a transportation structure. When the packaging box is transported below the soup outlet, the servo motor controls the opening of the outlet, and when the preset amount of soup is reached, the servo motor controls the switch to close it [13]. The liquid auxiliary material delivery structure is shown in Figure 6:

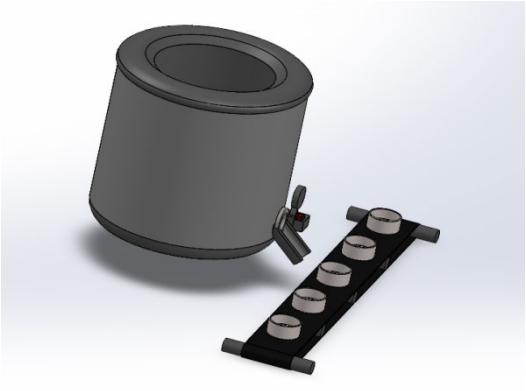

Figure 6 Liquid Auxiliary Material Delivery Structure

4. Functionality

4.1. Ingredient Dispensing Functionality

Merchants prepare relevant ingredients and place them in the ingredient dispenser as needed. The camera checks in real-time whether the dish meets safety standards [14]. If it passes, the process moves to the next step. If it fails, the system stops working and issues an alarm. Once the dish is replaced, the system resumes operation and waits for the next ingredient dispensing cycle. The functionality of the ingredient dispenser is shown in Figure 7:

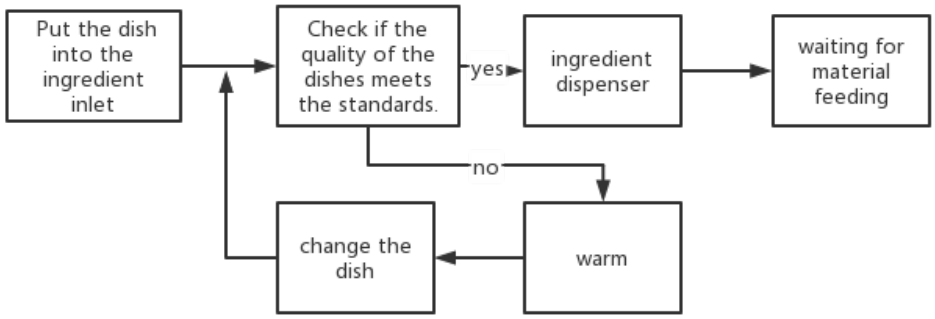

Figure 7 Ingredient Dispensing Functionality Diagram

4.2. Weighing and Feeding Functionality

After the ingredient dispenser carries out its function, the ingredients are fed to the weighing mechanism. The gravity sensor located below the weighing mechanism checks in real-time whether the dish has reached the preset weight. If it does, the weighing mechanism sends a signal to the feeding mechanism to stop. The packed box is then transported to the food conveyor outlet. The weighing and feeding functionality is shown in Figure 8:

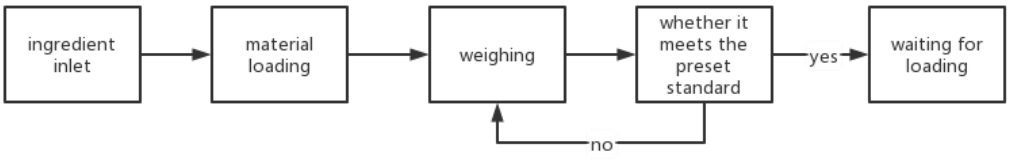

Figure 8 Weighing and Feeding Functionality Diagram

4.3. Food Packing Functionality

The packed box is transported by the conveyor belt to the food conveyor outlet, where it waits for the assignment of dishes. Once the dishes are placed into the packed box, the conveyor belt continues its operation, awaiting the addition of soup and condiments in the next step. The food packing functionality is shown in Figure 9:

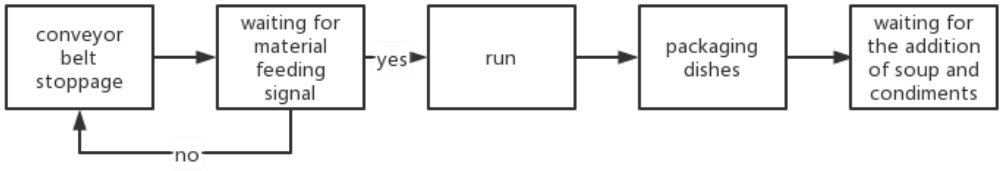

Figure 9 Food Packing Functionality Diagram

4.4. Liquid Condiments Delivery Functionality

Once the dish-filled packed boxes are packed, they are transported by the conveyor belt to the liquid condiments output port. The soup and condiments are sent through the pipeline to the packed boxes until the preset quantity is reached. Once the required quantity is reached, the liquid condiments delivery stops, and the packed boxes filled with the prepared sour fish pickles dish are transported to the food outlet. The liquid condiments delivery functionality is shown in Figure 10:

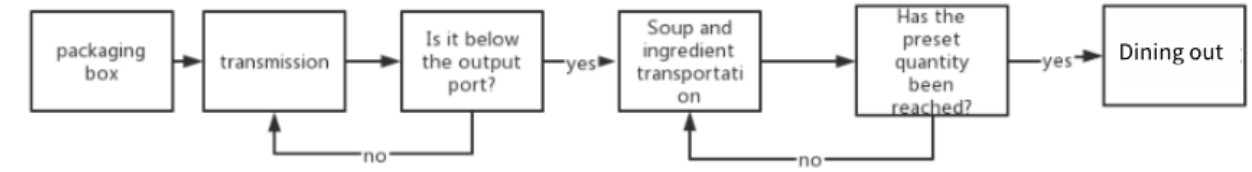

Figure 10 Liquid Condiments Delivery Functionality Diagram

5. Conclusion

(1) The intelligent and automated sour fish pickles dish production system designed in this article has a high level of integration in structural design and occupies less space. It can be flexibly assembled and matched according to different use scenarios and is suitable for various catering scenes. Through the highly intelligent and automated internal control system, it realizes efficient and convenient production of sour fish pickles dishes, improves food quality, saves labor costs and time costs, and enhances the commercial and market benefits of the sour fish pickles dish manufacturing process.

(2) Combined with the mature electronic control technology, the system can quickly produce dishes through intelligent regulation and external control, ensuring the good taste and food safety indicators of the sour fish pickles dish while achieving fast serving. It not only provides convenience to sellers but also provides food safety guarantees to customers, improves dining experience, and reduces waiting time during dining.

(3) With the increase of environmental awareness, the intelligent and automated sour fish pickles dish production system also has the potential impact based on green environmental protection. The system can achieve more energy-saving and reduce chemical pollution through the reconstruction of kitchen space and heat management arrangements. However, with the development of technology, the intelligent level of the system still needs to be continuously improved.

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