

## Research on Intelligent Catering Robot

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### Abstract

**Tianjin University of Technology and With the improvement of labor cost, large-scale use of robots in labor-intensive areas has been a trend of future development. In view of the development of the catering industry and the market needs under the current epidemic environment, an integrated working platform of cooking and catering is proposed, which can be applied in a variety of scenarios. The platform can realize automatic feeding, cooking, seasoning, dish out and automatic cleaning. From the perspective of system integration, this paper studies an intelligent catering platform with low cost and high efficiency through collocation of one or more control methods. The experimental results show that the intelligent stir-fried food catering robot can well meet the market demand for catering under the background of The Times, and can efficiently complete the catering with full automation to improve the dining experience of consumers. Education, Tianjin, China**

### Keywords

**Intelligent integrated control; Robot; Catering platform.**

### 1. Introduction

China's catering market has been growing healthily, with the market size growing from 2.9 trillion yuan in 2014 to 4.7 trillion yuan in 2019, with an annual compound growth rate of 10.1%. Due to the impact of the epidemic, the size of the catering market in 2020 declined by 15.4% to 4.0 trillion yuan [1], and the national catering income in 2020 was 395 trillion yuan, down by 15.4% year-on-year. At the same time, a large number of catering outlets closed down due to the impact of the epidemic [2]. The problem of feeding a large number of workers, including community workers, volunteers and doctors, is also a challenge. In addition, some areas of the country catering company food health problems. Food safety, nutrition and health side dishes are also particularly important. Intelligent robots are playing an important role in the catering industry in order to reduce exposure, solve the problem of food preparation in epidemic prevention work and the nutrition and health of side dishes.

Compared with the traditional stir-frying machine, this project intends to study the intelligent catering preparation by combining software and hardware, and develop a set of physical robot intelligent nutritional catering table. Through intelligent unmanned meal preparation, meal preparation and meal delivery, it not only improves the efficiency of meal preparation and meal preparation, but also provides a guarantee for safe and secure food. Unmanned operation not only saves manpower and material resources, efficiency and high efficiency, but also the process safety and health. It can help solve the problem of catering and food safety in epidemic prevention work, and help realize the intellectualization of catering industry, which is of great significance for the development of national intelligent catering industry.

## 2. Design Scheme

### 2.1. The working logic of the platform is shown in Figure 1:

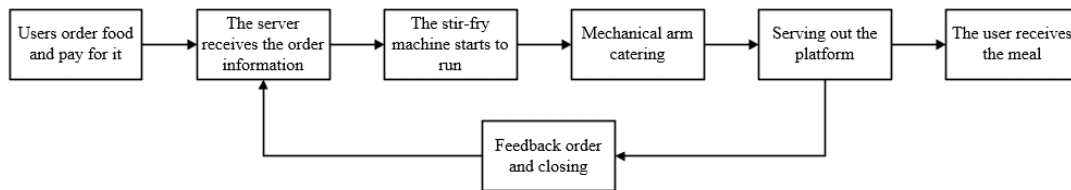


Fig.1 Working logic diagram of intelligent stir-frying and catering robot

### 2.2. Overall scheme design

The main body of the intelligent stir-frying platform consists of an intelligent stir-frying machine, a seasoning platform, a cooperative robot, a catering platform and a breakfast area (including steamed bun and steamed egg). Through the cooperative robot, the dishes to be processed are put into the automatic stir-frying pan, and the automatic stir-frying pan rotates to drive the slices in the pan for stir-frying. The cooperative robot then puts the spices in the seasoning platform into the stir-frying machine. After the dishes are cooked, the stir-frying machine tilts at a certain Angle to pour the dishes into the serving plate, and then the cooperative robot puts the dishes on the serving table for customers to take away. Meanwhile, the cooperative robot can also put the food in the breakfast area into the serving plate together after customers choose it, as shown in Figure 2 below for specific design.

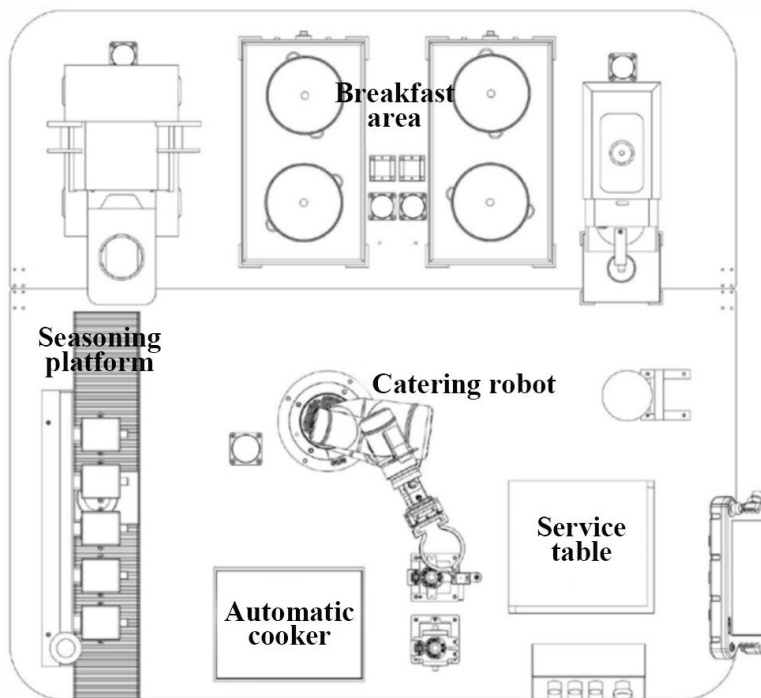


Fig.2 Overall scheme design of stir-fry catering platform

### 2.3. Structure design of stir-frying machine

The wok body of the stir-frying robot is cylindrical, and the narrowing of the wok mouth can make the energy gathering effect of the whole pot better, and the dishes can gather together better in the process of stir-frying. And only the frying pan without stirring mechanism can not work, so the design of the bottom side of the frying pan to add a pick to achieve stir-fry function, when cleaning, compared with some complex stirring device, the pot body is convenient to clean, the advantage is more obvious. Combined with the shape of the pot, a supporting frame is designed, and the pot is installed on the frame, the frying pan is connected with the flange

and the shaft, and then a rotating motor is installed at the bottom of the shaft to drive the pot body to rotate repeatedly to achieve the function of frying. When frying, the whole pan will turn to a fixed Angle, and then the pan body rotation to achieve stir-frying. A sensor is installed on the right side of the pot body to measure the rotation Angle of the pot body, which is convenient to realize the functions of cooking, serving, cleaning and so on. Heat source is the core component of the stir-fry machine, choose different heating sources will have different heating effects. At present, the common heat energy on the market are combustion heat, electric heat and solar heat. By comprehensive comparison, burning heat needs burning materials, has greater limitations, and the heating process will produce toxic and harmful gases, inconvenient to carry, can not be automatically controlled, so the heat source is locked in electromagnetic heating. By winding a circle of copper wire around the bottom of the pot and placing it on the components of the electronic circuit board to generate alternating magnetic field, the surface of the container cuts alternating magnetic force lines and generates alternating current (namely eddy current) in the metal part at the bottom of the container. The eddy current makes the iron atoms at the bottom of the container move at high speed and irregularly, and the atoms collide and friction generate heat energy, thus achieving the effect of heating things. The specific design drawing is shown in Figure 3 below.

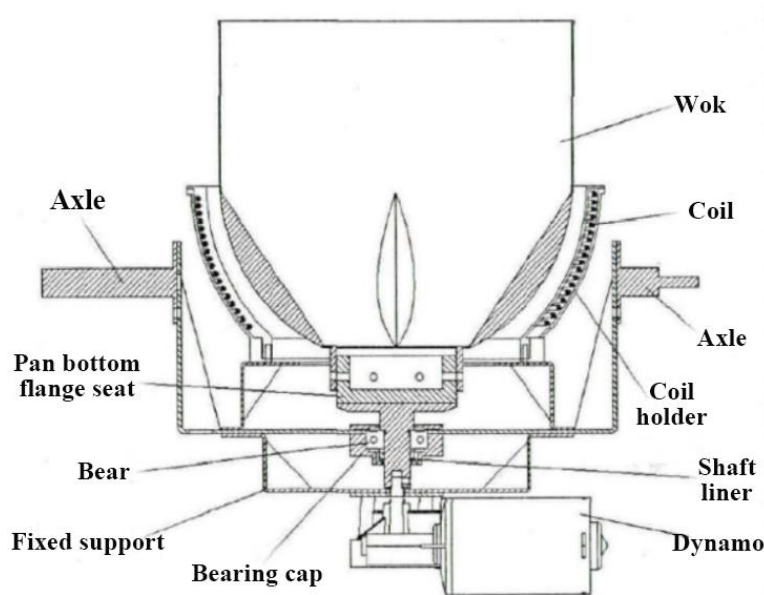


Fig.3 Final assembly drawing of pot body structure

#### 2.4. Design of the seasoning table

The key to the design of the dressing table is how to separate the dressing and put the dressing down. In this project, a controllable valve is installed in a hole at the bottom of the container. By controlling the switch of the valve, the condiments fall into the condiment cup under the action of gravity, and different flavors can be formed through the movement of the conveyor belt. Then, the cooperative robot pours the condiment into the stir-frying machine to realize the condiment unloading. The specific design is shown in Figure 4.

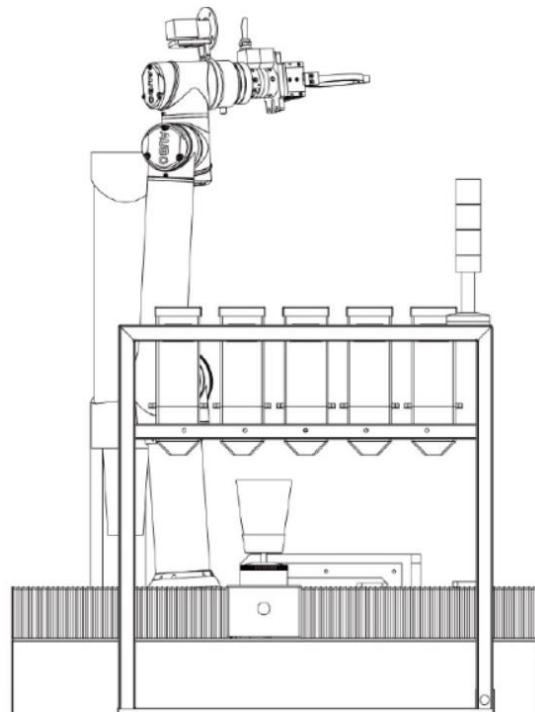


Fig.4 Design drawing of the seasoning platform

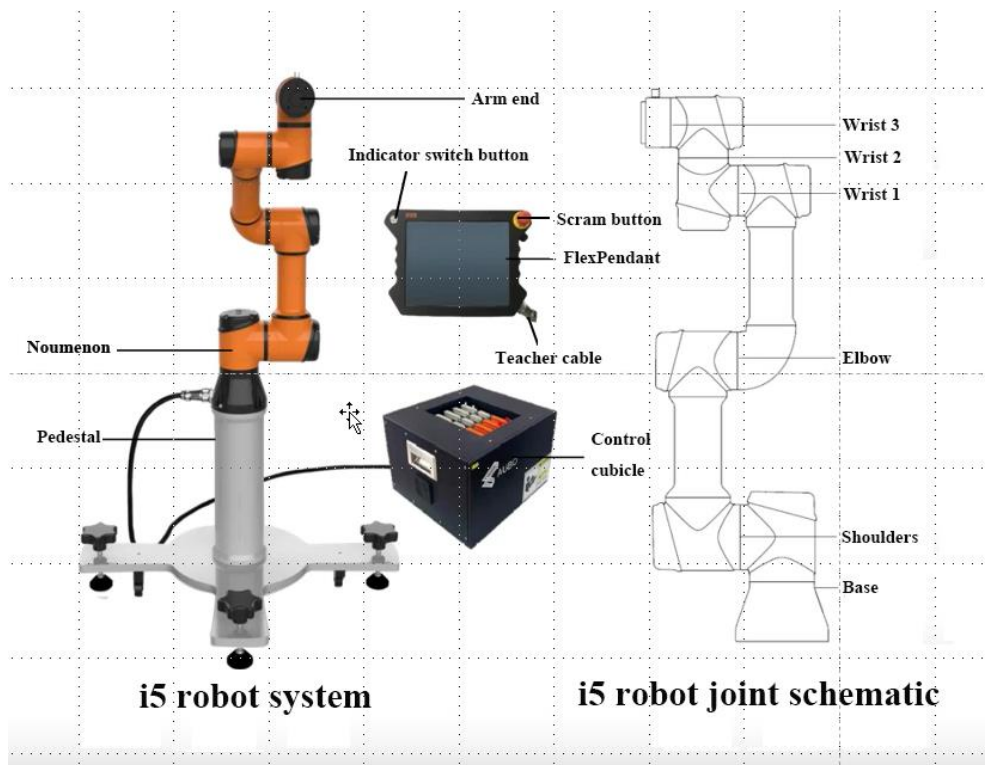


Fig.5 BNRT-SRi5 cooperative robot

### 2.5. Selection of catering robot

According to the existing industrial robots on the market, BNRT-SRi5 cooperative robot is selected. i5 robot system is mainly composed of robot body, control cabinet base and teaching device. The robot body mimics the human arm with six rotating joints, each representing one degree of freedom. As shown in Figure 5, the robot joints include the base (joint 1), shoulder (joint 2), elbow (joint 3), wrist 1 (joint 4), wrist 2 (joint 5), and wrist 3 (joint 6). The base is used to connect the robot body to the base, and the tool end is used to connect the robot to the

tool. The arm tube is used between the shoulder and the elbow and between the elbow and the wrist. Through the operation interface of the demonstrator or dragging the demonstrator, the supply of stir-fried food in the stir-frying machine and the delivery of stir-fried food to customers are realized.

### 3. Construction of stir-frying machine and robot simulation software

The model of stir-frying machine and robot was imported into the simulation software RobotStudio, the layout of the stir-frying catering platform was constructed, the path was optimized, and the service application scene was creatively designed. The feasibility of the intelligent stir-frying catering platform was verified as a whole through the production of simulation animation. The specific flow chart is shown in Figure 6 below.

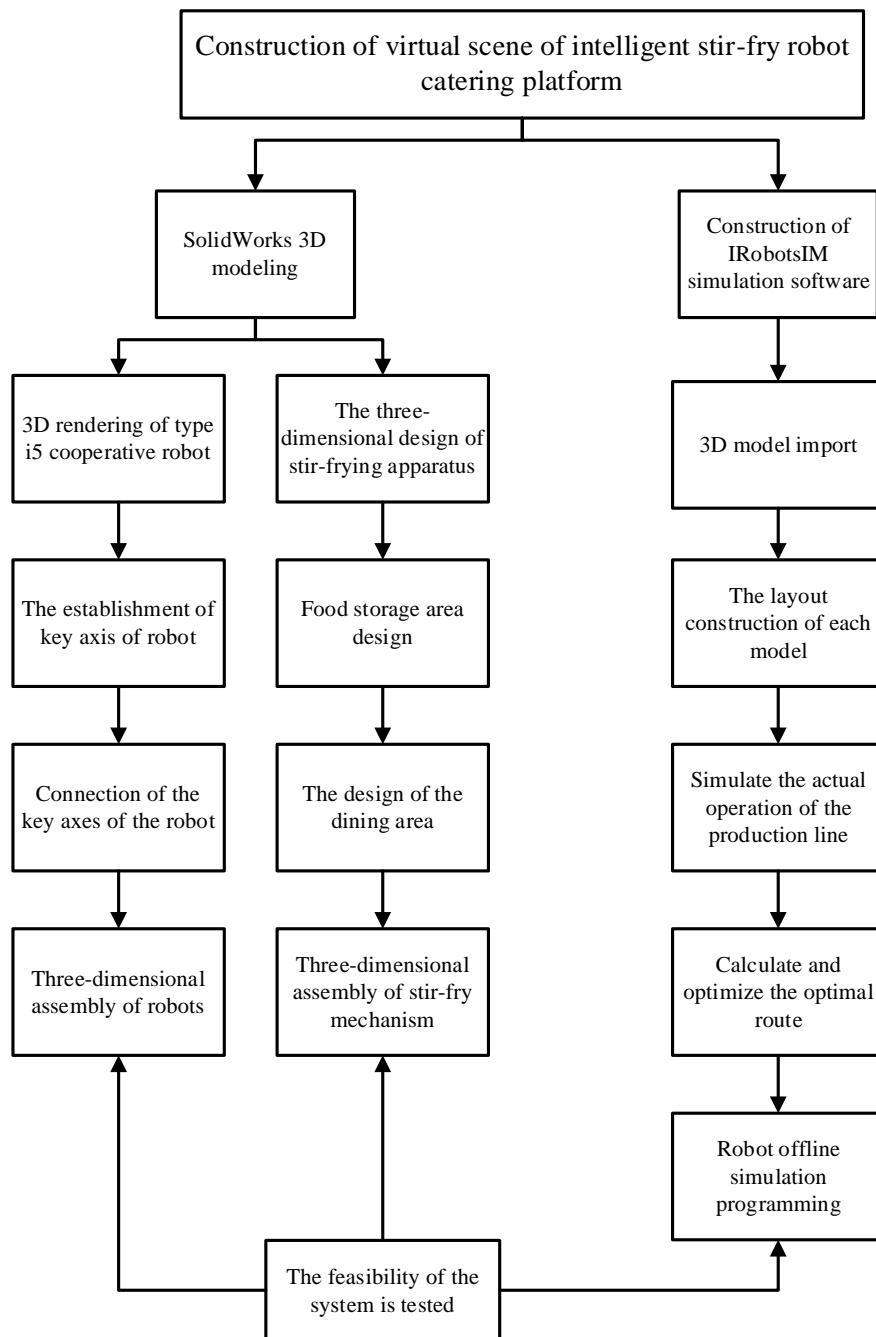


Fig.6 Flow chart of virtual scene establishment of intelligent Stir-fry catering platform

### 3.1. Construction of physical platform for robot stir-frying and catering

The intelligent stir-frying and catering robot physical platform is composed of 5kg BNRT-SRi5 cooperative robot, intelligent camera, automatic stir-frying pot and PLC automatic control system. Through the actual layout optimization of raw material storage area, stir-frying area and food delivery area, offline simulation is carried out. Through the dynamic consistency of virtual scene and simulation, information exchange and fusion are carried out. Through the dynamic real-time monitoring of the changes of the platform robot in virtual scene, the movement state of the robot is accurately grasped. The specific design flow chart is shown in Figure 7.

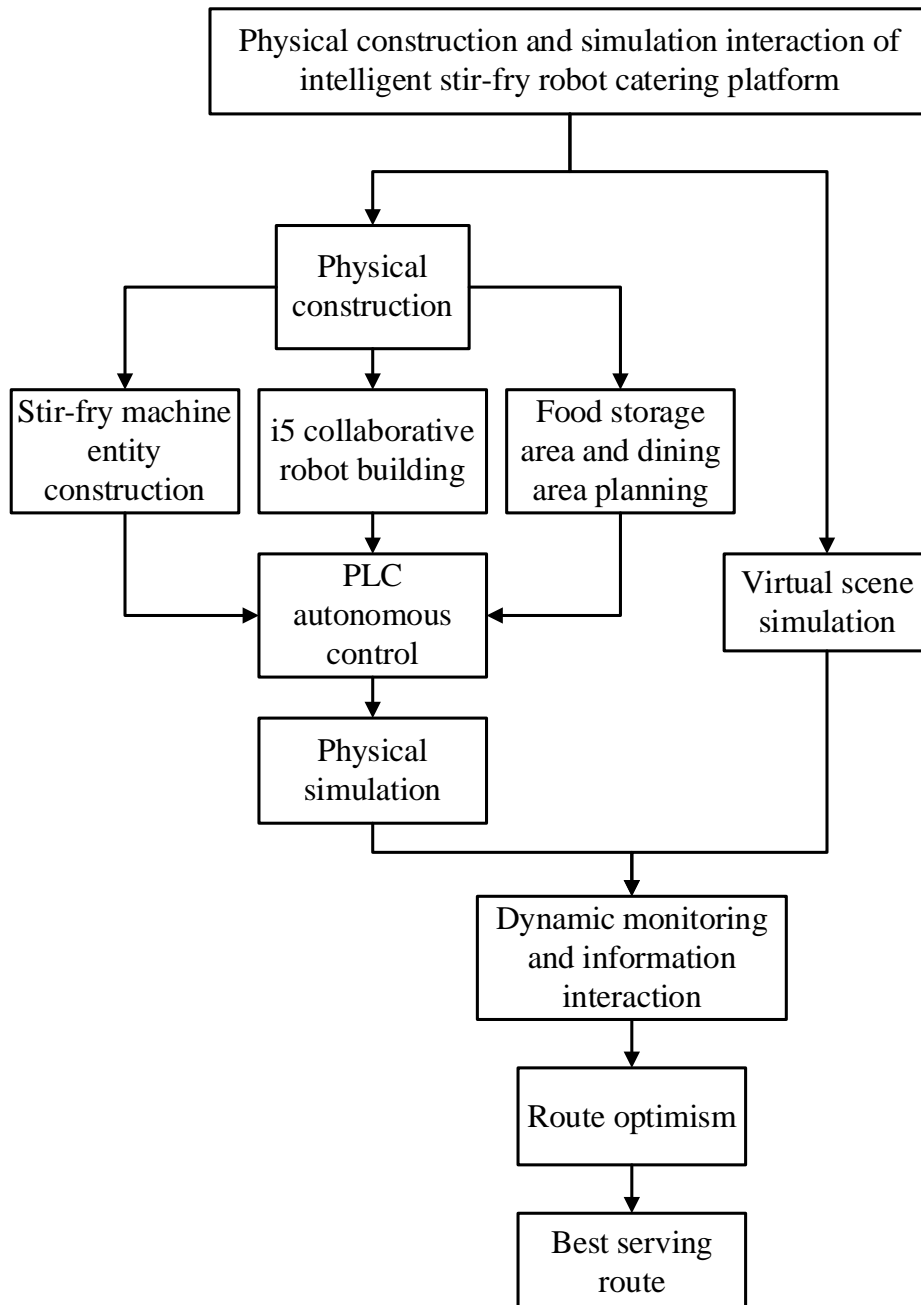


Fig.7 Interactive flow chart of physical construction and simulation of intelligent stir-fry catering platform

### 4. Intelligent integrated control

Intelligent control technology is the core of modern new technology revolution, up to now, we have developed a lot of integrated control methods, each control method has its own advantages and disadvantages, a single intelligent control scheme sometimes can not achieve satisfactory control effect, therefore, in some specific control occasions, It is necessary to combine several different intelligent control methods or even non-intelligent control methods, which is the so-called intelligent integrated control<sup>[3]</sup>.The workflow of intelligent integrated control system is shown in Figure 8.

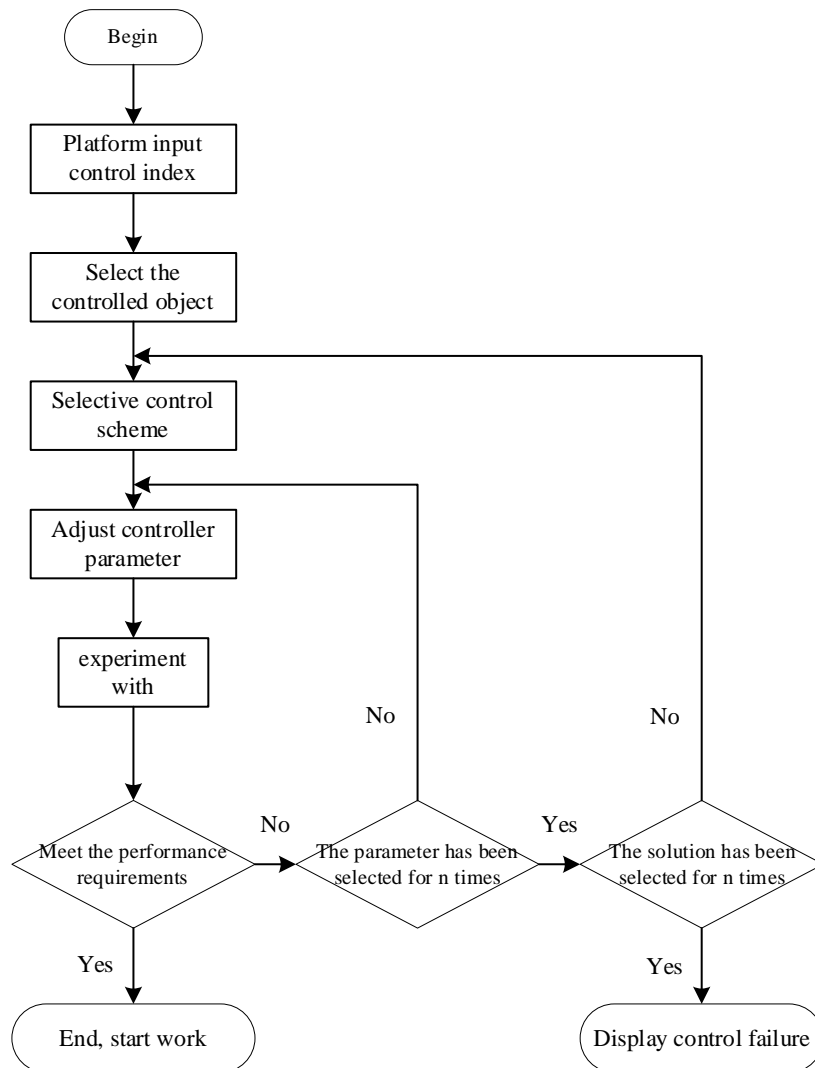


Fig.8 Flow chart of intelligent integrated control system

#### 4.1. Selecting a Control Scheme

An expert policy library is set up in the platform. In the expert strategy library, stored for different input and control requirements of the control scheme, such as commonly used PIDF control, two degrees of freedom PID control, self-learning control, zero phase tracking control, etc., to provide the system selection. Also according to the choice of route, there are several non-intelligent control modes, such as fixed track, fixed belt, etc. Depending on different requirements, the control scheme chosen may be one or the integration of several schemes. By optimizing the control, the work efficiency and motion accuracy are improved.

## 5. Conclusion

In view of the demand of catering market in the current environment, food safety problems, personnel contact during the epidemic and a large number of urgent catering problems are solved by means of unattended catering and efficient catering. Through the combination of intelligent control and each module, cooperate with the robot, the efficiency has been greatly improved. The stir-frying machine is designed to be safe and easy to clean. The overall platform is low cost, high efficiency, and smart. The emergence of intelligent stir-fry catering robot platform has a certain degree of social value and practical significance.

## Acknowledgements

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## References

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