

Research and preliminary design of cooking robots

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Abstract: In the "Internet of Things" and "Internet plus" environment, the intellectualization of people's lifestyle has become the trend of the times. As a service robot that intersects with food science, automatic cooking robots replace humans in carrying out complex cooking labor. With the promotion of automatic cooking robots and the application of cloud technology, it has gradually led the upgrading and huge transformation of the trillion level catering industry. Although cooking robots are still an emerging industry, market acceptance, and industrial chain maturity are still in the basic development stage, we need to change the various drawbacks of high energy consumption, high pollution, and high manual labor brought about by the backward production mode of traditional catering in China, Effectively promoting the development of intelligent technology in China's catering industry and empowering the transformation of the catering industry with unmanned technology, cooking robots will become a breakthrough point. Therefore, the research on cooking robots has broad application prospects.

1. Introduction

With the gradual improvement of people's living standards, while meeting their basic physiological needs, they have begun to pursue more spiritual pursuits. Therefore, some daily activities have also been given more meaning. As the most important activity of the day, eating has also undergone changes with the development of the times. Not only have the locations and forms of eating changed, but cooking tools are also becoming increasingly intelligent, with the emergence of intelligent stir fryers as a type of household appliance. In recent years, hygiene issues in the food delivery industry have always existed, so there is an urgent need for a device that can ensure food safety and quickly cook.

In addition, the country is also vigorously promoting the development of the intelligent small home appliance industry. In the "Eleventh Five Year Plan" to "Fourteenth Five Year Plan" of China's national economy, it is mentioned that the country's support policies for the small home appliance industry have undergone changes from "ensuring sustainable development of the industry" to "developing from a home appliance power to a home appliance power" and then to "actively promoting innovative development".^[1]

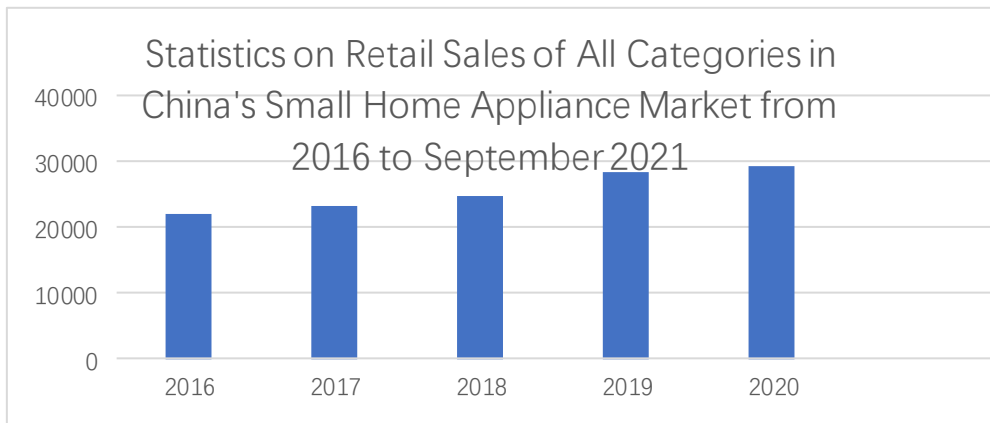


Figure 1: Market development trend of intelligent vegetable fryer industry

As shown in Figure 1, from 2016 to 2020, the market size of China's intelligent stir fry machine industry increased from 27.44 million yuan to 57.373 million yuan. Intelligent vegetable fryer enterprises are continuously accumulating research and development experience, and the degree of intelligence of vegetable fryers is improving. At the same time, the market recognition of intelligent vegetable fryers is also increasing, and the industry will continue to mature.

There are not many existing intelligent stir fry machine enterprises, only 5 or 6 well-known ones such as Midea, Jiuyang, and Supor. Taking the existing Jiuyang intelligent stir fry machine as an example, this product can complete some preset dishes, but its shortcomings are that the cooking ingredients need to be prepared and processed by oneself, and the amount of seasoning and ingredients added cannot be adjusted according to personal taste. It can only work according to the preset recipe, inevitably encountering situations that do not meet the user's taste. It is also not possible to remotely control the product for stir frying, and it must only be used after the user returns home.

2. Current research status at home and abroad

The research on the automatic cooking robot at home and abroad is also limited to the prototype, principle and market analysis. Relevant references mainly introduce the structure and function realization, market application, teaching research and single module analysis of the automatic cooking robot [2]. Melody Robotics, a kitchen robot, is mainly used in Western cuisine mode. It is a robot kitchen system that can achieve fully automatic cooking. The system has robotic arms and palms that can mimic the movements of human hands, but currently it can only replicate the movements and cannot be distinguished. In terms of market application, the standardization level of Chinese fast food is low, and the brand influence is weak. To build a development model of Chinese fast food based on an automatic cooking robot platform, it is necessary to establish a precise food supply system, product service system, and efficient and standardized management service system. Research and design a parallel measurement and control system based on BP neural network to adjust PID controller parameters to complete the cooking and production of dishes, achieve parallel operation control mode of frying system and heat system, and control the production of dishes is urgent [3].

3. Technology roadmap

3.1 Overall scheme design

This device consists of five modules, namely storage module, transportation module, processing

module, cooking module, and control module. The storage module is responsible for storing food, refrigeration and preservation, while the transportation module is responsible for transporting food, the processing module is responsible for processing food, and the cooking module is responsible for cooking the processed food ^[4].

3.2 Storage Module

The storage module is responsible for storing food, refrigeration and freshness preservation, ventilation and other functions. The outer frame of the refrigeration compartment can bear storage blocks, and the hollow internal space serves as a circulation channel for cold air, achieving the function of using vehicles to achieve refrigeration. The storage block is used to hold food with small volume, water stains, and needs to be soaked in solution. The ventilation plate is placed behind the refrigeration compartment frame, and is connected to the gas gun, providing air circulation and quality assurance for food.

The telescopic rod, the supporting pulley rod and the power screw rod group are positioned at the rear of the integral frame and are used for supporting and fixing the integral frame and the device frame, the telescopic rod is a triple structure, the inner rod is connected to the device frame, the outer rod is connected to the integral frame, when the integral frame moves outward, the central rod is used for connecting the inner rod and the outer rod, and the triple telescopic rod provides the supporting effect of sufficient telescopic range.

The function of the support pulley rod and the telescopic rod is basically the same, and it is also used for support and fixing, and is divided into three layers: inner rod, central rod and outer rod, and the fixing mode is the same as that of the telescopic rod. The telescopic rod is used for the support fixation of the upper and lower end faces, the support pulley wheel rod is used for the tangential stress support of the side, and the pulley installed on the middle rod acts with the inner rod and the outer rod respectively, and the outer rod is connected to the upper and lower rods, and the support of sliding is provided simultaneously.

3.3 Transport module

The transportation module is mainly responsible for the transportation between storage modules, processing modules, and cooking modules. The transportation module consists of upper and lower transportation rails, left and right transportation rails, load-bearing platforms, and mechanical arms. The upper and lower transport rails, as well as the left and right transport rails, allow the transport modules to be transferred between different modules, and the robotic arm is used to pick up or put down ingredients. The carrying platform is used to carry the ingredients taken by the robotic arm.

The left and right transport platforms are installed on the upper and lower bearing platforms, and the left and right transport platforms are made up of bearing plates, gears, bevel gear rods, motors, etc., and the bearing plates are installed on the upper and lower bearing platforms, and are connected by the small bearing wheels installed inside, so that the supporting conditions that the bearing plates move on the upper and lower bearing platforms are ensured. The motor is installed under the bearing plate, and two motors are respectively connected with two bevel gear rods, and bevel gears are installed at both ends on one bevel gear rod. At the same time, the bearing plate is also installed with four groups of gear-bevel gear shafts, and the gear-bevel gear shaft is connected with the bevel gear rod by the bevel gear, and the gear is connected with the rack, and the rack is installed on the upper and lower bearing platforms, and the power chain of motor-bevel gear rod-gear-rack is formed. The power conditions for the left and right transport platforms to move on the upper and lower bearing plates are provided.

3.4 Processing module

The processing module consists of a translational lifting robotic arm, a peeling unit, a high-pressure cleaning unit, a rotary crushing unit, a chopping module unit, etc. The translational lifting robotic arm is used to transfer ingredients from the transportation module to the processing unit.

The peeling unit is composed of a debris pool, a moving roller and a cutting platform. The debris pool is installed at the bottom of the lower level of the module frame, and above it is installed moving rollers and cutting platforms. The moving roller is composed of a moving block and a roller, the moving block is equipped with a roller and is capable of linear motion on the debris pool, and the roller is equipped with a motor and is able to rotate on the moving block. The cutting platform is composed of a roller support and an upper and lower cutting group, the roller support is installed on the debris pool, and the roller is used to move, and the upper and lower cutting group is composed of two groups of cutting tools, one is a cutting group that uses up and down movement to cut, and one group is a cutting group that uses forward and backward movement to cut, and moves up and down to adjust the cutting depth. The cutting group is used to segment the food, and the cutting group is used to remove the skin of the food.

3.5 Cooking module

The cooking module consists of a translation and lifting mechanical arm, an automatic cooking machine, and a steaming and baking integrated box. The steaming and baking integrated box is mainly used for steaming and baking common foods, and can also be used for steaming rice. The automatic cooking machine includes a rotating clamp, a rotating mixing group, an automatic seasoning box, etc.

The automatic cooking machine is mainly composed of a rotating splint, a rotating stirring group, and an automatic seasoning box. The rotating cleats rotate around the shaft to lift the knives of the rotating mixing group out of the pot. The rotary mixing group is composed of a motor, a connecting rod, and a mixing knife, which is used to stir ingredients while cooking. An electric block is used to heat the pot under the automatic cooker, providing the temperature conditions for cooking.

The automatic seasoning box is composed of three parts, a collection dish, a regulating valve, and a seasoning container, and the seven seasoning containers above are installed above the regulating valve, and the falling time is controlled by the regulating valve to control the amount of use. At the same time, the gathering dish will collect all the seasonings and guide them into the pot to achieve the purpose of healthy intake.

4. Conclusion

Through the optimal design of the core mechanism including the dispensing motor and shaft, the stirring motor and the shaft, and the heat load of the burner, the potential failure hazards are solved and the stability of the automatic cooking robot is improved. The corresponding action of the movement of the robotic arm is controlled by the application APP to complete the realization of various operations; At the same time, based on ergonomics, the relevant dimensions of the automatic cooking robot in user operation, feeding and observation are optimized, and the optimized operation size can meet the use of 90% of the operators in the current machine application site, so as to achieve comfort and reduce labor intensity.

The infrared thermometer is applied and the design is optimized through simulation analysis, which realizes the convenient and fast, easy to disassemble and clean installation and protection. The dishes achieve the accuracy of constant temperature heating, empty pot temperature control, hot oil

temperature control, etc., which ensures the consistency of the dishes and also protects the pot coating.

The application of the control board and the heat dissipation analysis and structure optimization, the structure of the cooling fan is added on the cover of the control box to improve the heat dissipation effect, which not only solves the shortcomings of the control board in the practical application of the automatic cooking robot, but also significantly improves the service life of the control board and increases the reliability.

Through the optimization design of the heating uniformity of the insulation bucket and smoke baffle, the uniformity of the heating of the pot and pan during cooking is realized, and the overall temperature range of the pot is 200 °C~350 °C, and the thermal efficiency can reach 35.68%, which improves the stability of cooking. Combined with the mechanism design of the integration of raw material storage, processing and cooking, the overall mechanism is coordinated, orderly, convenient and reliable, so as to complete the multi-functional cooking function of the whole process, so that users can eat meals more conveniently and quickly.

Cooking robots are a revolution in traditional cooking techniques. They not only replace human cooking labor, but more importantly, they systematize, standardize, and simplify the processing and production of dishes; And with the help of programmatic flexibility and personalized characteristics, more diverse forms of dishes can be created. The role of cooking robots in promoting social development and improving people's lives: new intelligent household appliances and innovative cooking methods will change the way of life in 21st century human society. Therefore, studying cooking robots has a significant role in improving people's quality of life ^[5].

The cooking robot is designed with an integrated mechanism that integrates raw material storage, processing, and cooking, making the overall mechanism coordinated and orderly, convenient and reliable, thus completing the multi-functional cooking function throughout the entire process, making it more convenient and efficient for users to eat food. This has important inspiration for the development of subsequent cooking robots.

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