Design of a fully automatic intelligent cooking robot

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Abstract. With the rapid development of Internet of Things artificial intelligence, people’s life becomes more and more convenient. Intelligent frying machines have been favored by consumers because of their advantages of saving time and saving time. However, most of the existing market fry machines have the disadvantages of low automation, low quality and complicated operation, but they have not been widely promoted. Therefore, this paper designs an intelligent cooking robot with full automatic, high intelligence and convenient operation. It is based on the Internet of things information technology, and improves the structure, circuit, software and user experience in all aspects. It has the functions of automatic weighing of food materials, intelligent recipe generation, intelligent seasoning precise addition, automatic cooking, voice interaction and other functions. It realizes the full automation, precision and intelligence of the cooking process, and the user experience is good.

1. Introduction
Cooking is to provide people with delicious dishes of color, shape and taste, and to meet the dietary and physiological requirements of all kinds of people (Li, 2006; Ma, 2011). After thousands of years of development, the methods and types of cooking are increasing, and the dishes are increasingly rich, but the cooking process is manual operation, and has never realized mechanization, automation and standardization. In the busy social rhythm, people are eager to get leisure and make their life more relaxed and pleasant. However, in the face of the complexity of cooking, cooking fumes and time cost, many people are at a loss. At present, there are many kitchen appliances in the market, such as cooking machine, rice cooker, induction cooker, microwave oven, bean paddle machine, etc. (Zhu, 2014). The emergence of these devices to a certain extent reduces the valuable time people spend in the kitchen, so that people can do more other things. However, most of the frying machines on the market at this stage have defects such as low degree of automation, standardization, imperfect function or unreasonable structure. These defects make it difficult to apply to specific application scenarios (Liu, 2019). Specifically, the automatic cooking machine on the market now has basic automatic temperature control and frying functions, but the cooking machine still needs to rely on manual work when adding seasoning and transporting cooking materials (Wu, 2017). At the same time, the operation is cumbersome, and the degree of intelligence is not high. For example, when making dishes, users need to choose recipes program, power and heating time, which seriously affects people’s experience.

Therefore, we need to design a more automatic, intelligent and convenient cooking robot.

2. Overall Design
In this paper, a full-automatic cooking robot is designed, which has a variety of human-computer
interaction, from the structure, circuit, software, user experience to improve in all aspects. In the structure, a full-automatic cooking integrated structure is designed, including drum type cooking pot (Wang, 2015), manipulator, incubator, cooking table, seasoning rack and central console. The temperature sensor, pressure sensor, touch screen and voice module are designed in the circuit. In terms of software, technologies such as intelligent electromechanical control technology based on multi-sensor information fusion technology of internet of things, intelligent heating technology, step-by-step intelligent addition of seasoning (Huang, 2015), intelligent recipe program and voice interaction mode have improved the whole process of cooking automation, accuracy and intelligence, and improved user satisfaction.

The full automatic intelligent cooking robot represented in this paper is mostly used in hotel, family, schools and canteens of large companies, etc, which is used to substitute for cooking by people, so as to achieve the intellectualization, modularization, standardizing and automation of food cooking. The chief working pattern of the cooking robot is to separate standardized recipes into different modules by writing routines, and transform them into compute instructions as to regulate the actions of the mechanical arm, control the heating, control the seasoning addition and the connection between different actions by the timer to complete a dish (Lv, 2021). As shown in Fig. 1, the workflow of cooking a food is broken down as below: type of dishes to be fried - weight of dishes - user preferences - Intelligent recipe - pot heating - add cooking oil - manipulator grab the plate with food ingredients - manipulator moves the dish - manipulator rotates to pour the vegetables into the pot - put down the plate – stir fry – add seasoning - stir fry again - pour the dishes onto the plate - manipulator grabs the dish with cooked dish - move the dish to the incubator - release the manipulator – keep cooked dish warm.

For different dishes, different routines should be written based on their respective recipes and cooking programs, so as to achieve the intellectualization, modularization, standardizing and automation of cooking foods.

Fig. 1. Work flow chart of the full automatic intelligent cooking robot
3. **Structure Design**

![Diagram of the fully automatic intelligent cooking robot]

1. Incubator 2. Drawer 3. Turntable 4. Steering gear 1 5. Big arm 1 6. Steering gear 2 7. Small arm 1 8. Big arm 2 9. Electromagnetic heating coil 10. Big gear 11. DC motor 12. Small gear 13. Mixing shaft 14. Pot cover 15. Seasoning box 16. Solenoid valve 1 17. Solenoid valve 2 18. Hose 19. Touch screen 20. Pot 21. Mixing blade 22. Steering gear 3 23. Bracket 24. Steering gear 4 25. Mechanical claw 26. Rocker 27. Steering gear 5 28. Steering gear 6 29. Vegetable table cover 30. Serving table 31. plate

Fig. 2. the full automatic intelligent cooking robot

The structure of every part of the mechanical system of the fully automatic intelligent cooking robot is shown in Figure 2. The mechanical arms are the arms of carry and pour dish into the pot (3, 4, 5, 6, 7, 24, 25), the arms of covering or opening pot cover (20, 26, 27, 28) and the arms of pancake turner (8, 20, 21, 26). The obscured part in the picture includes a temperature sensor installed in the center of the heating area of the stove to detect the temperature in the pot. There are pressure sensors at the bottom of each bowl (31) on the prepare food table (30), which are used to measure the weight of dishes. The seasonings in the spice and seasoning rack (15, 16, 17, 18) can be added into the pot (20) in order and quantity.

The action flow of parts of the robot is loosely as below: person can use voice or touch screen (19) to choose the program to act, the electromagnetic heating coil (9) starts to heat up, the pot (20) start to rotate a certain angle, the spice and seasoning rack (15,16,17,18) pour the oil into the pot (20). When the temperature sensor checks that the oil temperature arrive the preset temperature, the carry arms (3,4,5,6,7,24,25) move the plate contains ingredients, rotate the plate at an angle, pour the vegetables in the plate (31) into the pot, and then the spatula arms (20, 26, 27,28) are lowered, the motor 3 (11) drives the mixing blade (21) to rotate to spread the ingredients evenly. The spice and seasoning rack (15, 16, 17, 18) add the right seasoning on time and in order, with the right weight and type, and then the spatula arm and spatula move again to stir-fry the dish, repeating this many times until the cooking of a dish is...
finished.

4. Hardware Design of Control System

The hardware of the full automatic intelligent cooking robot mostly contains the singlechip microcomputer of STM32F4, pressure sensor, temperature sensor, speech recognition module, touch screen, power supply, 1 DC motor, 5 steering engines, 1 electromagnetic heating coil, serval solenoid valves. The singlechip microcomputer is core controller, which regulates the actions of all other hardware and software. The pressure sensor measure the weight of dish to be cooked, which determine the weight of seasoning add to dish. The temperature sensor monitors the temperature in the pot in actual time and changes the data to the singlechip microcomputer, that successively controls the heating system to adjust the temperature. Every motor is regulated by the singlechip microcomputer to achieve the right working location and speed respectively on the basis of the running program. The solenoid valve is regulated by the singlechip microcomputer to add the type and wight of seasonings to the pot according to the type of vegetables. As a human machine interface, the speech recognition module and the touch screen could be used to input and output information, and simultaneously show the pressure and the temperature on the display screen. The flow chart of hardware system structure is shown in Fig. 3.

![Diagram of Hardware System Structure](image)

Fig. 3. Structural Sketch of the Control System Hardware

5. Software Design of Control System

When the fully automatic intelligent cooking robot devised in this paper is used to accomplish the production of a dish, the mechanical arm 1 - the arm of loading ingredients equipment and the mechanical arm 2 - the spatula arm and the switch of pot cover, the seasoning rack - add seasoning in order and quantity, which make duplicated actions throughout the process. Thus, we could use loops to achieve the main program.

When beginning to write a program, define an i = N first, and get i-1 after looping once, "i" is used to judge which dish to be cooked. Then the control programs of electromagnetic heating coil, solenoid valve, DC motor and steering gear can be organized and used as subroutines, and the time-delay between every action is used to control the time. As shown in Fig. 4.

In the program flow chart, the procedure is partitioned into four modules, Lable 1: Intelligent recipe generation. According to the type, weight of ingredients and the user's hobby, the intelligent recipe
program is generated, that is, the type, weight and order of seasoning, heating mode, heating time, etc. Label 2: Temperature detection. Label 3: Action 1, the turntable, the steering gear 1, the steering gear 2, steering gear 4 controls the action of the carry arm to grab the plate that contains the raw ingredients, sends the plate to the designated position, and pours the cooking materials into the pot. Then the steering gear 5 and steering gear 6 which regulates the spatula arm goes down (cover the pot), and the DC motor drives the the mixing blade to turn. After the delay, the spice and seasoning rack (16, 17, 18) add the right seasoning on time and in order. Then the spatula move again to stir-fry the ingredients, repeating this many times until the cooking of a dish is completed. After the delay, the the steering gear 5 and steering gear 6 moves up (remove the pot cover). Then the steering gear 3 rotates the pot to take out cooked food. Label 4: Action 2, the turntable, the steering gear 1, the steering gear 2, Steering gear 4 control the action of the carry arm to grab the plate that contains the cooked food, and move it to the incubator. The whole program code uses loops. If there is a new requirement in the actual state, the decision statement should be changed to achieve the addition or subtraction of the types of cooking stuff. Meanwhile, the control of the time in this program can be achieved by the delay in the program. That is, the time of a certain procedure or certain process could be changed by the human machine interface, so as to achieve the innovation and personalization of cooking.

Fig. 4. Program flow chart of control system

6. Conclusion
The basic principle of the fully automatic intelligent cooking robot is to separate the cooking program into many different standardized modules, transform every action into program instruction, connecting electrical technology, mechanical structure to imitate the whole cooking process of humans and achieve automated cooking.

The control system of the fully automatic intelligent cooking robot is devised in this paper. Firstly, the integrated design of the device is analyzed to decide the scheme of control system and the mechanical system. Then, the main body design of the fully automatic intelligent cooking robot, the software and hardware design of the device are accomplished gradually. Finally, the system design of the whole device is completed, and the relative functions of the fully automatic intelligent cooking robot device are realized.

The fully automatic intelligent cooking robot which is designed in this article is more intelligent and
automatic than the former frying machine. As long as people press one button, they can realize the full automation of the frying process, such as pour the raw materials into the pot, add seasoning by weight and in order, stir-fry, pour the dish out the pot, keep the cooked food warm, etc. And it could realize the cooking of multiple dishes in order, which can greatly improve the user experience.

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