Campus canteen takeaway robot based on Raspberry Pi

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Abstract. In this era of rapid technological development, the related technologies of intelligent robots have made great progress, and the application scenarios of robots have also expanded from the industrial field to the service field. In order to obtain a more convenient way of dining, more and more people choose to order take-out, especially on campus, takeaway members are everywhere. Aiming at the special group of college students, we proposed a takeaway robot system for campus canteens based on Raspberry Pi. The system is mainly composed of Raspberry Pi, navigation module, obstacle avoidance module, voice module, driving module and applet ordering platform. Users only need to order food on WeChat applet, and the takeaway robot will deliver the food to the target address. The takeaway robot runs safely and stably, and can complete the unmanned delivery of takeaway. The system can help college students save time while eating hygienic canteen takeout, and it can also effectively solve the problem of speeding and hurting people on campus.

1. Introduction

With the rapid development of the Internet, the food delivery industry has entered our lives, providing people with new choices for dining and bringing a lot of convenience. The mainstream takeaway apps in the current market are difficult to guarantee the quality of take-away meals. And the delivery mode of takeaway industry is manual delivery at present. Because the delivery time of the delivery platform is very demanding, you can often see takeaways riding electric bikes in a hurry. Speeding and retrograde are very common for takeaways in a hurry. In high-traffic universities, this is very dangerous. It is not uncommon for a delivery man to have a collision caused by speeding, which is a great hidden danger to students. College canteens are the main way for college students to eat. Compared with businesses in society, college canteens have relatively safer and healthier meals. However, college canteens often suffer from the problem of excessive number of meals during peak periods, which leads to waste of students’ dining time. With the booming food delivery industry today, college canteens are mainly faced with college students who are pursuing freshness. They also need to catch up with the trend of the times, improve their own sales model, develop towards a new model, and provide students with more convenient and efficient services.

At the same time, great progress has also been made in the technology related to intelligent robots, and the application scenarios of robots have also expanded from the industrial field to the service field. Under the form of the food delivery industry's impact on the traditional dining mode, in order to make more people willing to choose a relatively safe and healthy canteen, many scholars have put forward certain ideas, such as designing a college canteen APP, and students can order meals remotely through mobile phone software. Meals can be picked up immediately after arriving in the cafeteria. This method solves the problem of difficulty in queuing in college canteens, and will make canteen dining
more intelligent, simplified and humanized [1]. However, some college students, due to the large campus and the living area far away from the dormitory, feel that it is more convenient for takeaways to deliver meals downstairs in the dormitory, so they tend to choose takeaway meals. In response to this phenomenon, in order to make it more convenient for college students and encourage students to eat in the school canteen, this paper designs a campus takeaway robot system. The system uses takeaway robots instead of humans, so that students can eat take-out from the canteen more conveniently.

2. System Scheme Design

2.1. System overview

The overall block diagram of the system is shown in the Fig.1.

The canteen takeaway robot system is mainly composed of raspberry pie, accurate navigation system, intelligent obstacle avoidance system, motor drive module, WeChat small ordering program and power module. Using the cloud Internet of things platform as the data storage terminal, WeChat applets upload the user's basic information and store it in the cloud. The delivery robot can also access the delivery address and other information in the cloud based on the user's bound mobile phone number. In the delivery process, the unmanned delivery robot can sense the surrounding environment according to the intelligent obstacle avoidance system, and identify its position in the high-precision map of the campus with the precise navigation system, so as to ensure the security and stability in the delivery process. After reaching the target address, the robot will send the meal code to the corresponding customer's mobile phone. After the customer inputs the meal code according to the prompts, the delivery robot will check with the cloud meal code information, open the corresponding meal box of the customer, and complete the delivery of this order. After delivering all the food on the bus, the robot will return to the canteen and enter the charging state.

2.2. Raspberry Pi and its Function Introduction

This design uses Raspberry Pi 4B as the main control terminal. Raspberry Pi is an ARM-based miniature motherboard. The board provides 40 GPIO pins, 4 USB ports, 1 Gigabit Ethernet port, and supports 2.4G/5G dual WiFi. the Raspberry Pi 4B is equipped with the official Raspbian system. Its processor uses the Cortex-A72 core, and the highest frequency can reach 1.5Ghz. It has powerful code
execution capabilities and rich controller applications, making it possible for the takeaway robot to run smoothly [2]. In the text, the Raspberry Pi mainly implements the following functions:

1. The GPS module is connected to the Raspberry Pi main control system to transmit the location information of the takeaway robot to the Raspberry Pi, and the Raspberry Pi transmits it to the cloud IoT platform through the 4G module.

2. The ultrasonic obstacle avoidance module is directly connected to the Raspberry Pi main control system, and transmits real-time road information back to the main control system, and the Raspberry Pi makes steering commands based on the information.

3. The DC geared motor is connected to the motor drive module, and then the pins of the motor drive module are connected to the GPIO of the Raspberry Pi, and the GPIO port is programmed to output control signals to control the motor rotation.

2.3. Introduction of Motor and Motor Drive

The motor adopts a DC geared motor, which has the advantages of simple assembly, easy disassembly and light weight, thus reducing the load of the takeaway robot. Because of the large rotation torque, it can drag the takeaway box with large weight, and the small size saves more space for other modules. The DC geared motor reduces the speed of its internal high-speed motor through the reduction gear set, which can generate larger torque [3]. Industrial grade high-power dual DC motor drive is selected as the motor drive module, which is stable and reliable, with double H bridges, can drive two DC motors at the same time, the single output current can be as high as 7A, and it is equipped with optocoupler isolation circuit and undervoltage protection circuit, which conforms to the EMC design specifications and has a high-power TVS and electrostatic discharge circuit to suppress transients, which suppress transient interference pulse and static electricity. Take only one H-bridge circuit as an example to list the logic control table of the motor drive module, where INA and INB represent the two signal input terminals of the first H-bridge, which control the robot to move forward, backward and brake. ENA is the enabling terminal of the motor, which can be connected with PWM to adjust the speed of the motor.

| Motor Status            | Signals for Control |
|-------------------------|---------------------|
|                         | INA | INB | ENA |
| Brake                   | 0   | 0   |     |
| Hang in the air          | 1   | 1   |     |
| Forward speed regulation| 1   | 0   | PWM |
| Reverse speed regulation| 0   | 1   | PWM |
| Full speed forward       | 1   | 0   | 1   |
| Full speed reversal      | 0   | 1   | 1   |

2.4. Precise Navigation System

The unmanned takeaway robots need to deliver food to customers autonomously, and the entire process requires an accurate navigation system.

The navigation system of the canteen takeaway robot is designed by combining GPS navigation and high-precision map navigation. GPS navigation is realized through the GPS module, which integrates RF radio frequency chip, baseband chip, core CPU and related peripheral circuits. The GPS module continuously receives data from satellites and sends it to the Raspberry Pi for processing to
obtain its own location information. With the laser navigation technology, the takeaway robot can collect the laser point data by itself, correct and supplement the satellite navigation data, and perceive the situation of the surrounding environment in real time through the laser radar and ultrasonic module. It can build high-precision maps at the centimeter level, and store it in the database for the navigation operation of the takeaway robot [4]. The robot can identify its position in the high-precision map by matching the position information of GPS navigation with the high-precision map, so as to achieve more accurate navigation.

2.5. Intelligent Obstacle Avoidance System
Obstacle avoidance means that the takeaway robot can effectively avoid obstacles according to certain methods. When the robot senses objects that hinder its passage through the sensor during the food delivery process, it effectively avoids the obstacle according to a certain method, and finally reaches the target address of the food delivery. The necessary condition for obstacle avoidance and navigation is environmental perception. In unknown or partially unknown environment, obstacle avoidance needs to obtain surrounding environment information through sensors, including the size, shape and position of obstacles. Therefore, sensor technology plays a very important role in obstacle avoidance of mobile robot [5]. In this design, lidar sensor and ultrasonic sensor are used to realize the intelligent obstacle avoidance of takeaway robot. The lidar sensor can scan the surrounding environment 360° to construct a centimeter-level campus high-precision map, sense the static information of the road surrounding environment, and realize the perceptual update of the campus high-precision map. With the use of ultrasonic sensors, it can also identify objects such as glass and mirrors, and finally realize the intelligent obstacle avoidance function of the takeaway robot.

2.6. Introduction of WeChat Ordering Applet
Applet is an application that can be used without downloading and installing. It has realized the dream of application "within reach", users can open the app by scanning or searching, it embodies the concept of "use up and go". In this design, the user first binds the applet with the phone number, and after ordering the takeout, the user sets the meal address and submits the order. Applet is connected to the cloud Internet of things platform, which stores user information in the cloud platform. In addition, applet will record the current location of the take-out robot. When the take-out robot arrives at the specified location, it will show that the take-out robot has been delivered and send a text message to pick up the meal code. The applet will show that the order has been completed after the students have picked it up.

3. System Function Design
The main function of the system is to use takeaway robots to realize unmanned delivery of take-out. The complete flow chart of the system design idea is shown in the Fig.2.

Step 1: Users use the WeChat applet to order food. After the school canteen staff is ready for the take-out, they enter the user's mobile phone number and put the take-out into the takeaway robot.

Step 2: The takeaway robot queries all the food delivery addresses according to the user's mobile phone number. The takeaway robot can plan the delivery route according to the algorithm, and judge whether it has sufficient power. If the power is insufficient for the round-trip distance, it will give a voice warning of insufficient power. If the battery is sufficient, the first destination address will be selected.

Step 3: The user can view the current location of the takeaway robot on the WeChat applet, and the distance between the takeaway robot and the user will be displayed on the applet.

Step 4: The takeaway robot will determine whether it has reached the target address. If its position on the high-precision map matches the target address, the takeaway robot will send a meal code to the user's mobile phone. If it does not reach the target address, the takeaway robot will continue to follow the navigation.
Step 5: After the user enters the meal retrieval code, the takeaway robot will correspond the meal retrieval code with the meal retrieval code stored in the cloud to determine the correctness of the meal retrieval. If the meal retrieval code is wrong, the user will be reminded to re-enter. When the user enters the correct meal retrieval code, the takeaway robot will open the corresponding meal retrieval box. The applet will also show that the delivery has been completed.

Step 6: Each time the takeaway robot has delivered an order, it will judge whether all the takeaways have been delivered. If the takeaway has not been delivered, the takeaway robot will choose the next delivery address. When all the takeaways are delivered, the takeaway robot will return to the canteen and enter the charging state.

Fig.2 System Flow Chart
4. Conclusion

The rapid development of 4G in the past few years has greatly promoted the development of the food delivery industry. More and more catering industries have joined the food delivery industry. The existence of takeaway breaks the limitations of having to eat in the dining room, which makes customers have more freedom to choose the dining place and enrich the inspection of the store's word-of-mouth. The development of the takeaway industry has also provided employment conditions for many people and increased the employment rate of the society. Looking at the current food delivery industry and current research, the delivery methods of takeaway mostly depend on the delivery person. Therefore, this design breaks the traditional delivery model of takeaway and uses takeaway robots to deliver food to customers.

This article uses Raspberry Pi as the master computer to design a canteen takeaway robot, which can establish a connection with the cloud platform through a 4G module, and then access user information stored in the cloud, including food delivery address information and phone number information. Based on the GPS guidance system, the takeaway robot uses laser navigation technology to build a more high-precision campus map to meet the requirements of use, and it will continuously send its own location information to the cloud during the delivery. Customers can view the location of the takeaway robot through the applet. Through the combined use of lidar sensors and ultrasonic sensors, the takeaway robot can sense dynamic and static information to avoid accidents in the road. Due to the limitations of the takeaway robot, the use scene of this design is set on campus. After the customer orders the food in the WeChat applet, the canteen staff will place the takeaway in the robot, and the robot will deliver it to customers. The realization of this design uses the Internet of things, cloud computing and other knowledge, which is in line with the current trend of technological development and has a good market prospect. This design provides personalized service for customers, allowing users to eat more conveniently. I hope this design can make more people feel the convenience brought by the development of science and technology.

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