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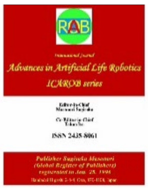

Research Article

Design and Simulation of Welcome Guests and Explain Robot

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ABSTRACT

A welcome guests and explain robot was designed to solve the problems such as fewer interpreters in museums and other venues, and large demand for audience consultation. The robot consists of a mechanical system, a sensor system, and a motion control system. In order to improve the efficiency of development and debugging, and reduce the cost of experiments, it is necessary to test related algorithms in a virtual simulation environment before the robot enters the actual working state. Experiments have proved that the robot can autonomously guide guests to the destination and explain according to a preset path; the robot has multiple sensors to sense obstacles, and can autonomously avoid obstacles during the explanation and continue to move; the robot can accurately and efficiently recognize faces and provide accurate services Fast.

1. Introduction

With the rapid development of intelligent technology, the quality of people's lives continues to improve. Because the existing "tour guide" intelligent robot has few functions, it can only realize the function of navigating the road, and the existing "tour guide" intelligent robot can not guide and remind tourists [1]. Aiming at the problems of museums and other venues such as the lack of interpreters and the large demand for audience consultation, a welcome guests and explain robot was designed and simulated in gazebo software. The robot mainly realizes the following 3 functions:

(i) Welcome explanation: The robot can guide the guests to the destination and give an explanation according to a preset path. After the explanation, the robot will automatically return to the original starting position;

(ii) Audio guide: The robot can interact with people by voice. During the robot's explanation process, the audience can interact with the robot at any time if they have questions or problems.

(iii) Face recognition: The robot takes pictures of the user who is guided for the first time to collect public information, continuously enriching the public's personal portraits, establishing more complete personal information materials, and providing accurate and fast services.

2. The Composition of the Robot

The robot consists of four layers. The first layer is the operation decision-making layer, including upper computer, camera, display, microphone and speaker; The second layer is the driving layer, including the lower computer, three ultrasonic sensors, a temperature and humidity sensor, a smoke sensor and a battery; The third layer is the lidar layer, with a lidar; The fourth layer is the chassis motion layer, including a universal wheel, two driving wheels, two motors and three infrared sensors. The schematic diagram of the robot is shown in Figure 1. The upper computer is an industrial computer with high anti-magnetic, dust-proof and impact-proof capabilities [2]. There is a special power supply in the chassis, and the

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power supply has strong anti-interference ability. The processor is an inter i7 processor with four usb3.0 interfaces And four usb2.0 interfaces, two network ports. The lower computer controller mainly realizes the bottom-level motor drive, power management and acquisition of various sensors such as ultrasonic and infrared, and at the same time feeds back the collected data to the upper computer in time. The lower computer controller uses STMicroelectronics' STM32F103ZET6 chip as the main control, the chip flash has 512K, the SRAM is 64KB, and the pins are 144 [3]. The chip runs the FreeRTOS system. The infrared sensor can prevent the robot from falling when walking to the road pit, and can realize the function of auxiliary obstacle avoidance [4]. Lidar is used to realize the range finding scan and generate the plane point cloud map information of the space. These cloud map information can be used in practical applications such as map surveying, robot positioning and navigation, and object/environment modeling. The block diagram of the robot system is shown in Figure 2.

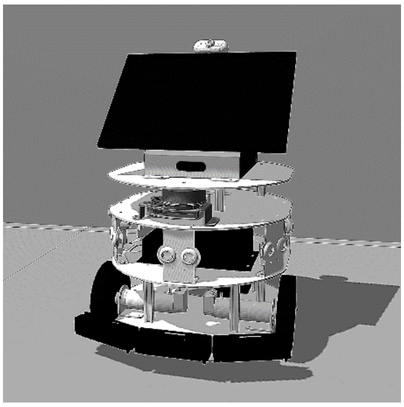

Fig.1. The schematic diagram of the robot

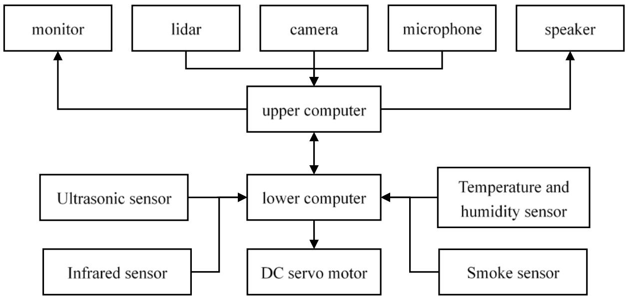

Fig.2. The block diagram of the robot system

3. Robot Simulation Test

3.1. Construction of simulation environment

The simulation environment of the robot is built on the gazebo simulation platform, and the walls are drawn by the building editor tool provided by gazebo. What we have built is an indoor exhibition hall scene including 16 venues in Chinese cities such as Chongqing and Shanghai. Each venue is 12 meters long and 4 meters wide. The robot model is built and exported by solidworks software. The initial position of the robot is in the center of the hall of the exhibition hall. The simulation environment of the robot is shown in Figure 3.

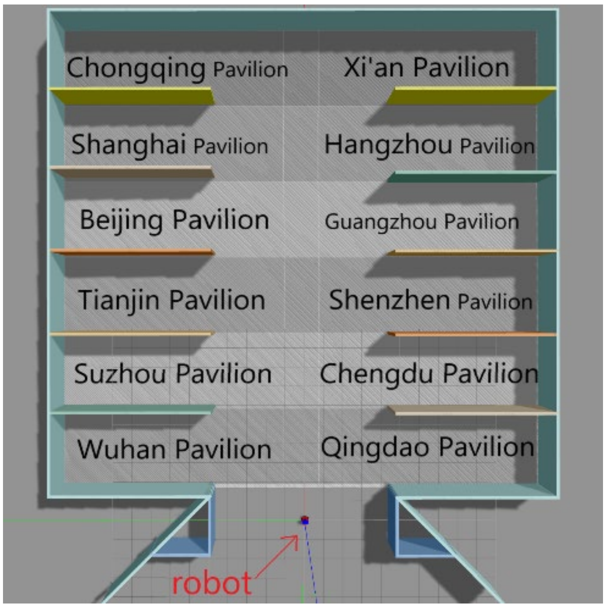

Fig.3. Robot simulation environment

3.2. Mapping and navigation

Only after the establishment of the map is completed and the map is obtained, the robot can be controlled to navigate. SLAM is simultaneous localization and mapping, which can be described as: the robot starts to move from an unknown position in an unknown environment [5]. During the movement, it locates itself according to the position estimation and the map, and at the same time builds an incremental map to realize the robot's autonomous positioning and navigation [6]. This design uses the most commonly used and mature gmapping algorithm in SLAM, gmapping integrates the Rao-Blackwellized particle filter algorithm, the following is the overall framework of gmapping and navigation shown in Figure 4.

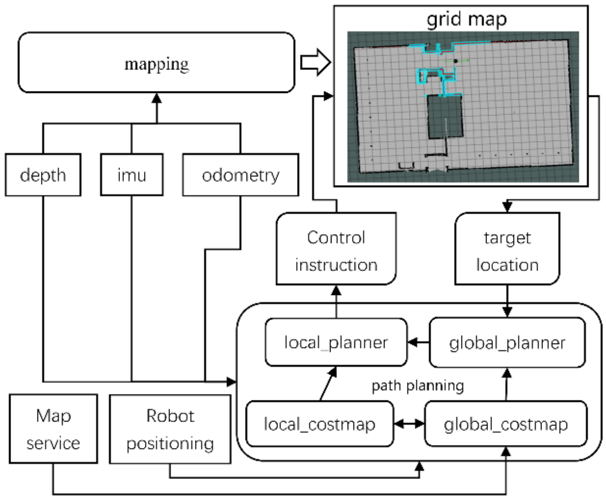

Fig.4. The overall framework of gmapping and navigation

The gmapping function package is used to create and output a probability based two-dimensional grid map, which subscribes to the odometer information, IMU information and depth information of the robot, and completes the configuration of some necessary parameters. The key to navigation is robot positioning and path planning. The navigation function package needs to collect the sensor information of the robot to achieve the effect of real-time obstacle avoidance. It also needs the odometry information of the robot and the corresponding TF transformation. Finally, the navigation function package outputs instructions that can control the movement of the robot.

Use the keyboard node to control the robot to move in the Gazebo environment. After the map is created, save it. This map will be called during the navigation process.

Move_ base function package is used for local real-time path planning and global path planning. In the global map, the a * algorithm is used to calculate the global path from the robot to the target point to complete the most efficient planning of the global path. In practice, obstacles may appear at any time, so local real-time planning must be carried out to make it conform to the global optimal path as much as possible. Use the Dynamic Window Approaches algorithm to search for multiple paths to avoid and travel, and select the optimal path according to the evaluation index. The robot should calculate its position in the global map in real time, that is, the autonomous positioning function, which is realized by the AMCL function package [7]. Perform navigation simulation in Rviz, as shown in the Figure 5 below, where the red arrow is the specified target position, and the green line between the red arrow and the robot is the global path planned by the navigation function package.

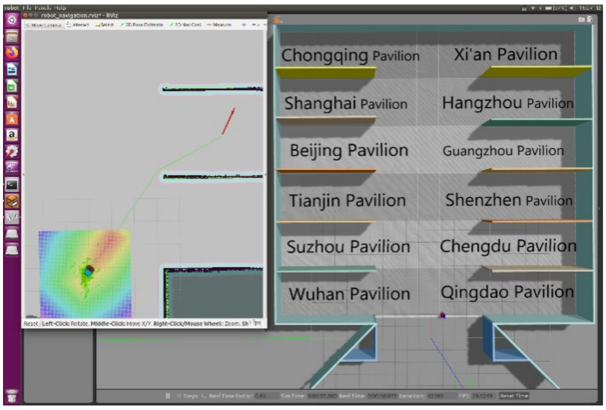

Fig.5. Robot navigation simulation

3.3. *Welcome explanation*

Robots can lead tourists to scenic spots through path planning. After arriving at the scenic spot, the robot will give voice explanation to each scenic spot. After the explanation, the robot will return to the initial position and wait for the next round of tour guide explanation. When building a map, record the location of each venue as a navigation target point. Move_base implements path planning through action, and action uses a client/server architecture. Use the send_goal() interface to send to the server of move_base. After receiving the target task, the server will realize the path planning function according to the current pose of the robot, and output the speed command to control the movement of the robot. Go to the target location and return the result to the client. If the result is successful, it will send the introduction of the corresponding venue to the speech synthesis module, and let the robot speak the introduction. This function module is based on the tts_sample program in the iFLYTEK SDK, modify the main code file, add the ros interface, subscribe to the introduction topic, receive the input voice string, and use the SDK interface in the callback function to convert the string into Voice, after the voice broadcast is completed, the robot will navigate to the next target point and continue to broadcast until the last target point is finished.

3.4. *Audio guide*

This function is based on the speech recognition SDK provided by IFLYTEK and is constructed using the ROS system. The iat_record_sample program in IFLYTEK

SDK is modified and the required ROS interface is added. This design adds a move_base client, a subscriber and a publisher. The Subscriber is used to receive the voice wake-up signal. After receiving the wake-up signal, the wakeupFlag variable is set, and then the voice dictation function of the SDK is called in the main loop to recognize Human voice information, set resultFlag variable after successful recognition. Then use dataString.find() to determine the meaning of Chinese voice input, and publish the corresponding target point pose through the send_goal() interface. After receiving the target task, the server of move_base will realize global and local Path planning function according to the current pose of the robot, output speed command to control the robot to move to the target position, and return the result to the client. If the result is successful, it will send the introduction of the corresponding venue to the speech synthesis module, and let the robot speak the introduction.

3.5. Target face recognition

The specific process of face detection is shown in Figure 6. First, load the face detection classifier that comes with opencv. In this article, the classifier based on haar feature values is used. In this article, we mainly use the contour of the face and human eye recognition to realize face detection. The next step is to preprocess the image to be recognized, to grayscale the image, obtain its histogram, and then perform equalization. The function of this step is to better extract the face feature values in the picture. Because the size of the input image is inconsistent, the detectmultiscal function should be called to identify and detect the image in multiple dimensions [8]. By calling the rectangle function, draw the rectangular frame of the face profile recognized by the program. Finally, the drawn rectangular frame of the face is cut out in the original image shown in Figure 7.

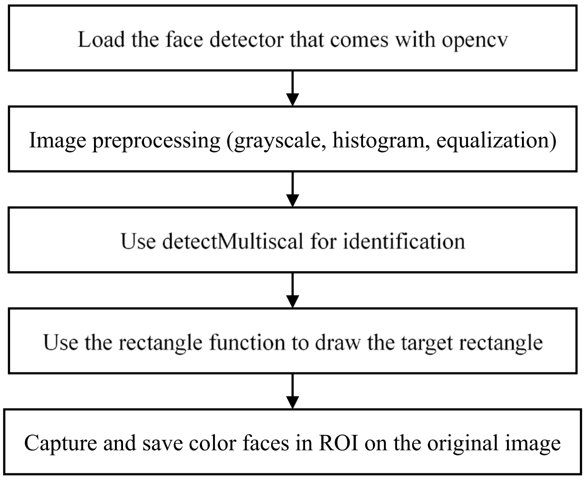

Fig.6. Face detection flowchart

Fig.7. Face detection

A specific face can be recognized only when there is a recognized target. The robot can know who to recognize through face model training. Firstly, preprocess the target face image, including sample normalization and sample graying. Sample normalization is to make the size of the image the same. Next, label the sample, this is to tell the training model which number belongs to whose face. Then start training, mainly using three methods, namely EigenFaceRecognizer, FisherFaceRecognizer and LBPHFaceRecognizer. The EigenFaceRecognizer method is also face recognition based on PCA transformation. The principle of PCA transformation is a way to reduce the dimensionality of an image, because in face recognition, the image is generally processed as a vector, but at the same time, the dimensionality of the vector is too large, and the huge dimensionality is quite difficult for subsequent image calculations. Therefore, it is necessary to reduce the image dimension without losing important information as much as possible. The FisherFaceRecognizer method is a face recognition based on Fisher transform [9]. LBPHFaceRecognizer is a face recognition method based on local binary patterns. The trained model is saved to the upper computer, and finally the specific face recognition is carried out shown in Figure 8.

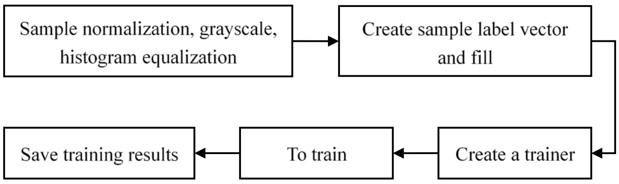

Fig.8. Face training flowchart

After having the above foundation, the final face recognition can be performed. First, image preprocessing is performed, and then the trained classifier is loaded to obtain the label value on the input image, and then the character name is obtained through the label value shown in Figure 9.

Fig.9. Target face recognition

Conclusion

In view of the small number of lecturers in museums and other venues and the large demand for audience consultation, the overall robot design was completed, and experiments were carried out on the gazebo simulation platform. The test shows that the robot can well complete the functions of voice explanation, tour guide and specific face recognition. By interacting with robots, visitors can understand the situation of each exhibition area. The robot's way-guide function can also provide more convenience for visitors. This solution can improve the construction effectiveness and quality of museums and other venues, as well as a smart and personalized service system.

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