DESIGN AND RESEARCH OF CLEANING ROBOT BASED ON ISC ALGORITHM

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***ABSTRACT**: With the rapid development of computer and information technology, the home robot has become another new product that is rapidly popularized due to its simple operation, low price, time saving and labor saving. Service robots enable automatic cleaning of the interior environment, replacing traditional heavy manual cleaning. It combines mechanics, electronics, sensor technology, computer technology, control technology, robotics, artificial intelligence and many other disciplines as a whole. It is an environment-friendly, healthy and intelligent service robot with good application prospects and a wide range of market needs. Cleaning robots use visual sensors such as cameras and associated vision system software to process environmental visual information to find and locate the target object (object being cleaned).*

***KEYWORDS**: ISC algorithm, cleaning robot, design, route, collaborative analysis, research*

1 INTRODUCTION

With the continuous improvement of technology and computer technology and the rapid development of robotics, service robots have gradually entered human society. As a service robot that combines mobile robot technology and service technology, more and more attention has been paid. Service robots enable automatic cleaning of the interior environment, replacing traditional heavy manual cleaning. As a special application of smart mobile robot, service robot embodies many key technologies of mobile robot and has strong representativeness.

Indoor floor cleaning is a boring and repetitive work, the traditional vacuum cleaner not only need people involved in the work, and the operation of inconvenience, low efficiency of cleaning, poor results, to achieve automation and automation of cleaning operations is efficient and effective cleaning of high quality . Indoor floor cleaning robot combines mobile robot technology and vacuum cleaner technology to realize the semi-autonomous or self-cleaning indoor environment. It integrates many subjects such as mechanics, electronic technology, sensor technology, computer technology, control technology, robot technology and artificial intelligence. Is an environmental, health, intelligent service robot, has a good prospect and a wide range of market demand. In recent years, indoor floor cleaning robots have received the attention both at home and abroad and become a new research direction in the service robot industry.

The United States, a clean robot "Roomba" with anti-winding, anti-drop, automatic charging, self-switching cleaning modes and other characteristics, you can walk in all corners of the room, the flexibility to complete a variety of cleaning tasks. The Roomba robot progresses in a progressively larger spiral, gradually sweeping the entire area from the inside to the outside, walking along its edges when it encounters walls, and shutting down itself when the vacuuming is done. A Swedish robot Trilobite uses ultrasonic bionic technology with built-in search radar to detect and avoid any obstacles, such as tables, wardrobes and pets. When the robot detects an obstacle, it can resume path planning to complete the cleaning of the entire room. Trilobite also has the function of storing information, and when cleaning is suddenly interrupted for some reason, the next cleaning can continue from the interrupted position.

Cleaning robots use visual sensors such as cameras and associated vision system software to process environmental visual information to find and locate the target object (object being cleaned). Using passive acoustic ranging method to measure the distance between the cleaning robot and other objects, in order to complete the positioning, radio frequency technology enables cleaning robots to communicate with each other. Cleaning robot work, the need for its control system, sensors, power systems, such as design and combination. Cleaning robot positioning and path planning is one of the key technologies that reflect the level of robot intelligence. When the initial position and direction are known, the position information can be obtained

by using the accelerometer, gyrocompass, gyroscope and other sensors or by using the camera and the ultrasonic sensor to obtain the position information. In addition, a radio frequency identification positioning method may also be used. The method mainly receives and stores the identification number and other information of the radio frequency tag by the reader, so as to obtain the specific orientation of the robot. The path planning problem is to find an optimal path without collision from the starting point to the ending point. For the cleaning robot, full coverage path planning is its core technology. Full Coverage Path Planning refers to the robot traversing all accessible areas of the environment at the lowest possible repetition rate with the goal of achieving a path of maximum coverage and minimum repetition rate within the enclosed area.

The mechanical structure of the robot consists of a longitudinal balance section and a directional balance section. In the vertical balance, the robot travels back and forth through a motor connected to the wheels. In the lateral balance part, the system designed to rely on servo connection baffle to control the center of gravity, when the steering gear driven baffle tilt left and right, the system center of gravity changes, the role of gravity to achieve lateral balance at the same time turning radius and driving speed In large cases, the unicycle robot is steered by gravity control. The basic principle of GPS navigation system is to know the position of the receiver through the distance between the satellite at the known location and the receiver of the user and then synthesize the information of multiple satellites. Compared with the feet and quadruped robot, six feet and eight feet walking robot has a unique discontinuous support way, namely under the condition of a leg buckling robots still have good movement stability, at the same time have a different gait in response to different terrain environment; Compared with the eight-legged robot, six foot has relatively simple mechanical structure, at the same time also makes the control algorithm is more convenient, predictably, these advantages will make six-legged robot in complex environment the best choice for robot operation.

At the same time, the two legs can be converted into operation arm and arm operation when needed. Therefore, the research on hexapod robot has profound theoretical value and practical significance. In general, the system contains the listed aspects.

1) PC wireless transceiver unit by the level conversion chip MAX232 and wireless transceiver module APC220 form. The APC220 receives GPS signals collected by the GPS autopilot detection robot and converts the 7rrL level into a 232 level recognizable by the PC side through the MAX232 chip.
2) The upper computer has automatic and manual modes for robot control. Automatic navigation, suitable for long distance navigation on PC input to specify a target of latitude and longitude, by transformation, finally sent to the robot is the angle and distance, robot after receiving the data to the target point. The driving route can be automatically corrected several times to improve navigation ability. The manual control can control the robot's back and forth movements by sending response instructions by the upper computer, which is suitable for short distance position adjustment and general detection.
3) Through the wireless data acquisition module, PC data acquisition the latitude and longitude of the location of the robot and the azimuth angle; the target point of latitude and longitude is known, so can coordinate target obtained by Gauss Kruger projection transformation method and the starting point by point; electronic compass detecting robot angle to robot path planning. Because the robot is affected by the center of gravity and all kinds of external factors, there may be a deviation in the driving process.

In the face of some relatively complex cleaning tasks, using a cleaning robot may not be able to complete the task, such as cleaning a large area in a short period of time housing. Due to the low price of a single indoor cleaning robot, tasks can be accomplished through the use of multiple robots at the current state of robot technology. The key to the problem of robot collaboration is how to maintain or realize the coordinated actions of multiple robots during the execution of tasks.

2 ISC-BASED CLEANING ROBOT

2.1 Interior Cleaning Robot Cooperative Control Modeling Based on ISC

In order to simplify the analysis, as shown in Figure 1, the indoor cleaning robot as a rigid body, along the X - Y plane X - axis motion, the kinematics equation can be simply described as:

$$\dot{p}_i = v_i, i = 1, 2 \tag{1}$$

$$\dot{v}_i = u_i, i = 1, 2 \quad (2)$$

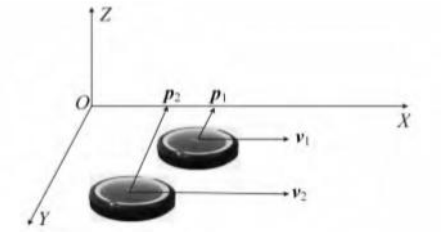

Fig. 1 Moving along X axis of robot

$$\lim_{t\to\infty} p_1(t) \to \lim_{t\to\infty} p_2(t) \quad (3)$$

$$\lim_{t\to\infty} v_1(t) \to \lim_{t\to\infty} v_2(t) \quad (4)$$

It is assumed that indoor cleaning robots can exchange positional velocity information with each other through a communication module and, in order to keep their positions and velocities consistent, a control input of the following form is designed:

$$u_i(t) = -\alpha(p_i(t) - p_j(t)) - \beta(v_i(t) - v_j(t)) \quad (5)$$

The establishment of the color octree mainly consists of octree coding of the color value, octree insertion and octree merging. First, traverse each pixel in the image, record each color, and record the frequency of each color in the image. The octree color quantization method used in image processing is to check the octree as the existing color of the tree is compared with the number of the colors K that the desired color palette will control. The basic idea of the algorithm is to select the candidate node sets from all the neighbor nodes in the node perceived radius, and to obtain the optimal distance from the node to the next hop based on the energy consumption model in the ideal state. In order to prevent the next hop node from deviating the destination node takes into account the vertical distance between the current node and the destination node and sets different weights for these two factors to ensure that the entire path consumes the least energy from the following procedures.

In the node sensing radius or communication radius can directly communicate node called the neighbor node, the node between the neighbor node and link bandwidth is greater than the bandwidth needed for the user, the neighbor node can be used as candidates for the next-hop node, all can communicate directly with the current node and meet the demand of the user bandwidth under the nodes of a candidate set of nodes.

In the process of data transmission, the more uniform the energy consumption of nodes on the path, the longer the network can survive. It is assumed that in an ideal state, the data is transmitted along the linear path from the source node S to the destination node D, and each hop node on the path is evenly distributed on the path.

2.2 The key technology of cleaning robot

The cleaning robot system usually consists of 4 parts: moving mechanism, sensing system, control system and vacuum system. With the rapid development of computer technology, artificial intelligence technology, sensing technology and mobile robot technology in recent years, the research and development of the vacuum robot control system already has a solid foundation and good development prospects. At present, the rapid development of the vacuum cleaner robots greater impact on the key technologies are: multi-sensor information fusion technology, power technology and full coverage path planning technology.

Fig. 2 Collaborative experiment of the robots

2.3 Multi-sensor faithful touch

Cleaning robot in unstructured environment needs to use a variety of sensors to obtain different types of different state information. These messages are independent of each other or related to each other, and even contradict each other. Information fusion is a collaborative use of a variety of sensors and a variety of sensor information effectively combine to form a high-performance perception system to obtain a consistent description of the

process of the environment. To date, no single sensor can fully meet the reliability, high stability, high accuracy and low cost requirements. Therefore, we can comprehensively analyze the information from each sensor through the fusion process, and take advantage of the differences and complementarities of various sensors to obtain effective, reliable and complete information. In this way, even if the information provided by each sensor has certain errors and uncertainties, the information provided by them can be effectively combined to obtain a more reliable and complete fusion result than any single sensor information. Therefore, the multi-sensor information fusion technology in vacuum robot development has great application value.

The idea of multi-sensor information fusion for a clean robot is to build a multisensor system that takes full advantage of multiple sensor resources. By reasonably controlling and using these sensors and their detection information, redundant or complementary information of multiple sensors are combined according to a certain criterion to obtain a consistent explanation or description of the obstacle information. The basic goal of integration is to derive more information on obstacles through data combinations. Utilizing the advantages of multiple sensors working together or in combination increases the effectiveness of the sensor system, thereby enabling the information system to achieve superior performance over single sensors of its various components.

2.4 Cover path planning technology

Whole-area planning of path planning is a key part of robot intelligence. Path planning is an important research topic of autonomous mobile robot. The general path planning refers to planning a path without any touch from the initial state to the target state according to a certain standard (algorithm or rule base) under the premise of obstacles, that is, "point-to-point" path planning. And what we do is the path planning for the entire region. In a way, this can be seen as a combination of the former, but not simply overlay, but much more complex. At present, domestic cleaning robot has been finished in overseas market, but in China is still in its infancy. The main problems of this type of robot are focused on the path planning - both to ensure the integrity of the region and to maximize efficiency, but also to deal with unexpected situations during the cleaning process. From the first generation of popular Roomba products, the path planning is extremely intelligent and causes a great waste of energy.

2.5 Power Technology

Power wipe in clean robot status is very important, it can be said that it can basin source. The mobile power supply needs to simultaneously meet various energy broadcast needs of the cleaning robot, such as powering the moving mechanism, supplying the control circuit with the voltage and providing energy for the cleaning operation module. In this city, the chemical battery is generally used as a mobile power supply. The ideal power supply should be able to maintain a constant voltage during discharge, small internal resistance can be quickly discharged, rechargeable and low cost. But in fact no one battery can have the above advantages, which requires designers to choose a suitable battery, as much as possible to increase the robot's uninterrupted work for a long time.

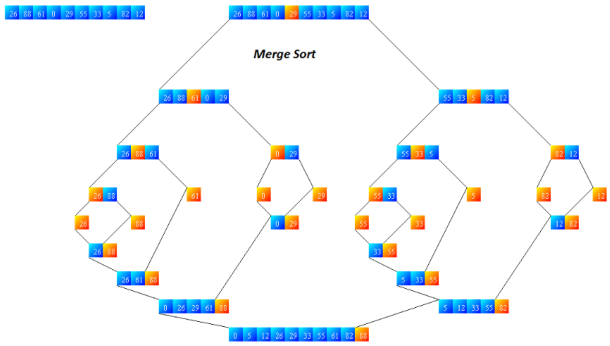

Fig. 3 The node distribution demonstration

At present, robots use batteries as their energy sources, and batteries have primary batteries, secondary batteries and fuel cells. As a robot battery energy demanding, less self-discharge, high reliability, a battery of manganese dry batteries, alkaline manganese batteries, batteries, mercury batteries, silver oxide batteries. Wide range of applications of dry batteries, the higher the temperature, the voltage increases at the same time, but may cause self-discharge and gas generation, the use of temperature up to 50-60 ℃, sharply reduced below 0 ℃. Alkaline manganese batteries suitable for large current discharge, discharge capacity, the same size and dry batteries, with interchangeability. Li battery electromotive force is high, high density, wide operating temperature range, less self-discharge, is gradually moving toward practical, is a very good robot energy. Secondary batteries, also known as batteries, lead-acid batteries, silver-zinc batteries, nickel-cadmium batteries and nickel-cadmium batteries. Lead-acid battery is a relatively good robot energy, high voltage, long life, high rate of discharge, low price, simple and reliable structure, mature technology,

but the pot density is low. Silver-zinc battery is the largest output power of the existing secondary batteries, the highest energy battery, self-discharge slow, high mechanical strength, short-term overload discharge, discharge voltage stability, but expensive, long charging time, short life, charging Less frequently. Nickel Fu battery and nickel-zinc battery voltage is low, the price is high with less application.

2.6 Sweeping Robot Positioning Algorithm Based on Kalman Filter

The Kalman filter algorithm is essentially a set of recursive algorithms implemented by a digital computer. Each recursion cycle includes two steps of updating the time of the estimator and updating the measured data. The time update is determined by the update result of the measurement data in the previous step and prior information when the Kalman filter is designed. The measurement update is determined on the basis of the time update based on the measurement data obtained in real time. The Kalman filter uses the feedback control method to estimate the process state: the filter estimates the state of the process at a certain moment and then obtains the feedback as a (noisy) measurement variable. Therefore, the Kalman filter can be divided into two parts: the estimation phase and the measurement update phase.

In this paper, the service robot algorithm is analyzed and studied. The service robot model is established. The inner helix coverage algorithm and autonomous docking charging algorithm based on grid map representation and the sweeping robot localization algorithm based on Kalman filter are proposed. In the lower hardware cost, the intelligent service robots in the indoor environment are precisely located. Finally, the indoor positioning experiments verify the effectiveness of the localization algorithm.

3 CONCLUSION

This article mainly considers the problem of coordination of indoor cleaning robots. By designing the control inputs for the indoor cleaning robot to be consistent in position and speed, the task of working together can be accomplished. Compared with the work of a single indoor cleaning robot, the indoor cleaning robot can effectively improve the efficiency of cleaning the room by cooperating with each other. Computer simulation and experiment verify the effectiveness of the algorithm.

During the working process of the indoor cleaning robot, the communication signals of the robot are easily blocked by the tables and chairs in the room and become unstable, so that the real-time communication cannot be performed with each other.

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