Multi mobile robot positioning technology and path planning design based on WiFi Positioning

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Abstract: With the continuous development of science and technology, robots are widely used in all walks of life, including industrial manufacturing, social services, and daily life. Multi-mobile robot positioning technology and path planning and design are extremely challenging issues in the field of robotics research, which is also the core content of robot navigation. WIFI-based positioning technology has the advantages of low deployment cost, high positioning accuracy and easy expansion. Through the positioning of multiple mobile robots and the joint display of multiple positions, it can achieve complete planning and management of the area. The task of path planning for multi-mobile robots is to find an optimal path from the starting point to the target point for each mobile robot in the environment with obstacles, according to certain evaluation criteria, and at the same time, to ensure that there is no collision between mobile robots and obstacles or between robots. Different application fields provide broad space for the development of robot technology, and also put forward many challenges and research directions. In this paper, the positioning technology and path planning design of multi-mobile robots in WIFI positioning environment are discussed and studied. At present, WIFI wireless communication technology has been widely popularized, and the robot can directly use the existing WIFI signal in the environment to complete the positioning, so it provides the possibility for the mobile robot to achieve low-cost and high-precision positioning and navigation.

1. Introduction

Since its birth, robots have been widely used in various industrial production. Various types of robots have improved product quality, accelerated industrial process, greatly improved social productivity, and fundamentally changed the production appearance of traditional industry. With the continuous improvement of social production demand, all walks of life also put forward higher requirements for the functions of robots. Mobile robots need to integrate the functions of path planning, task execution, and motion control and information fusion [1]. In fact, most robots are fixed robots, and they only operate on the items placed in front of them; On the contrary, the mobile robot can move from one place to another. If it is equipped with a mechanical arm, it can operate the surrounding objects to meet more needs of people. In addition, on many occasions, a single fixed robot is no longer competent for related tasks, but a group of robots needs to coordinate and cooperate to make up for the deficiency of single robot. Robot navigation technology is one of the research cores of multi-robot systems, and its key technologies include robot positioning, task planning and path planning.

2. Research status of multi mobile robots

2.1 Research status of multi mobile robots at home and abroad

In 1954, George dewall, an American, produced the world's first programmable robot, and the robot research officially kicked off. The first manipulator can be programmed according to different programs and has different flexibility. Then there are autonomous mobile robots and robots with environmental awareness [2]. With the advancement of information processing technology and

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intelligent control technology, the research of mobile robot has entered a higher level. In the international field, the mechanical structure of robot is developing towards reconfiguration and modularization, and the intelligent control system of robot is developing towards an open controller based on industrial computer. Moreover, multi-sensor fusion technology has been used in many systems. At present, foreign mobile robots mainly focus on high-integrity robots, remote control robots, integration of mobile robots with the environment, biological robotics and multi-robot systems.

Although the domestic research on mobile robot started relatively late, it has made considerable progress. The main research work includes: the research on global path planning of mobile robot in known environment, the research on local path planning relying on sensor information fusion technology in unknown environment, and the realization of path planning simulation, design and implementation of mobile robot [3].

2.2 Research status of location technology and path planning

Wireless positioning is to determine the geographical location of the positioning terminal by using various types of signals received. Common positioning technologies include infrared positioning, ultrasonic positioning, Bluetooth positioning and ZigBee positioning. In recent years, with the rapid development of Internet and mobile communication, a large number of WiFi nodes are arranged in many occasions. At the same time, intelligent mobile terminals are also equipped with WiFi signal transceiver modules, which makes the multi mobile robot positioning technology based on WiFi have natural advantages [4]. The WIFI positioning technology adopts the location fingerprint matching algorithm based on signal strength, through the joint display of multiple location-related videos, so as to realize the complete video collection of the area in which it is located, and use it in the system's positioning subsystem to improve the system's positioning accuracy.

Path planning of mobile robot is to plan a path from the starting point to the target point by intelligent calculation in the working environment with obstacles, and the path can't collide with obstacles and is as short as possible. Path planning is an important issue in the research of mobile robots. Many researchers have put forward many excellent algorithms, mainly including the early visible method, free space method, artificial potential field method, grid method, and the later genetic algorithm, neural network algorithm, ant colony algorithm, fuzzy logic algorithm, etc. [6]. According to the robot's mastery of environmental information, mobile robot path planning can be divided into global path planning and local path planning. In general, the two planning methods can be combined and each has its own advantages, that is, firstly, the global path planning is carried out according to the prior information of the environment to obtain the initial global path, and then the local path planning is completed while walking according to the environmental information detected by the sensor [7]. Through the research status of robot path planning, it is understood that there are many methods and strategies for robot path planning, but far from forming a set of systematic theories and methods, it is still under continuous development and improvement.

3. Path planning of multiple mobile robots in dynamic environment

3.1 Global path planning

Multi mobile robots give full play to the advantages of group robots and make use of the coordination and cooperation between robots to effectively avoid the defect of insufficient ability of single robot in dealing with complex tasks. Due to the diversity, complexity and uncertainty of multi mobile robot working environment, the path planning problem has the following characteristics: complexity, randomness, multi constraints and multi-objective. The multi-robot system is an extremely complex group system, and its research contents mainly include: communication and negotiation, learning, modeling and planning, coordination [8].

According to the distributed planning method, the multi-robot path planning problem can be divided into two sub-modules: independent path planning of each single robot and path coordination

among robots. The optimization goals of multi-robot path planning include the shortest path length, the smallest delay time, the least energy consumption, and the smooth rate curve.

The global path planning algorithm is a path optimization algorithm based on the environment map model. It relies on certain criteria to find a safe and collision-free optimal or approximate optimal path from the starting point to the target point. The methods of global path planning mainly include: visual view method, structure space method, topology method, grid method, involving two parts: the establishment of the environment model and the path search strategy [9]. For example, viewable refers to the mobile robot looking at a point, connecting each obstacle, starting point and obstacle, target point and obstacle with a straight line, and ensuring that the connection between them cannot pass through the obstacle. Then the environment model is established in this way, that is, the visual graph is formed, and then the shortest and obstacle free path is found through the optimization algorithm. Multi-robot coordination is also very important in multi-robot path planning. At present, the proposed coordination strategies mainly include speed adjustment method, traffic rules method, priority method, geometric correction method and behavior-based collision avoidance method [10].

3.2 Positioning, navigation and obstacle avoidance

The safety and real-time of mobile robot in the process of movement are particularly important, so mobile robot should detect and avoid obstacles in its surrounding environment in real time. The obstacle avoidance behavior of mobile robot can be divided into two parts: navigation and obstacle avoidance.

Navigation is the process that the mobile robot continuously approaches the target point from the starting point. It is completed by the real-time position, distance and angle information of the mobile robot and the target point [11]. The positioning system of mobile robot mainly includes hardware and software. The hardware is mainly based on router, control panel, camera and console. It needs to display the images collected by the robot in real time and send instructions to them. The software is mainly the positioning system, which can receive the WIFI information uploaded by the robot control terminal and return the positioning results to the robot control terminal through the WIFI location fingerprint positioning algorithm. There are many navigation modes for mobile robots, mainly including electromagnetic induction guidance, optical guidance, tape guidance, laser navigation, GPS navigation and inertial navigation.

Obstacle avoidance is to determine whether to implement obstacle avoidance behavior by judging the distribution information of obstacles around the mobile robot and the distance information between the obstacles and how to adjust the speed of the left and right wheels of the mobile robot to make it turn to avoid obstacles and After avoiding the obstacle, adjust the movement direction of the mobile robot so that it still moves towards the target point after avoiding the obstacle. The obstacle information is judged by the distance information measured by the combination of ultrasonic sensor and infrared sensor, in which ultrasonic distance measurement means that the distance between the carrier and the obstacle can be calculated by using the reflection characteristics of ultrasonic wave. The principle is shown in Figure 1, while the triangulation method is commonly used in infrared distance measurement. The information of obstacles in the environment is different, and the obstacle avoidance methods are also different. The safety distance of obstacle avoidance should be set, and the obstacle avoidance methods should also be selected according to the distribution of obstacles. It is mainly considered to avoid the obstacles in front, left / right front and moving obstacles. The corresponding calculation methods are different in each case [12].

At the same time, because the data measured by ultrasonic sensors and infrared sensors vary greatly, and gross errors often occur, it is necessary to process the data measured by them, for example, using multiple measurements, eliminating unreasonable data, and then averaging the data, so that the stability and accuracy of the measured data are improved, and the obstacle avoidance effect of mobile robots is enhanced.

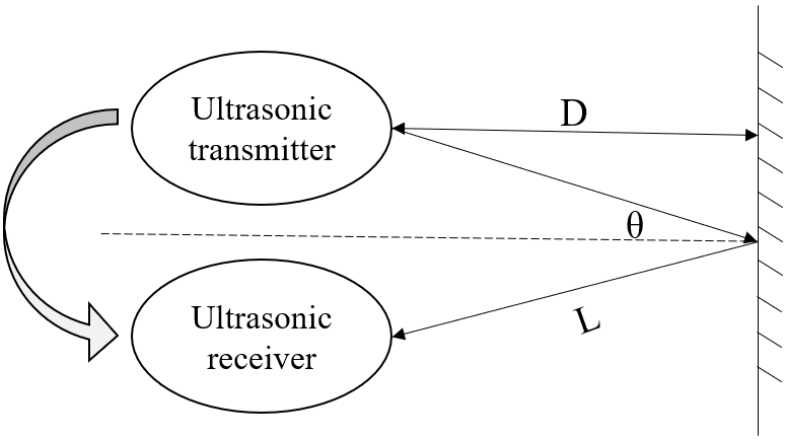

Figure 1 Schematic diagram of ultrasonic ranging

4. Conclusions

With the continuous improvement of social production demand and the continuous development of robot technology, the research of multi robot system has become a hot issue. The problem of robot path planning is the basic problem in the research of mobile robot technology, and it is also the basis for the practical application of mobile robots. In this paper, the development status of mobile robots and the status quo of path planning are reviewed, and the principle and design of some path planning methods are discussed and studied, including the modeling method of global path planning, path planning algorithm and the combination of simultaneous positioning. Although the research on positioning and path planning of multi-mobile robots based on WIFI positioning has achieved fruitful results so far, there are still certain shortcomings in various technologies, and continuous in-depth research is needed to make mobile robots more in line with social needs and help humans better the completion of the task.

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