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Path planning of robot in epidemic situation

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Abstract. With the development of information technology in the world, human life is becoming more and more intelligent, which leads to the robot path planning algorithm becoming more and more important. Combined with the environment of new coronal pneumonia in China, this paper first introduces the environment of the cabin mobile hospital, and then deduces the role that the automatic obstacle avoidance robot with path planning ability can play in the mobile cabin hospital, and introduces the construction of the whole system model in the virtual simulation platform. This paper discusses the improvement and application of breadth first search algorithm, including the explanation of algorithm reference formula, and the experiment and subsequent analysis on the webots platform, and successfully proves its feasibility. Finally, the existing problems are explained and the parts that can be improved are discussed. Then, the research on robot path planning under the environment of new coronal pneumonia is summarized and prospected.

Keywords: Robot, path planning algorithm, new coronal pneumonia, cabin mobile hospital.

1. Introduction

After the design and research of our group, the team designed an automatic obstacle avoidance robot with path planning capability on the webots simulation platform. Between the designated end point and the starting point, it can plan a shortest path through the breath first search algorithm. At the same time, it can use radar to automatically avoid dynamic and static obstacles in the process of traveling.

Such robots have a wide range of applications in manufacturing, industry and other fields. The team found a new application scenario in combination with the background of the COVID-19 epidemic and the epidemic prevention measures with local characteristics. As we all know, in order to deal with the epidemic situation and prevent the spread of the virus, China has established many mobile cabin hospitals for infected people or potential infected people. In mobile cabin hospitals, everyone has his own bed. In order to avoid cross infection, no one can leave his or her bed at will without special circumstances. In addition to the survival needs of everyone, such as eating and going to the bathroom,

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in order to take care of the personal needs of the inpatients, mobile cabin hospitals should also provide services to help them transport the items they need, such as snacks and toys. In most mobile cabin hospitals, this kind of service is cancelled directly to prevent the spread of viruses, or is carried out by medical personnel at great risk, and the robot can just complete this work. With the help of this robot, this work can be divided into two parts. First, outside the isolation door, the medical staff can put the items designated by the inpatient on the robot, and then the robot enters the isolation door to deliver the items to the designated bed. This will not only meet the needs of inpatients, but also avoid excessive contact with the outside world. In a word, the robot can help improve the living environment of mobile cabin hospitals and better avoid the spread of viruses. This is a new and appropriate application scenario for our robot.

2. System model

A simulation environment including several stationary obstacles and moving obstacles is established on Webots. After setting the starting point and ending point of the robot, the robot can plan a safe path from the starting point to the target point. Consult related path planning algorithms, implement more than one algorithm and compare with each other. Source code, test results, and demonstrations are required [1].

2.1. Create a new world

By adding nodes, different obstacles can be placed in different positions. Webots provides various built-in basic nodes. Expand the node, you can set the specific properties of the node, including transition, rotation, color, size, etc.

In addition to the built-in nodes of webots, you can also implement independent design by modifying the children property in the basic node and adding child nodes. In this experiment, I used the built-in e-puck node for obstacle avoidance experiments, and also independently built a robot equipped with GPS, compass, two engines and 8 distance sensors for path planning experiments.

2.2. Use e-puck robot to realize automatic obstacle avoidance

The E-puck has 8 built-in distance sensors and two left and right engines [2]. Its motion principle is to judge the surrounding environment and drive two wheels according to the sensor readings by reading the return values of 8 infrared distance sensors located around its turret. The value returned by the distance sensor [3] is scaled between 0 and 4096. The larger the value, the closer the obstacle is.

3. Path planning method

With the continuous development of society, the complexity of the application scene of automatic obstacle avoidance robot with path planning ability is also increasing. Most path planning methods have very high requirements [4] for running time and storage space, as well as for all aspects of knowledge.

In the application of mobile cabin hospital, due to the relatively simple and determined environment, there are fewer constraints. The more constraints, the more complex the solution process will be and the longer it will take. According to the current application environment, the team mainly studies the shortest path planning problem [5].

3.1. Algorithm introduction

The team improved the breadth first search algorithm and proposed a path planning algorithm based on steering constraints and the shortest path. In the application of robots equipped with radar and infrared sensors, this algorithm reduces the options in path planning, thus improving the efficiency of robot path planning, shortening the search time, and improving the overall performance of robot path planning.

3.2. Equation Reference in the algorithm

The team simulated the application of the robot in the preset environment by building a virtual environment on the webots platform.

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$$H = -\sum_{i=1}^{n} = p(x_i)log_2 p(x_i) \quad (1)$$

In this equation, H stands for total. Where n represents n classification categories (For example, suppose there are two Class problems, then n=2) and p represents probability.The probabilities p1 and p2 of the two types of samples in the total sample are calculated respectively, so that the information entropy before the attribute branching is not selected can be calculated.

Now select an attribute xi to branch. At this time, the branching rule is: when $x_i = vx$, divide the sample into a branch of the tree. When it is not equal, it will enter another branch. Obviously, the samples in the branch are likely to include two categories. Calculate the entropy H1 and H2 of the two branches respectively, and calculate the total information entropy $H' = p_1 * H_1 + p_2 * H_2$. Then the information gain at this time is $\Delta \mathrm{H} = \mathrm{H} - H'$. Based on the principle of information gain, all attributes are tested at one side, and one attribute that maximizes the gain is selected as the branching attribute [6].

3.3. Algorithm conclusion

At present, people's research on path planning methods mainly focuses on the optimization and improvement of various algorithms. Researchers are committed to proposing better algorithms to make path planning faster and more accurate [7]. The team found a suitable and relatively simple application scenario while researching and improving the algorithm. After consultation and demonstration, it is confirmed that the automatic obstacle avoidance robot with path planning ability can replace part of the human resources in the mobile cabin hospital and reduce the risk of virus transmission.

4. Experiment and subsequent analysis

The team creates a stimulation environment to stimulate a real scene of hospital that robots can automatically plan paths and avoid obstacles. Through the experiment, the team can analyze the experiment results and improve the algorithm method [8].

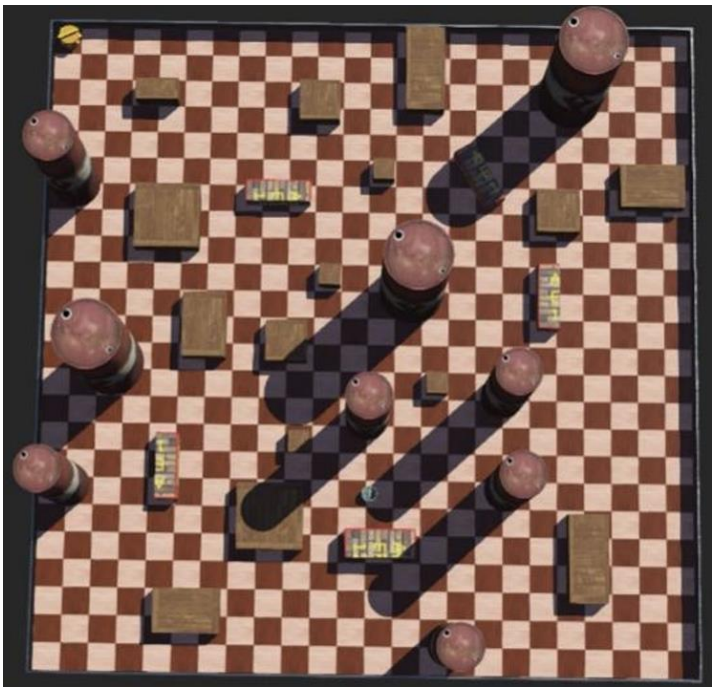

Figure 1. Simulation Scenario.

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4.1. Experimental results

The e-puck and the robot connected to the BFS controller were placed in the same scenario for testing. The e-puck robot can automatically turn and avoid obstacles when it encounters static obstacles (such as wooden boxes in the map) and dynamic obstacles (such as robots in motion). During the robot test, the team sets the upper left corner as the starting point and the lower right corner as the end point. In the test, the team found that the robot can plan a reasonable path according to the given map and output the number of path steps in the console. As shown in Figure 1.

4.2. Experimental difficulties

When implementing the experiment, the team encountered a series of difficulties. First, when implementing BFS, the list type and dictionary type are used many times and they are used in combination. The distinction between shallow copy and deep copy was ignored when building the queue, resulting in path planning errors that took a lot of time to correct. Second, in addition to BFS, the team tried to implement the artificial potential field method, but due to lack of familiarity with the software, there are still problems in the code implementation part, so it was not implemented. Third, before building the path, it is needed to manually enter the map list. There is no sensor or corresponding sensor parameter that directly obtains the entire layout state, resulting in wasted time and errors. Last, when the automatic obstacle avoidance car collides with a ball obstacle, the position of the ball obstacle will sometimes be offset, which will affect the accuracy of path planning. In the team's final experiment, other obstacles such as oil drums or wooden blocks were used instead [9]. The team needs to find a way to overcome the random movement characteristics of spherical obstacles [10].

5. Conclusion

With more and more application scenarios for intelligent navigation robots, this paper proposes a path planning based on breadth first search algorithm to realize the shortest path planning and transportation of intelligent robots in environments with simple constraints, such as mobile cabin hospitals. According to the location distribution of sickbeds in the hospital, input the map list and transfer it to the robot controller to realize the navigation function between the transportation center and the distribution point, and realize the obstacle avoidance function through the radar and sensors installed on the robot during the transportation process. This not only effectively improves the transportation efficiency of goods, but also avoids cross infection of viruses caused by human transportation. The research results can provide useful reference for relevant personnel and choose to provide path planning algorithm for mobile robots.

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