Research on Path Planning of Intelligent Fire Robot based on Genetic Algorithm

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Abstract. With the progress of integrated circuit technology and the development of intelligent technology, the control module of robot technology is also reduced, the performance is improved, and the power consumption is also reduced. It makes it possible to design and implement a compact and powerful robot. At the same time, based on the improvement of wireless communication technology, the data collected by the robot can be quickly transmitted to the intelligent terminal, and the data processing and response are guaranteed. Based on the above background, all kinds of robots have been applied in many walks of life. Especially in some high-risk situations, the application is particularly important. In this paper, a genetic algorithm applied to path planning is put forward for the application of intelligent firefighting robot. The application scenario is also discussed.

Keywords: intelligent robot, path planning, genetic algorithm.

1. Introduction

Path planning technology and optimization methods have been one of the hot topics in the fields of electronics, control and robot intelligent control. Fire fighting robot is one of the fields that need to be covered by this method all the time. Reasonable path planning and optimization of intelligent fire fighting robot can solve the problems of firefighter's position discrimination, fire situation analysis, fire situation location judgment and personnel trapped judgment, and can greatly improve the rescue efficiency of fire scene. The provincial firefighters entered the fire field to save more lives. But because the fire situation is different, the location and degree of fire are different, it is very important to choose a universal and fast algorithm. Path planning of intelligent robot is how to find an appropriate path from a given starting point to the end point in the working environment with obstacles, so that the robot can safely and collisionlessly bypass all obstacles in the course of motion. Robot path planning problem can be modeled as a constrained optimization problem, which needs to complete the tasks of path planning, location and obstacle avoidance. According to the degree of robot's mastery of environmental information, path planning of intelligent robot is divided into global path planning based on model and local path planning based on sensor. The former refers to all the information of the working environment known, also known as static or off-line path planning; the latter refers to all or part of the unknown information of the working environment, also known as dynamic or online path planning. The path planning of intelligent robot has the following characteristics:

Complexity: in complex environments, robot path planning is very complicated and requires a lot of computation.

Randomness: there are many random and uncertain factors in complex environment.

Multiple constraints: the shape, speed and acceleration of the robot restrict the movement of the robot.

2. Genetic Algorithm is used to Optimize the Path Planning Process.

GA (Genetic Algorithm) is also often referred to as evolutionary algorithm. Genetic algorithm is an automatic heuristic search algorithm based on Darwin's evolutionary theory and referring to the process of biological evolution in nature. According to the shape and characteristics of each generation, it can be filtered out, so as to achieve the optimal screening results and ultimately achieve the optimal results.

Referring to the theory of biological evolution, the problem to be solved by genetic algorithm is simulated as a process of biological evolution. The next generation of solutions are generated by copying, crossover, mutation and other operations. The solutions with low fitness function values are gradually eliminated and the solutions with high fitness function values are increased. In this way, it is possible to evolve individuals with high fitness function after the evolution of N generation.

For example, using genetic algorithm to solve the 0-1 knapsack problem: the solution of 0-1 knapsack can be encoded as a series of 0-1 strings (0: no, 1: take); first, M 0-1 strings are randomly generated, and then these 0-1 strings are evaluated as the solution of 0-1 knapsack problem; then, some strings are randomly selected to pass through. Overcrossing, mutation and other operations produce the next generation of M strings, and the better solution is selected more likely. This evolution after G generation may produce an approximate optimal solution for the 0-1 knapsack problem.

Coding: we need to encode the problem into string form to use genetic algorithm. The simplest form of encoding is binary encoding, which decodes the problem into binary bits. For example, if the solution of the problem is integer, then it can be encoded as a binary digit group. The solution of the 0-1 string as a 0-1 knapsack problem belongs to binary encoding.

There are many optimization methods for path planning problems, such as construction space method, grid method, free space path method and so on.

Genetic algorithm is used to optimize the path selection to obtain multiple weights, and as a screening, thus completing the optimal path planning for robot obstacle avoidance in the fire field.

The specific algorithm is as follows: take the middle point of the vertex line of each obstacle as the path point, connect each path point, limit the starting point and the end point of the robot movement to each path point, use the shortest path algorithm to find the shortest path of the network graph, and find the shortest path from the starting point P1 to the end point Pn. The above algorithm uses the condition of the midpoint of the connection line, so it is not the optimal path in the whole planning space. Then the genetic algorithm is used to find the shortest path of each path point Pi(i = 1,2,... N) Adjustment, so that each path point i n the corresponding obstacle endpoint connection line sliding, using Pi = Pi1 + Ti * Pi2-Pi1 (ti < [0,1] I = 1,2,... N) can determine the corresponding Pi, that is, the new path point, connecting this path point to the optimal path.

Assuming the robot works in a finite area on a two-dimensional plane, the starting point and the target point of the robot's motion are represented by S and G, respectively. It can reach the adjacent grid in eight directions on one grid, as shown in Figure 1.

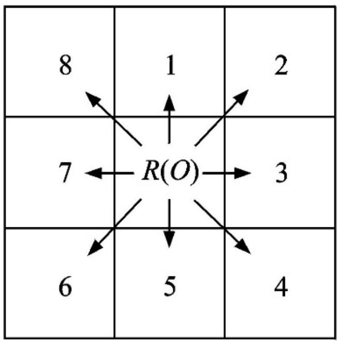

Figure 1. modeling of robot motion

In addition, the following assumptions are made: (1) the robot is circular, its diameter is R, regardless of any time, through the sensor robot can perceive the radius of R range of environmental information, the information is the center of the current grid as the center. (2) When the known static obstacle boundary is extended outward to R/2, the robot can be represented by its center point and considered as a particle in the planning process. (3) The speed of the robot is VR, and the dynamic obstacle in the environment is circular. The diameter of the robot is the width of a single grid (each square grid represents a unit area), the speed is VO and the robot moves in a uniform straight line. The VR and VO are constant.

Simulation results and analysis

In order to verify the validity of the algorithm, the simulation is carried out by using MATLAB, and the experimental simulation is carried out respectively for the two cases in which there are new static obstacles and moving obstacles in the environment.

Simulation of static path planning

Firstly, an improved genetic algorithm is applied to the global path planning of the robot when the obstacles (represented by black in the grid) are distributed as shown in Figure 3. In the simulation, the initial population size is 30, the crossover probability is 0.7, the initial mutation probability is 0.1, the maximum genetic algebra is 100, k = 1. The experimental results are shown in Figure 2.

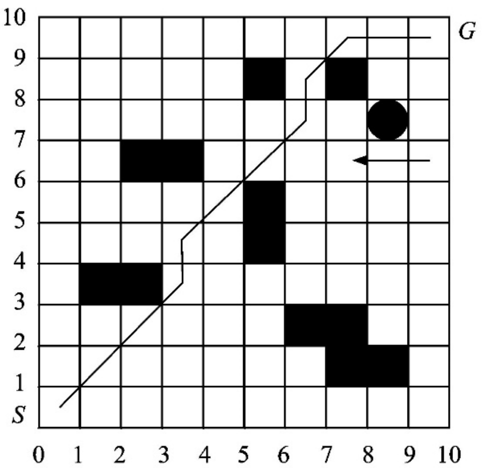

Figure 2. simulation results

3. Conclusion

The path planning method based on genetic algorithm can effectively identify and evade obstacles on the path of robot in complex fire field based on multi-coupling field sensor system, and can quickly and accurately determine the optimal escape and rescue route. It can also take the place of firefighters to enter a complex fire site environment, carry out detection and removal of obstacles, and provide time and security for lifesaving.

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