Application of Artificial Intelligence Combined with Neural Network in the Research of Mobile Robot Path Planning

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Abstract. With the development of artificial intelligence mobile robots, it has been widely used in many fields. Mobile robots are an important development direction in the field of robots, and path planning is one of the important issues in the research of mobile robots. In the known and unknown static environment, the application of neural network technology to the path planning of mobile robots has become one of the current research hotspots. In this paper, the common algorithms of artificial neural network algorithm in mobile robot path planning process are introduced in detail. The path planning of mobile robot in known and unknown static environment is studied, and its application is prospected.

Keywords: Path Planning, Mobile Robot, Artificial Neural Network, Artificial Intelligence

1. Introduction
In the application of mobile robot navigation technology, path planning is an indispensable algorithm. Path planning requires that the robot can determine obstacles by itself, so that it can decide the path independently and avoid obstacles. Autonomous path planning can automatically require the mobile robot to achieve intelligent mobile signs safely. Generally speaking, there are many paths chosen by robots. Therefore, under the predetermined criteria of shortest path, shortest use time and least energy consumption, it has become a hot and difficult point for many computer scholars to choose an optimal path. Path planning of mobile robots is an important technology in robotic applications. It can not only save human resources and reduce capital investment, but also lay a good foundation for the application of robots in various industries11. Combining artificial neural network and other methods, a new intelligent path planning method can be formed, which can improve the obstacle avoidance accuracy of robot path planning, accelerate the planning speed and meet the needs of practical application.

2. Application of neural network in path planning of mobile robot

2.1. Characteristics of neural networks
Neural network simulates evolutionary thinking of organisms, and has a unique structure of neuron feedback mechanism. It has the characteristics of distributed information storage, adaptive learning, parallel computing and fault tolerance. The unique structure and information processing method of
neural network have been widely used in the fields of automation control and combinatorial optimization. Especially in large-scale network data analysis and situation prediction, it can build a good classification learning model, and optimize the neurons of each layer and each node in the learning process[2]. Generally speaking, the network topology model can be divided into forward network and feedback network, as shown in figure 1 below.

![Figure 1. Neural network topology model](image)

2.2. Application of neural network in path planning of mobile robot
Local planning of mobile robots is a mapping from state space to action space. The mapping relation is difficult to express by an exact mathematical equation. As a highly parallel distributed system, neural network can approximate any nonlinear function. The sensor data is used as the input of the network, and the desired robot action is used as the output of the network. The original sample set is composed of a group of data from several selected locations. After eliminating duplicate or conflicting samples, the final sample set is obtained.

Global planning of mobile robots is to find a path from the starting point to the target point in a known environment, which can be regarded as a constrained optimization problem. Neural network is usually used to represent the shape of obstacles[3]. Each path point calculates the collision penalty function according to the distance to the obstacle. The criterion to judge whether the path is optimal is whether the collision penalty function of the whole path is minimum. Neural network path planning algorithm, including network structure and simulated annealing method, is simple to calculate, can avoid some local extreme cases, and has the advantage of parallelism.

3. Path planning of mobile robot based on artificial neural network
Based on the neural network, the path planning of mobile robot can be solved. Using the neural network algorithm, the constraints of the mobile environment can be described and the collision function can be calculated[4]. The iterated path set can be regarded as the sum of collision energy function and distance function as the objective function that the algorithm needs to optimize, and the optimization function can be solved by solving the optimization function. It can determine the point set and realize the optimal path planning. The algorithm of neural network in path planning of mobile robot is shown in table 1 below.

| Algorithm phases       | Contents                                                                 |
|------------------------|--------------------------------------------------------------------------|
| Neural network algorithms | If we initialize all the elements in the neural network of the computer, the target position set by the robot will also be exposed according to the position of the origin. |
| Dynamic optimized      | In other words, the robot can reflect the external output environment and |
### 3.1. Neural network for local path planning

As a typical dynamic recurrent neural network, Elman network has the function of mapping dynamic characteristics by storing internal states on the basis of the basic structure of BP network, so that the system has the ability to adapt to time-varying characteristics. It can learn both spatial and temporal modes, which can make the trained network have non-linear and dynamic characteristics, and avoid the disadvantage that the traditional neural network cannot change the model structure in real time and lack the adaptability to future mutations\(^5\). Elman network has feedforward and feedback connection, which overcomes the shortcomings of slow convergence speed, easy to fall into local minima and lack of dynamic learning, and can make the trained network have non-linear and dynamic characteristics.

![Figure 2. Simulation result of local path planning](image)

The network algorithm is simulated and unknown obstacles are arranged in static environment. In the environment with dense obstacles, as shown in Figure 2, it can be seen that this method can avoid obstacles and has the shortest path length.

### 3.2. Neural network for global path planning

In fact, the global path planning of mobile robot refers to the method of selecting the best path from the starting position to the end position in the environment that the computer can calculate. In this process, we can use neural network technology to describe various constraint objects of the environment. In this way, we can calculate the energy function. According to the energy function and distance function reflected by the path, the motion equation of the robot is calculated by combining the
above objective function with the simulation algorithm. According to this motion equation, the computer can choose the best planning path.

4. Mobile robot path planning technology based on artificial neural network
The main development direction of the application of artificial neural network in the process of robot path planning is to integrate with information theory to determine the optimal objective solution of the neural network. The second is to combine with genetic algorithm to determine the global optimal solution. Thirdly, it combines with ant colony theory to determine the optimal objective solution of the neural network. Combining ant colony algorithm with neural network, the path planning method of ant colony algorithm firstly uses grid method to model the working environment of the robot, and then takes the starting point of the robot as the location of the ant nest. The final target point of path planning is used as the ant colony food source, and the ants interact with each other to find an optimal robot movement path avoiding obstacles.

5. Conclusion
Mobile robots are an important development direction in the field of robots, which are widely used in all walks of life. Path planning is one of the important issues in the research of mobile robots. With the development of artificial intelligence mobile robots, path planning has been more applied and developed, and many advanced algorithms have been introduced in the navigation process to optimize the mobile path. In the future, with the progress of artificial intelligence in neural network technology, the combination of more algorithm advantages will make the path planning more accurate and accurate.

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