Research on Path Planning of Mobile Robot Based on Artificial Neural Network

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Abstract: Mobile robot is an important development direction in the field of robotics, which is widely used in industry, agriculture, military, education and so on. Path planning is one of the most important problems in mobile robot research. In this paper, the path planning of mobile robot is based on artificial neural network technology. Firstly, the basic theory of artificial neural network is analyzed. Then this paper analyses the path planning algorithm of mobile robot. Finally, the application of artificial neural network in path planning of mobile robots is described.

1. Introduction

At present, the development trend of robots is highly intelligent, and path planning is an important indicator of intelligent evaluation. Path planning technology is that when a robot encounters obstacles and cannot move forward, it needs to find a new path to reach the end point. This new path can not only enable the robot to bypass obstacles, but also take the shortest time and choose the most scientific distance. With the development of robotics technology towards artificial intelligence, higher and higher requirements are put forward for the path planning of robots. Artificial neural networks have their own advantages in artificial intelligence, but there are also many drawbacks. Although neural network has good learning function and robustness, it cannot make good use of prior knowledge. In path planning, we can synthesize their advantages by using artificial neural network technology.

2. Basic theory of artificial neural networks

2.1 Overview of neuron model

The basic structure of the nervous system is the neuron nerve cell, which is the basic unit to process human information transmission. The brain can handle extremely complex analysis and reasoning. On the one hand, the number of neurons is huge, on the other hand, neurons can process input signals non-linearly. Therefore, the establishment of engineering neuron mathematical model can better study engineering problems, as shown in Figure 1. The model is a multi-input single-output nonlinear element. The weights represent the connection strength between neurons.

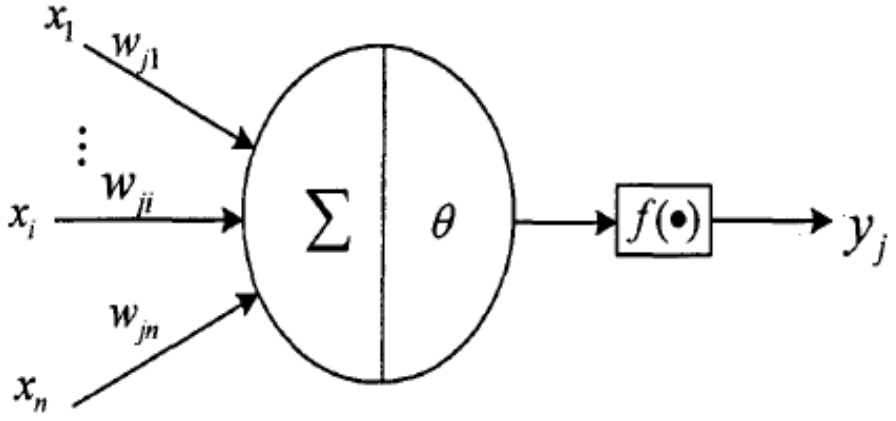

Figure 1 Mathematical model of neurons

Mathematical model expression of neuron:

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$$y_j = f(\sum_{i=1}^{p} w_{jp}x_p - \theta)$$

Among them,

w_{jp} is Connection Weight Coefficient;

x_p is the input signal at the input end;

θ is the neuron threshold;

p is the number of input signals;

y_j is the output of neuron at the j-time;

f(.) is the excitation function.

2.2 Structure of neural networks

After the model of the neuron is determined, the characteristics and ability of the neural network mainly depend on the network's topological structure and learning method. The structure of the neural network has the following basic forms.

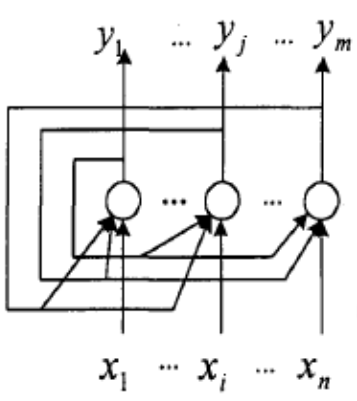
First, interconnection networks. The interconnection network structure is shown in Figure 2. Networks are formed by the interconnection of multiple neurons, and the output of some neurons is fed back to the same or front neurons. In this way, the forward and reverse flow of signals can be realized.

Second, forward network. Neurons in the network are arranged in layers. The first layer is the input layer, the last layer is the output layer, and the middle layer or more layers are the hidden layer. There is no interconnection between neurons in the same layer. In this way, signals from the input layer to the output layer flow through unidirectional connections, and neurons connect from one layer to the next.

Thirdly, horizontal network. The network itself is forward, and its neurons in the same layer are transversely connected with each other. We can achieve lateral inhibition or excitation between neurons in the same layer. Or we can divide the neurons into several groups, each acting as a whole.

2.3 BP neural network

Back Propagation (BP) Neural Network is also called Back Propagation Network and Multilayer Forward Network. The structure of BP Neural Network is shown in Figure 3.



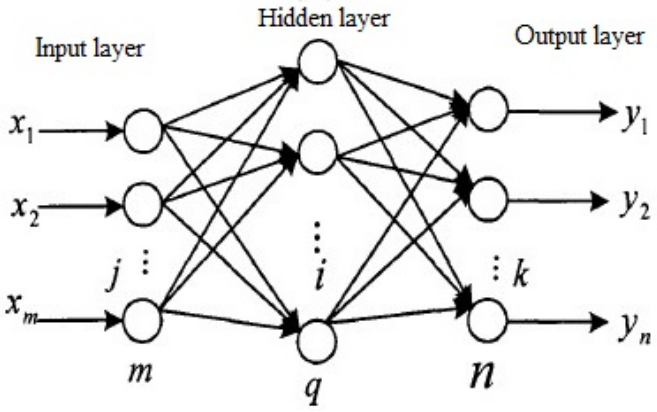


Figure 2 The interconnection network structure Figure 3 The structure of BP neural network model

3. Path planning algorithms for mobile robots based on artificial neural networks

The idea of neural network to solve the path planning of mobile robot is as follows. Neural network algorithm can describe various constraints of mobile environment, and then the collision function is calculated. The objective function that needs the algorithm optimizing is the sum of collision function and distance function. By solving the optimization function, we can determine the

point set, and finally we can achieve the optimal path planning.

The neural network algorithm is as follows. Firstly, all the neurons in the neural network are initialized to zero. The activity value of neurons at the target point was determined and the value of neurons was transmitted to the starting point. Secondly, dynamic optimization of neural networks. According to the specific target nodes and obstacles of the neural network, the external input of the neuron is generated in the mapping of the topological structure. Thirdly, the neuronal activity of the target value was determined. Fourthly, the neurons with the highest activity value in the current neighborhood are searched. Fifthly, if the robot reaches the target point, the path planning process is completed. Otherwise, step 2.

4. Development direction of mobile robot path planning

4.1 Integration of artificial neural network and information theory

With the integration of artificial neural network technology and information theory, we can determine the optimal objective solution of the neural network. In the application of neural network, the empirical value is difficult to determine. So we regard the neural network as a Bayesian network. According to the information entropy contained in Bayesian network, we can determine the optimal solution of the objective function of the neural network. Through the combination of the two, we can better judge the optimal path of robot movement.

4.2 Integration of artificial neural network and genetic algorithms

Neural network and genetic algorithm are combined. We can set the mobile environment of the robot as a 2D environment in which the number, location and shape of obstacles are arbitrary. Path planning can be composed of a series of basic points in a 2D workspace. Neural networks determine the motion control rules of robots. Robots capture unknown environments through neuron controllers. Then the robot takes the obstacle information and the distance between the target points as input data. Then it is transmitted by neural network. Next, through genetic algorithm, we can complete the weight training of the neural network. The output of the neural network is the motion force of the mobile robot. In this way, we can realize the path planning of robot in unknown environment.

4.3 Integration of artificial neural networks and ant colony algorithms

Combining artificial neural network with ant colony algorithm, we can reduce the search space and improve the accuracy of path planning. Firstly, the grid method is used to model the working environment of the robot. Secondly, we regard the starting point of the robot as the location of the ant nest, and the ultimate goal of path planning is the food source of the ant colony. Through the cooperation between ants, we can find an optimal mobile path for robots to avoid obstacles.

5. Conclusions

With the development of mobile robot technology, path planning, as one of the most important components, has been widely used and developed. In the future path planning, the artificial neural network technology will choose the appropriate algorithm for different application environments to optimize the mobile path. In the future, with the improvement of neural network technology, we will introduce genetic algorithm, information theory, ant colony algorithm and so on. Through the combination of artificial neural network technology and algorithm, robot path planning will be more accurate and accurate. With the continuous development of science and technology, the application of robots is expanding. With the more complex working environment, the research of robot path planning should be more in-depth.

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