Path Planning for Mobile Robot Based on BP Neural Network Algorithm

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Abstract

Improves the BP neural network algorithm, so the shortage of path- planning with the BP neuralnetwork algorithm is overcomed.The simulation results indicate that on the bases of accessional momentummethod can efficiently improve this algorithm in convergence speed.At last,mobile robot dynamic path plan-ning simulation is carried outin the environmentwith immobile andmobile obstacle,the simulation resultindi-cates that the method is feasible.

Keywords

Mobile Robot, Path Planning, BP Neural Network.

1. Introduction

Modern robots are widely used in many industries, especially in some cases where the working environment is bad and the labor intensity is high, robots will play a huge role in replacing manual labor. Path planning is a very important technology in the application of robots and a focus problem in the field of modern robotic control. This paper mainly studies how to find a collision-free path from the starting point to the end point. When the precision of the hardware system of robots can not be solved in a short time, the algorithm is studied. Neural network is a network which is widely interconnected by a large number of processing units. It is proposed on the basis of the scientific research achievements of modern neural network. It can simulate the recognition, thinking and cognitive process of human brain, and reflect some basic characteristics of human brain function, but it is not the real description of human brain, but only its abstraction, simplification and simulation. Neural network is a highly non-linear and very large-scale continuous-time dynamic system. Its main characteristics are continuous-time non-linear dynamics, the global role of the network, large-scale parallel distributed processing, high robustness and Learning Association ability. At the same time, it has the common characteristics of general non-linear dynamic systems: No. Predictive, attractive,dissipative,non-equilibrium,irreversible,high-dimensional,extensiveconnectivity and self-adaptability. Therefore, it is actually a super large scale nonlinear continuous time adaptive information processing system.

2. Organization of the Text

2.1 Presentation of problems

BP neural network is not a perfect network, but it still has some defects.

(1) The convergence rate of learning is too slow. A relatively simple problem sometimes requires hundreds or even thousands of times of learning to converge.

(2) It is not guaranteed to converge to the global minimum point.

(3) Up to now, there is no theoretical guidance for the selection of the number of layers and the number of units in the hidden layer of the network, but it is determined by experience. Therefore, the network is often very redundant, virtually increasing the learning time of the network.;

(4) Network learning and memory are unstable. When a trained BP network is provided with a new memory mode, the original connection weights will be disrupted,resulting in the disappearance of the information of the original well-remembered learning mode. In order to keep this situation from

happening, we need to add the new model to the original model for training. For the human brain, the new information will not affect the information that has been memorized. This is the stability of the human brain's memory.

In order to overcome the shortcomings mentioned above, a BP algorithm with additional momentum terms is proposed. The main goal of BP algorithm improvement is to speed up training and avoid falling into local minimum. The main methods of avoiding network trapped in local minimum are simulated annealing algorithm, genetic algorithm, additional momentum method and injecting noise into training mode. That is to say, in the early training period, the noise generated by random signal generator may be very large. As the training proceeds, the noise gradually decreases and finally reduces to zero, so the algorithm converges. The standard BP algorithm is only the simplest static optimization algorithm with negative gradient descent. Its convergence speed is relatively slow, which seriously affects the practical application of the network in many aspects. The influence of the last weight change is transmitted by a momentum factor, which makes the adjustment of the weight change towards the average direction at the bottom of the error surface, and helps to make the network jump out of the local minimum. The momentum term added in this method is essentially equivalent to the damping term. It accumulates the previous learning experience, reduces the oscillation trend of the learning process and improves the convergence. In this paper, the improved BP algorithm is used to get better control effect. The BP neural network with additional momentum term is used for path planning of mobile robot. The training of BP neural network with additional momentum term consists of three parts: sample input, network learning and network output. Neural network learning and training is a process of repeated learning. A group of training modes need hundreds or even thousands of learning processes to make the network converge and get the most model required by the experiment.

2.2 Determination of network structure

The input layer of the BP neural network acts as a buffer memory and adds the data source to the network. The number of nodes depends on the dimension of the data source, that is, the dimension of the input eigenvector. When selecting feature vectors, we should consider whether the selected vectors fully describe the essential characteristics of things. If the eigenvector can not effectively express the characteristics of things, the output of the network after training may have a greater error with the actual. Of course, the more dimension the eigenvector is, the better. The more dimension the input eigenvector is, the more computation of the network will be exponentially increased, which will lead to combinatorial explosion. Therefore, when choosing feature vectors, we should proceed from reality and properly select those features that best represent the essence of things. Good characteristics should have the following 4 characteristics.

Distinguishability,reliability,independence and quantity.。 There are certain rules for determining the number of nodes in the output layer. (1) When there are fewer types of modes, the number of nodes in the output layer is equal to the number of categories of modes. The output of class m uses M output units. Each output node corresponds to a pattern class, that is, when the value of one output node is 1 and the value of the other output nodes is 0, the corresponding input is a sample of a particular pattern class. (2) When there are many types of modes, the coding of output nodes is used to represent each type of modes. That is to say, the output of class m only needs log2m output units. The hidden layer plays an abstract role, that is, it can extract features from input. Increasing the hidden layer can enhance the processing ability of the neural network, but it will complicate the training of the network, increase the number of training samples and increase the training time. In general, a hidden layer is set up, and then the hidden layer is added as required. According to the actual situation, this paper designs a three-layer BP neural network structure with one input layer, one hidden layer and one output layer., In the input layer, there are three neurons, which are the distance from the obstacles in the left, front and right directions to the mobile robot (the results of fusion of the data measured by three groups of sensors of the robot are used as input respectively). There are six neurons in the hidden layer (the number of layers in the hidden layer of the network and the number of units in the hidden layer can only be determined according to the experimental results without theoretical guidance); there are two outputs in the output layer (controlling the speed and deflection direction of the robot respectively). A neural network is built and simulated in MATLAB.

3. Determination of neural network parameters

3.1 Sample size

Sample size is an important factor that affects the future path planning of neural networks. The greatest characteristic of neural network is learning ability. It stores some information and adjusts its internal parameters through some learning method to accomplish the specific goal of path planning. Therefore, if the training sample set is very large and can reflect the information needed for path planning comprehensively, the effect of path planning will be good after learning. If the training sample is small and the structure is single, the effect of path planning will deteriorate, and there will be even the risk of collision. The training samples used in this paper are based on the experience of human walking to get speed and deflection angle. The total number of training samples is 6. The initial weights are chosen as random numbers generated by rand function in MATLAB; the expected error value is selected as 0.0001; and the training times are less than 1500.

3.2 Learning rate and momentum term

Because the improvement of the network is closely related to the selection of learning rate and momentum terms, they are emphatically analyzed in the experiment. Within a certain range, when the learning rate is large, the number of iterations decreases and the error convergence speed is fast. The momentum term also has a similar relationship with the error and the number of iterations. In this control system, the learning rate is 0.4 and the momentum term is 0.2. The results of many experiments are satisfactory, and the error is well converged and the number of iterations is less Fig. 1 is an error convergence diagram when the learning rate is 0.4 and the momentum term is 0. When the expected error value is reached, the number of iterations is 773, and the convergence is slow. Fig. 2 is a sketch of error convergence curve when the learning rate is 0.4 and the momentum term is 0.2. When the expected error value is reached, the number of iterations is 280 and the convergence rate is faster.

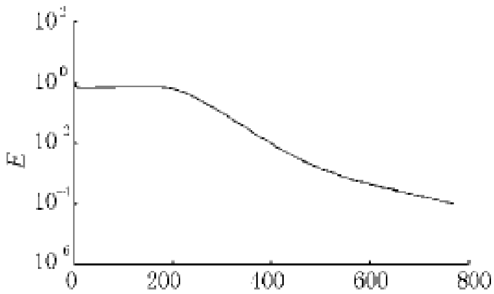

Fig. 1 Error convergence curve with additional momentum term of 0

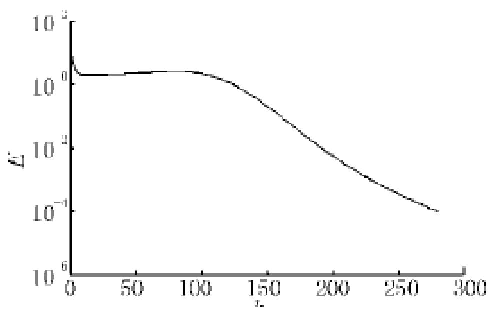

Fig. 2 Error convergence curve with additional momentum term of 0.2

4. Simulation result

Because the improvement of the network is closely related to the selection of learning rate and momentum terms, they are emphatically analyzed in the experiment. Within a certain range, when the learning rate is large, the number of iterations decreases and the error convergence speed is fast. But more than a certain value, the error curve will appear very oscillatory divergence, not up to the required control error effect. The momentum term also has a similar relationship with the error and the number of iterations. In this control system, the learning rate is 0.4 and the momentum term is 0.2. The results of many experiments are satisfactory, and the error is well converged and the number of iterations is less. Fig. 1 is an error convergence diagram when the learning rate is 0.4 and the momentum term is 0. When the expected error value is reached, the number of iterations is 773, and the convergence is slow. Fig. 2 is a sketch of error convergence curve when the learning rate is 0.4 and the momentum term is 0.2. When the expected error value is reached, the number of iterations is 280 and the convergence rate is faster.

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