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A ROBOT PATH PLANNING SCHEME BASED ON NEURAL NETWORK

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ABSTRACT

A method of Robot path planning based neural network has been raised in order to guarantee that the robot can simultaneously avoid movable obstacle intelligently when it is reaching the destination. In the first instance, every robot will be divided into spheres of influence, and the influence map will be worked out at the same time. Then neural network is used to select the path. In view of the problems of neural network(such as local-optimization and poor convergence, etc.),genetic algorithm is added to optimize neural network to help finding the best path . This technology can be widely used in many fields such as the navigation and computer games. Especially, it can be used in games of robot path planning and will get ideal results.

Keywords: *Genetic Algorithm, Neural Network, Path Planning, Influence Map*

1. INTRODUCTION

The field of Artificial Intelligence(AI) began in a blaze a glory. Within a decade or so of its inception, computers were solving geometry and physics problems at a college freshman level, playing chess like regional champions, diagnosing serious illnesses on par with expert physicians and designing complex VLSI circuits. No problem was too complex, but, as AI researchers discovered in the 1980's, many were too simple.

Indeed, the capabilities that humans take for granted, our basic sensorimotor skills such as walking, climbing, and grasping for objects, turned out to be orders of magnitude more difficult to program than backgammon, bridge and biochemical analysis[5].

Many attempts were made to force-feed this common sense into AI systems, in much the same manner and using similar knowledge-representation formats as had been successfully used to load expert rules-of-thumb into AI systems. In fact, the whole AI subfield of qualitative reasoning(QR)[4] was dedicated to this aim.

The representative studies of Robert in our country are as following: industrial robots, water robots and space robot and so on. These studies globally keep leading position .

But there is a gap on understanding to artificial intelligence between China and some developed countries. The intelligent robot has wide range of applications, for instance that the robot can find the way automatically to its destination and dodge the hostile moving robots.

Path-finding is a core component of most games today[1,3]. It in computer games is commonly approached as a graph search problem and consumes a significant amount of resources, especially in movement-intensive games such as multiplayer games[2].

How can do this? The methods needed are neural networks and genetic algorithms and the application of spheres of influence. This is an expansion of path finding automatically and the hostile robots are moving . This technique has been widely used in navigation and games business and so on. So it is highly significant . And It is studied in depth and perfect effects are received.

2. ESTABLISHMENT OF MODEL

As shown in Figure 1, it simulates that on a broad map there are moving enemies at will and path finding robot is set an entrance and exit and it can plan a best route from the entrance to the exit and dodge the hostile moving robots. In Figure 1,P is the path finding robot and E is the hostile moving robot .

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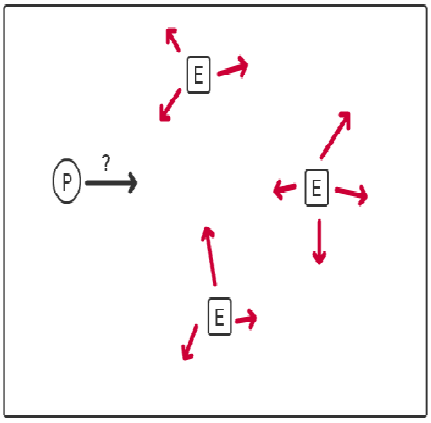

Figure 1: Simulation Map Of Path Finding

This is was a little like a path finding algorithm but the slightly difference is that in this map there are no preselected points to help finding path and these obstacles are moving, so pre-computing a path has come to mean little. So another program is adopt by using spheres of influence to assist AI finding path.

2.1 Sphere Of Influence

The so-called sphere of influence is shown as Figure 2. If a robot is in the O point ,the point has the biggest influence and the influence will be smaller outward. Here the value of influence has 4 levels standard(10,7,4,1) and the grid of 0 or 1 is relatively safe. We will make the best use of the relative safe grids when we find best path.

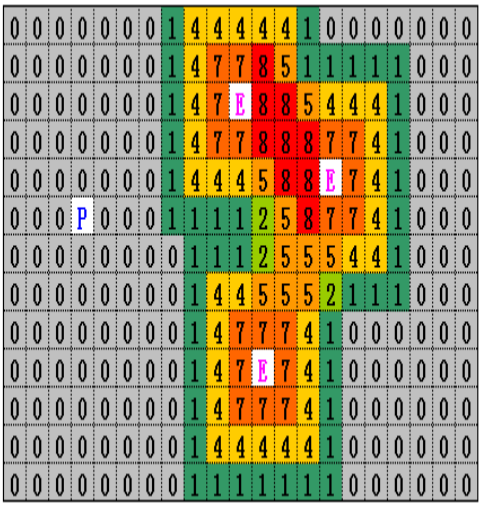

Figure 2: Sphere Of Influence

2.2 Neural Network Estimation

So far the BP neural network is very common and has been applied on many fields, such as :function approximation, image recognition and pattern recognition and so on[9,10].

This paper adopts three-tiered artificial neural network structure and it includes input layer, hidden layer and output layer. Every neuron connects with all the neuron of the next layer and doesn't connect with the neuron of the same layer as shown as Figure 3.

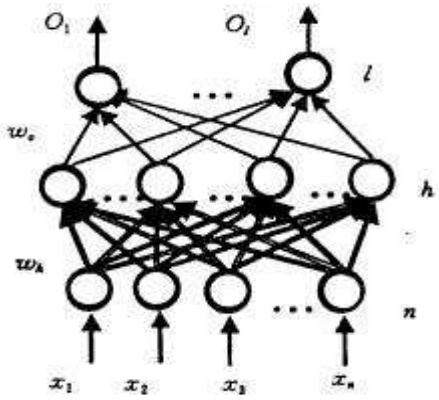

Figure 3: The Map Of BP Neural Network Structure

The data of input layer of neural network are center coordinates of the robot and the hostile robots and the data of output layer are the direction of progress next. With the case of one robot and three hostile robots, the input layer has the coordinates of the robot and three hostile robots and it means that the number of neurons of input layer is eight .And the neuron of output layer is the direction progress next and the number of neurons of output layer is one. The number of neurons of hidden layer is determined by orthogonal experiments as twenty.

However，each neuron is the center coordinates or the direction of progress next, so it includes two elements that are x and y. X and x are closely linked and y and y are closely linked, so if x and y can be computed separately ,better results will be received. The concrete implementation method is shown as Figure 4. In this figure, x and y are processed separately. All x coordinates are the data of the input layer and the data of the output layer is the x direction of progress next. In the same way, all y coordinates are the data of the input layer and the data of the output layer is the y direction of progress next.

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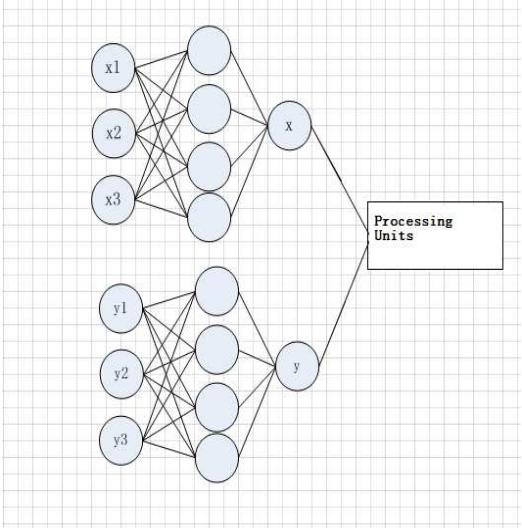

Figure 4: The Improved Map Of BP Neural Network Structure

2.3 Establish The Model Of Neural Network Based On Genetic Algorithms

BP neural network essentially is an algorithm of gradient descent, so it inevitably the limitations of poor convergence, and is easy to fall in local optima and so on. And this will affect the results of prediction.

A genetic algorithm (GA) is a search technique used in computing to find exact or approximate solutions to optimization and search problems. It is categorized as global search heuristics and a particular class of evolutionary algorithms (EA) that use techniques inspired by evolutionary biology such as inheritance, mutation, selection, and crossover[6]. It is a optimization method in high dimension space by using natural selection and evolution. In essence it is more efficient in finding global optimal solution and is widely applied in time series prediction and so on. So BP neural network optimized by genetic algorithm to build the neural network model overcome over some disadvantages of BP neural network to a certain degree. So it can get better results of prediction at a faster rate. A new method combining improved BP neural network and genetic algorithm is forward in this paper.

The process of optimizing neural network by using genetic algorithm is as follows:

(1) The weight values of hidden layer and output layer are w_1, w_2 and the thresholds are θ_1, θ_2. Then the random values generated between 0 and 1 will be the weight values and thresholds of groups of n. Every weight value represents a gene on a chromosome. One chromosome is N individuals of initial population of genetic algorithm.

(2) Sigmoid function is selected as activation functions of hidden layer and output layer:

$$f(x) = \frac{1}{1+e^{-x}} \quad (1)$$

(3) The square error is as follows:

$$E = \frac{1}{2}\sum (y_k - o_k)^2 \quad (2)$$

In the equation y_k is the ideal output and o_k is the networks output ,then the average backward error can be computed.

(4) Computing the value of individual fitness. Training the neural network by using training samples. The adaptive function is as follows:

$$F_i = \frac{1}{1+E_{av}^i} 1 \le i \le N \quad (3)$$

In the equation F is the fitness value of the individual of i and E_{av}^i is the average backward error .If the error is smaller the fitness value is bigger.

(5) Selection is going on in the individual of the chromosome and it adopts the strategy keeping the best individual.

(6) The cross method is as follows :

$$b_1 = \delta * a_1 + (1-\delta) * a_2 \quad (4)$$

$$b_2 = \delta * a_2 + (1-\delta) * a_1 \quad (5)$$

In the equation a_1 and a_2 are the parent individuals, b_1 and b_2 are the individuals generated after crossing and δ is the adjustment factor varying with the changing results.

(7) A new adaptive variation method is put forward to avoid the evolutionary stop by close relative reproduction and falling in local optima. This means that reverse proportion to the distances between parents and the mutant rates p_m . The adaptive variation of index declining can be reached adjusted by iteration rate(the ratio of the number of times of iteration and the biggest number of times of iteration). The equation is as follows:

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$$p_m = \begin{cases} p_{\max} \exp(-\frac{t}{t_{\max}}) * (1 - \frac{R}{R_{\max}}) & p_m < p_{\min} \\ p_{\min} & p_m > p_{\min} \end{cases} \quad (6)$$

In the equation $p_{\max} / p_{\min}$ are the biggest and the smallest variation ratio respectively. $t / t_{\max}$ are the number the biggest number of iteration times respectively. $R / R_{\max}$ are Euclid distance and the biggest Euclid distance between parents.

(8) Repeat from (5) to (7) until finding the qualified fitness value of the chromosome.

(9) Save the every parameters and indicators of the trained network for the future prediction.

3. THE SYSTEM OF ROBOT PATH PLANNING

The system of robot path planning is established by above methods.

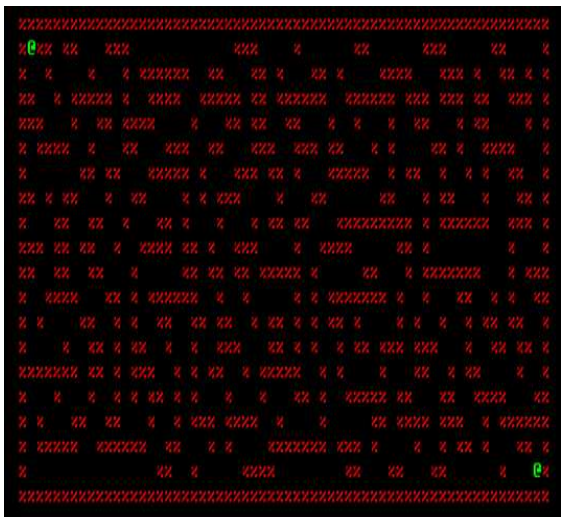

Figure 5: The Schematic Diagram Of This System

Firstly, we establish the schematic diagram shown as Figure 5.This schematic diagram has one entrance and exit. The robot can dodge all the obstacles and find a best path from entrance to exit immediately.

Secondly, we optimize the map to add changes of landscapes and improve the visual presentation. That is shown as Figure 6. The type of landscapes are various such as highlands and valleys.

Finally, all the robots have been added. The interface of this system is shown as Figure 7. The figure has many robots ,many hostile moving robots, one entrance and one exit. Through test, the path received is proved as the optimized path ,so the method is effective .

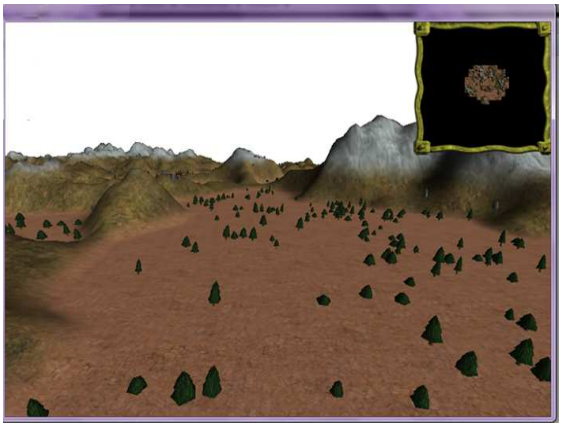

Figure 6: The Map Of This System

The technology of rendering the terrain is based on DIRECT. To increase the rendering speed, sectional rendering is adopted. This means that if the terrain is in sight ,it can be rendered, and otherwise it needn't be rendered. This method can improve the rendering speed largely.

Figure 7: The Final Result Interface Of This System

4. CONCLUSION

This article studies path finding of robot by using BP neural network. And to beat the innate defects of neural network, genetic algorithms are introduced to optimize the algorithm. Thus it can make the utmost possible effort to find out the global optimal solution.

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With the increasing application of neural network, the studies about neural network are beginning to accumulate and more research results are achieving. These results will help neural network being of great value in the application of robot path planning.

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REFERENCES:

[1] Liu G, "The ant algorithm for solving robot path planning problem", IEEE Third International Conference on Information Technology and Applications, July 4-7, 2005,pp.25-27.

[2] Hu X Z, Xie C X, Xu Q G, "Robot Path Planning Based on Artificial Immune Network". *Proceedings of the IEEE International Conference on Robotics and Biomimetic*, December 15-18, 2007, pp.1053-1057.

[3] Joshi M V, "On evaluating performance of classifiers for rare classes", *Proceedings of the 2nd IEEE International Conference on Data Mining*, December 9-12, 2002, pp.641-644.

[4] Cavagnari L L, Magni R S, "Neural network implementation of nonlinear receding-horizon control", *Neural Computing & Applications*, Vol.8, No.1, 2001, pp.86-92.

[5] Gao Bo, Yan WS, Zhang FB, Wang YT, " A Method of Constructing Complete Graph for Multi-objects Path Planning in Complex Environment", *Proceedings of the IEEE International Conference on Information and Automation*, June 22-25, 2009, pp.403-407

[6] http://blog.csdn.net/aris_zzy/article/details/5147994

[7] Bezerianos A, Chevalier F, Dragicevic P, Elmqvist N, FeketeJ D. GraphDice, " A system for exploring multivariate social networks", *Computer Graphics Forum*, Vol.29, No.3, 2010, pp.863-872.

[8] Nantian Huang, Lin Lin, "An Improved BP Neural Network Model Based on Quasic-Newton Algorithm", *Proceedings of Fifth International Conference on Natural Computation Natural Computation*, August 14-16, 2009,pp.352-356.

[9] Jianjun Ni, Xiaoping Ma, Lizhong Xu, Jianying Wang, "An image recognition method based on multiple BP neural networks fusion" *Information Acquisition*, June 21-25, 2004, pp. 323- 326.

[10] Xinyuan Chen,Yuan Guo, Chen Chen, Tao Lan , "Research on multi-parameter fault pattern recognition of electro- hydraulic servo valve based on BP neural networks", *7th World Congress* on *Intelligent Control and Automation*, WCICA 2008, June 25-27, 2008, pp. 6049-6052.