Dynamic Path Planning of Robot Based on Depth Learning

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Abstract. Multi joint serial industrial robot is widely used in industrial production because of its convenient operation, accurate positioning, flexible execution and other advantages. The working principle of industrial robot is mainly to remember the running track through manual teaching, and use control to make it reach the specified position and pose. Generally, industrial robots only follow one or more fixed routes in actual pipeline work. Dynamic path planning is a method types of robots, such as wheeled mobile robots or underwater robots (UUV). The key idea behind our method is to use the depth map generated by a stereo camera, rather than simply measuring the line of sight distance between two points as traditional methods. The depth map provides information about the relative position between two objects, which is crucial for finding a free path.

Keywords: robot · Deep learning · Dynamic path planning

1 Introduction

At present, the more successful and feasible traditional robot path planning methods mainly include genetic algorithm, artificial potential field method, fuzzy algorithm, A * algorithm, etc. But these methods all need to fully understand the environment information of the robot system, and then use some rules or algorithms to plan its path. Environments. Therefore, the research on how to improve the self-learning ability and adaptability of robot system in path planning is particularly critical [1].

Artificial intelligence is a branch of computer science. It tries to understand the essence of intelligence, so that computers can think like people!. As a part of artificial intelligence, machine learning is not a way to manually code software routines with specific instructions to complete specific tasks, but a way to "train" algorithms so that it can learn how to complete tasks. The reinforcement learning (RL) method is between supervised learning and unsupervised learning, and it does not need to give any marked information in any state. The then evaluates the actions selected for implementation through the feedback reinforcement signal. Finally, a satisfactory solution is obtained by using constant trial and error and selection [2].

With the increase of application fields and the complexity of tasks, if some tasks are completed only by a single robot, the efficiency is very low, and even may not be completed. Therefore, people are also increasingly considering the use of multiple

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robots to coordinate tasks that are difficult for a single robot to complete. For multi robot systems (MRS).

2 Related Work

2.1 Path Planning Method for Single Robot

The path search space based on the known environment information can generally be simplified into a two-dimensional model. The current representation methods can be roughly divided into three categories: grid representation, geometric information representation and topological graph representation [3]. The grid representation is to divide the whole working environment into several small squares, namely grids, according to the same size, and explain whether there are obstacles for each grid; It is characterized by easy creation and maintenance. If there is a directly connected path between nodes, it is equivalent to the arc connecting nodes in the graph. It can achieve fast path planning. However, when there are two very similar places, this method is difficult to determine whether this is the same node. Finally, on the constructed environment map, use the path finding algorithm (such as A * algorithm, etc.) to search for an optimal path without collision.

2.2 Multi Robot Path Planning Method

For the must be considered as a whole. Nowadays, there are four main types of path planning for multi robot systems: fully centralized path planning, incompletely centralized path planning, incompletely decentralized path planning, and completely decentralized path planning.

The centralized method is one of the simplest path planning methods for multiple robots, which is suitable for situations with a small number of robots. This method typically involves assigning tasks and planning paths through a central control unit. The central control unit will optimize and plan based on the robot's information and task requirements, and then assign tasks and routes to each robot. The advantage of this method is that it is simple and feasible, and is not affected by the interaction between robots.

The distributed method is suitable for situations with a large number of robots. In this method, each robot has its own decision-making and path planning abilities, and they collaborate to complete tasks and allocate paths. In distributed methods, robots achieve task allocation and route planning through communication and collaboration. Due to each robot having its own decision-making power, distributed methods are more flexible and fault-tolerant.

Collaborative path planning is a popular multi robot path planning method. In this method, robots collaborate to complete tasks and path planning, and adjust their routes in real-time based on task allocation and environmental changes. This method can achieve task planning and path allocation through the interaction and collaboration between robots, thereby improving the efficiency and security of the entire system.

Artificial intelligence technology is playing an increasingly important role in path planning for multiple robots. For example, optimizing robot path planning through techniques such as machine learning, genetic algorithms, and deep learning. This method can automatically discover path planning schemes from a large amount of data and adjust the path scheme according to real-time environmental changes.

In short, multi robot path planning is a complex problem that requires assigning tasks and planning routes among multiple robots. Different multi robot path planning methods have their own advantages and disadvantages, and in practical applications, it is necessary to choose the appropriate method based on the specific situation.

3 Deep Learning Theory

Neural network is a mathematical model of propagation between bionic neurons. It mainly has two propagation formats, one is feedforward and the other is feedback. The feedforward type mainly reflects the mapping relationship between a group of data and fits the objective function. At present, common perceptrons, BP, RBF, etc. are feedforward neural networks [4].

BP neural network belongs to the category of basic deep learning. Its full name is Back Propagation neural network, which is translated as back propagation neural network. This is also the biggest feature of BP neural network. It can not only forward transmit data, but also back transmit the error of result evaluation. All BP neural networks have a three-layer structure, including the input layer, hidden layer and output layer, as shown in Fig. 1.

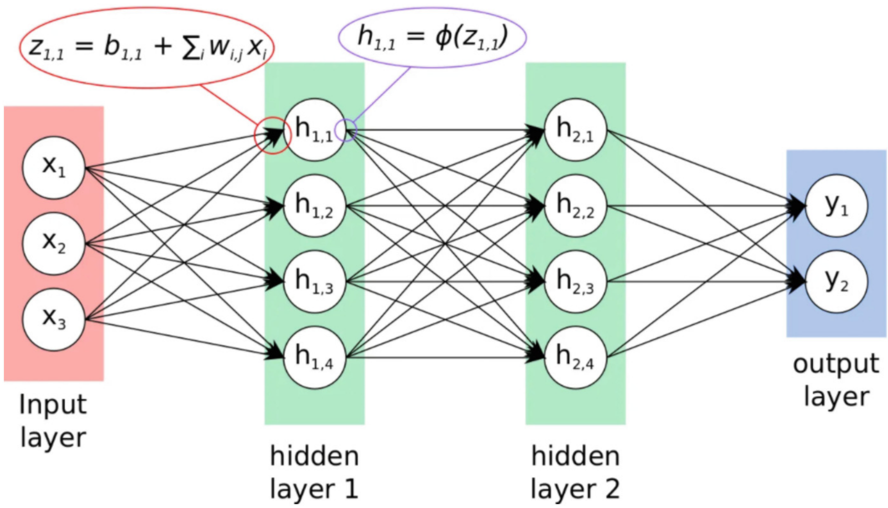

Fig. 1. Three layer structure of BP neural network

The output layer receives information variables from the hidden layer for further processing. At the same time, the most basic function of the output layer is to output the network results.

In BP algorithm, S-type function is generally selected as the transfer function. S-type function can realize nonlinear mapping between input data and output data of training data, and concentrate the mapping of output results in the range of (−1, 1), reducing the different effects caused by large data span.

$$E(w, b) = \sum_{j=0}^{n-1} (d_j - y_j)^2 \tag{1}$$

The propagation process of BP algorithm is divided into forward and backward propagation, the core of which is back propagation, and its learning algorithm is gradient descent method. The essence is to find the minimum error value. The difference is that the gradient descent method is applied to the BP neural network, which has its own network structure and connection mode, so it has formed its own algorithm, namely BP algorithm.

4 Robot Dynamic Path Planning Method Based on Deep Learning

The greedy strategy balances exploration and utilization. The disadvantage of this method mentioned above is that it may converge to a suboptimal solution or even a common solution. This defect will also affect the results in the single robot path planning.

For example, in the environment of Fig. 2, the yellow dot grid 4 in the upper right corner is set as the target state, and the red block grid 1 in the lower right corner is set as the starting state. Assuming that the initialization value function is both 0, when the robot reaches the target state, it will receive an immediate reward of r = 10, with a discount factor of y = 0.9. At the same time, grid 2 and grid 3 in the environment have obtained the optimal strategy, as shown by the arrow in the left figure of Figure 3-1. Then the value function of the selection action in grid 3 transferring right to grid 4 is 10, and the value function of the selection action in grid 2 transferring up to grid 3 is 0.9 × 10 = 9, then the current starting state is red block grid 1. Since the initialization value functions are all 0, there is no tendency for grid 1 to choose the action of up or left. However, since the left state is transferred to grid 2, the value function of grid 2 is 90, and the left action value function of grid 1 is updated to 9 × 0.9 = 8.1, far greater than the value function of upward action.

In Q-Learning, the exploration factor will decrease Then the robot may never attempt to move up to grid 4 at grid 1. Therefore, it will converge to a suboptimal solution, as shown in the right figure of Fig. 2.

At the beginning, because the robot has just started to explore the environment, and the number of successful path finding is not high, it should maintain a high exploration factor at the beginning ε, Make the robot continuously try new actions; With the robot's understanding of the environmental information, the number of successful path finding will exceed a threshold, which proves that the state action value function of the robot tends to be stable after that. But at this time, the optimal solution may not have been found, and it may have fallen into the suboptimal solution. At this time, the number of different paths found by the robot is added. If the number is very small, it means that the robot has been repeating the old path, and the exploration factor should be increased

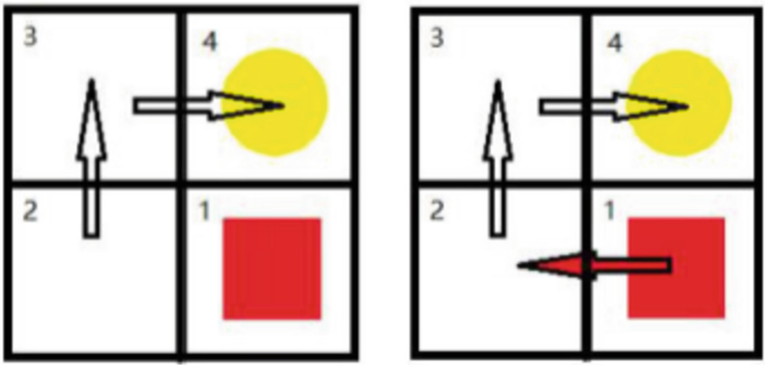

Fig. 2. Example Diagram of Robot Dynamic Path Planning

ε, Force the robot to try new actions; If the number is greater than a threshold, it is proved that the robot has basically found all the paths to reach the target state, and the exploration factor should be slowly reduced ε.

In this way, the above two bases are used to constantly update the exploration factors according to the learning effect ε The value of, so that ε- The greedy strategy has stronger adaptability and conforms to the operation rules.

5 Conclusion

Dynamic path planning for robots is currently an important issue in robot control. Its goal is to plan a suitable path for the robot to achieve its predetermined goals in the future. Unlike static path planning, dynamic path planning requires real-time response to environmental changes during movement and corresponding actions to ensure the safety and effectiveness of the robot. In recent years, deep learning technology has been widely used in robot dynamic path planning. This article will summarize the dynamic path planning of robots based on deep learning. Deep learning is a machine learning method based on multi-layer neural networks. In the dynamic path planning of robots, deep learning technology is mainly achieved through neural network models. Sensors are usually implanted in robots, and by collecting and processing a large amount of sensor data, the robot's environment is modeled. Deep learning technology is used to extract features for classification and recognition, thereby achieving dynamic path planning. In practical applications, deep learning based dynamic path planning for robots has been widely applied in fields such as robot navigation, environmental perception, and decision-making. By modeling and analyzing the environment, deep learning models can predict future environmental changes and adjust robot path design to ensure the efficiency and safety of robots in most situations.

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