

Survey of Iterative Learning Neural Networks for Robotic Arm Control

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Abstract: Through the research, induction and analysis of the research status of robotic arm control and iterative learning neural network in domestic and foreign scholars, the aim of this paper is to study the neural network algorithm and its motion planning, progressive tracking control and system stability and convergence. With iterative learning neural network control theory analysis, time-varying problem real-time solution research and application research, acquisition theoretical research basis, research ideas, research methods and research deficiencies, it lays the foundation for the innovation in the later research work inspiration.

1. Introduction

Since the concept of robots was proposed in 1920, robots have attracted great attention from all over the world, and robotics and theory have been established and developed accordingly. The robot has achieved a breakthrough from scratch, and has experienced the development from simple function to intelligent application. The robot system is a highly complex and highly coupled nonlinear system. The controller is often difficult to know the accurate mathematical model. . A very important aspect of robotics is the study of robotic arm motion. The robotic arm is an end-active mechanical device that is widely used in equipment manufacturing. Product processing, machine operations and other key areas of the national economy. The robot arm has more freedom and operation space, and the excess freedom can satisfy more functional constraints, such as logistics limit avoidance and environmental obstacle avoidance. A fundamental problem with controlling redundant robotic arms is real-time motion planning, which gives the Cartesian velocity/acceleration trajectory of the end motion. There are many different ways to get the speed, acceleration and/or torque values of each joint in real time. But they also have some shortcomings: (1) The scheme is a pseudo-inverse scheme, and there are defects that are not suitable for inequality constraints. (2) Due to its highly complex and highly coupled nonlinearity, it is difficult to obtain accurate mathematical models. (3) The search space is large, the search space structure is complex, and it is difficult to achieve good performance. (4) The amount of calculation is large. Robots are a class of highly nonlinear, strongly coupled and time-varying dynamic systems. Because of the tracking of a given spatial trajectory, the complex motions with high-order derivatives are often converted to the motion of each joint. . (5) Simple neural network learning has a slow convergence rate and a large memory capacity. The choice of classifier involves the construction of training samples and the difficulty in selecting and extracting features. Therefore, it is very difficult to use classical neural network methods. in order to solve. Through reference and inductive analysis of domestic and foreign research on arm control and iterative learning neural network, it provides powerful theoretical basis and research inspiration for motion control such as robotics and machine motion control in equipment manufacturing and processing operations. .

2. The research status of the mechanical arm

The birth of robots and the establishment and development of robotics were one of the most convincing achievements of automation in the 20th century, and also a major achievement in the advancement of human science and technology in the 20th century. A redundant robotic arm means that the end effector has more freedom to perform a given task than it needs to be, so that it can perform tasks more flexibly. In the kinematics research of redundant robots, both forward

kinematics and inverse kinematics are the core part of the research. Positive kinematics refers to a given joint variable, which can uniquely determine the end effector through a known function mapping relationship. Position; inverse kinematics refers to the Cartesian variable of a given end effector, which is directly related to motion analysis, off-line programming, and trajectory planning. It is the premise of transforming the position and posture of the working robot end into joint quantity. How to solve the joint variable of the robot arm in real time, that is, the inverse kinematics of the robot is a difficult problem. Generally, there are direct method, analytical method, geometric method, iterative method, geometric-analytic method, etc. or the mechanical search inverse motion problem is transformed into the optimization problem. Compared with the direct solution method, the latter can reduce a large number of matrix inversions and matrix phases. Multiplication operation reduces computation time, is more flexible and more intelligent.

At present, the control method generally adopted by industrial robot arms is mainly based on pseudo-inverse analytical method: the solution of the problem is transformed into a minimum norm solution plus a similar solution, and the target can be assigned to the same solution to control the robot. Self-motion to avoid obstacles, joint limits, singularities, and optimize other objective functions. This traditional approach has been adopted by most researchers and engineers. Its advantage is that the form is simple and easy to learn. The disadvantage is that the method has difficulty in dealing with inequality constraints, and he will encounter production infeasible solutions in the case of algorithmic singularity [1]. Other experts have proposed task-first strategies to remedy the drawbacks of traditional methods, but their algorithm convergence rate and additional computational load may greatly affect multi-degree-of-freedom sensor-based online engineering applications. This negative impact is particularly prone to occur when multiple physical constraints are considered [2, 3]. There are also some studies that are devoted to the optimization of joint torque. For example, Hollerbach and Suh proposed the algorithm of optimizing the joint torque in the invalid space algorithm area, so that the joint torque is distributed as much as possible in the median area of the joint limit. This method will appear in the middle and long motion trajectory. The shortcomings of torque divergence [4]. It also develops a global theoretical optimization method, which can produce a globally stable optimization solution. The disadvantage is that the method must know the complete path information in advance, and the calculation is relatively complicated. This method is therefore not suitable for real-time motion planning of the robot arm. Since then, many researchers have invested in this research and tried to propose other torque optimization schemes to remove the torque divergence problem. For example, Kang and Freeman proposed a method for minimizing the ineffective spatial damping torque. Ma Shugen proposed a scheme to minimize the balance between torque and speed. Domestic scholars Sun Lining and Zhao Jing proposed a scheme combining torque optimization and singular point avoidance [5,6], Chen Weihai, Zhang Qixian, etc. also considered some difficult problems of torque optimization. In the aspect of robot obstacle avoidance, people have also developed optimization methods for obstacle avoidance, such as maximizing the distance between the robot arm and the obstacle. The disadvantage of this method is that the calculation load is large (the function calculation function is required to calculate the joint velocity) Moreover, it is unwise to continue to use the redundancy for maximizing the distance between the robot arm chain and the obstacle when the robot arm is far away from the obstacle. Another way is to describe the obstacle avoidance as a mandatory equation. Constraint. That is, the escape velocity method with constant amplitude. In this study, the obstacle avoidance is described as a quadratic optimization problem. The quadratic optimization problem is subject to the linear equality constraint, and the iterative learning recurrent neural network is used to solve the quadratic optimization problem in real time. Real-time motion planning.

3. The research status of iterative learning neural network

In 1943, psychology McCulloch collaborated with mathematical logic Pitts to study the structure of brain cells and the biological behavior of neurons. A neural computational model, the MP model, was proposed. This is the first manual to describe the brain information processing process in mathematical language. The model, although the model has limited functions, provides a theoretical

basis for the subsequent neural network research. In 1949, psychologist Hebb proposed the famous Hebbian learning rule based on the psychological reflex mechanism: if both neurons are excited and activated, the synaptic connection weights will be enhanced. The Hebbian learning rule has had a profound impact on the study of post-neural network learning algorithms. Since then, many scholars have proposed a variety of other neural network models, and people's research on neural networks has gradually become more interested. At present, the research of neural networks has the following three trends.

Theoretically moving towards a more complex neural network system. The complication trend is manifested in the combination of neural network and fuzzy, evolutionary and iterative algorithms, the combination of neural network and chaos theory, the combination of neural network and biomedicine, and the emergence of various hybrid neural networks. The effectiveness trend is as follows: Based on the basic theory of neural network biology, the neural network biology principle is further studied, and the excitation response of the biological nervous system is more realistically simulated, which makes the structure and original function of the artificial neural network and the biological neural network closer [9]. Therefore, the transmission of artificial neural network information and the processing of artificial neural network data are more effective; or, from the theory of mathematics and control optimization, the structure of artificial nerves and the optimal method of network parameters are studied in depth, in order to obtain a more effective neural network. Optimal structure and corresponding parameters.

The application range of neural networks is expanding. At present, the theory and application of neural networks have penetrated into various fields, and have achieved in signal processing, intelligent control, pattern recognition, machine vision, nonlinear optimization, knowledge processing, automatic target recognition, sensor technology, forecasting, image processing, etc. A remarkable progress. Research on neural network application technology has been deepened and intersected with various disciplines, solving many difficult problems that traditional science can't solve. Humans know the world, open up unknown areas, improve the level of modern science and technology research, and use technology to drive productivity growth of the national economy. To promote, it is recognized as one of the world's leading research fields of cutting-edge technology.

New neural network models are constantly being proposed. From the actual point of view, people propose different neural networks models with different structures, different working principles and different functions, such as perceptron, linear neural network, BP neural network, radial basis neural network, competitive neural network, cerebellar model neural network, random neural network, self-organizing neural network, process neural network, feedback neural network, cell neural network.

4. The lack of research

Although there have been gratifying advances in the study of robotic arm control and iterative learning neural networks at home and abroad, there are some shortcomings: (1) Although many models have been proposed, the model summarizes the determination of neural excitation functions and how to select them. Theoretical basis. (2) The weights, values and parameters of the excitation function of many of the above models can be adjusted. Compared with the traditional neural network, it has the characteristics of fast learning speed, simple structure and good approximation performance, but the mathematical essence of the excitation function is the same. Sometimes, the parameters of the network weight and the neuron excitation function must be adjusted, which inevitably increases the complexity of the learning algorithm and the additional computational overhead. Some have problems in how to determine the number of hidden layers and the number of hidden layer neurons in the neural network. Because of the lack of a unified theoretical framework, it is usually based on experience or through a lot of time-consuming and laborious experiments to determine the appropriate neural network model. Learning algorithms and parameter settings make it difficult to guarantee optimal neural network performance. The neural network-based robotic iterative learning control method combines feedback control and neural network learning control. BP neural network is used to construct the learning controller to make the robot controller have

self-learning function, which can eliminate the robot dynamics model. Identify and load disturbances. This method can improve the robustness and adaptability of robot trajectory tracking and has good control performance.

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