Thinking and Exploration of Intelligent Machining Robot Technology in New Engineering Course Teaching

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Abstract. In order to build our country into a powerful manufacturing country, we need to constantly cultivate high-level scientific and technological talents. With the advent of the era of artificial intelligence, manufacturing industry has also ushered in intelligent processing and manufacturing technology. Intelligent processing robot technology is introduced into undergraduate teaching. Based on the existing 6-axis industrial robot experimental platform in the laboratory, intelligent control theories such as genetic algorithm and neural network are applied to robot trajectory planning and automatic control. Combining the theoretical knowledge of intelligent control technology with simulation and experiment can not only enhance the students' ability to operate, but also deepen theoretical learning. It also meets the needs of new engineering course teaching and cultivates more innovative and practical talents for the country.

1. Introduction

The new engineering course is to train diversified, innovative and technical engineers in the construction of teaching in colleges and universities [1]. It is also to adapt to the advent of the era of artificial intelligence, we set up relevant specialties of intelligent technology in undergraduate teaching [2]. Intelligent control technology is based on traditional control theory, human knowledge, thinking, language and other behavioral characteristics, knowledge-based, without the need for accurate mathematical model of the system [3], it can solve practical control problems, including system modeling, process optimization, control system and a series of engineering problems [4].

Intelligent Control Technology is a senior specialized course for undergraduates majoring in mechanical engineering and automation in our university. It mainly describes the application of intelligent control method in engineering. Different from the traditional theory teaching, it is also under the guidance of the new engineering. In the actual teaching, we use multimedia technology to combine the theoretical learning of the course with the actual engineering system-intelligent processing robot. Combining with specific cases, we carry out modeling and simulation analysis, and compare with the online experimental results. In order to solve the problem which is difficult to understand by students because of insufficient experimental equipment [5].

2. Teaching Task of Intelligent Control Technology

Intelligent control technology is a specialized course for senior undergraduates majoring in mechanical engineering and automation. On the premise that the students have finished the course ‘Fundamentals of Mechanical Engineering Control’, this course enables them to have a comprehensive understanding and mastery of control engineering. It mainly describes the knowledge atlas, genetic algorithm, fuzzy theory and fuzzy control, neural network, expert system, human-like intelligent control and other intelligent control methods which are widely used in scientific research. The course covers many new theories, new methods, new concepts and new technologies. Therefore, the course not only enables students to master various intelligent control methods, but also helps students to recognize the development trend and important theories of intelligent control and artificial intelligence technology, and to cultivate undergraduates' innovative consciousness and ability.

This course mainly enables students to understand the development process of control theory and technology, to recognize the necessity of intelligent control for non-linear, non-stationary and uncertain systems, to master the principles and application methods of genetic algorithm, neural network and expert system, and to know the fuzzy set theory and fuzzy control method. Therefore, students' ability to use theoretical knowledge flexibly to solve practical problems can be better cultivated, and even the ability of mechanical undergraduates to learn interdisciplinary knowledge.

3. Structural Characteristics of Intelligent Machining Robot

The existing ABBIRB 1200 industrial robot in the laboratory has an open structure with a rated load of 7kg and a working range of up to 0.7m. The robot can be flexibly applied in various processing and manufacturing industries, and can communicate with external systems extensively. It can be installed on the ground, upside down or at any angle. The mechanical structure of the robot is shown in Fig. 1. The robot has six degrees of freedom and belongs to the typical 6R industrial robot. Compared with other industrial robots, the main characteristics of the robot are light weight, wide range of operation and high precision.

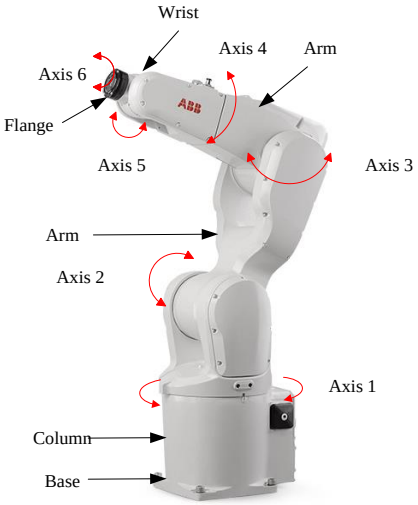

Fig.1. The ABB IRB1200 industrial robot

In the process of assembly and processing of large parts, robots have attracted more and more attention because of their flexibility, accuracy and small installation space. The installation of ABBIRB 1200 industrial robots requires only 105 mm radius, while the workspace can reach 703 mm. Compared with traditional multi-axis machining centers, robotic machining can operate flexibly on assembly site, replace end-effectors quickly to perform different tasks, and has good economical performance. With the continuous development of robotics technology, industrial robots used in mechanical manufacturing industry are increasing, and they are gradually applied in the field of robotic machining, such as drilling, grinding, milling, boring and other cutting.

Using robots for intelligent processing has the advantages of low price, flexible operation space, multi-station operation at the same time, which greatly reduces the investment and manpower cost of traditional equipment. Due to the limitations of rigidity, material hardness, required surface finish and complexity of parts, the stiffness of NC machine tools is usually 50 times that of robots. Scholars generally believe that although robotic machining can not replace 3-4 axis NC machine tool processing, nevertheless for the material with low precision or for the metal finishing and processing, robotic machining application turns to be the future development trend. For example, in large-scale mechanical assembly field, drilling, grinding, milling and other cutting processes are often needed. At this time, the traditional multi-axis NC machining center can not be applied because of the limitations of transportation and reassembly. While the industrial robot has the advantages of flexible operation space, high efficiency and convenient movement, so that it is widely used in large and

complex assembly field [6].

4. Application of Intelligent Processing Technology in New Engineering Course Teaching

4.1 Robot Path Optimization Based on Genetic Algorithms

Genetic algorithm simulates Darwin's theory of biological evolution. By simulating genetic coding rules, a certain number of individuals are coded into gene forms, so that each individual has certain characteristics of chromosomes, forming an initial population. And then according to Darwin's theory of biological evolution - survival of the fittest, through selection, crossover and mutation, new individuals and new populations are produced. In this way, the evolutionary mode will produce new individuals more adaptable to the environment, which can be decoded as an approximate optimal solution. This optimization method of genetic algorithm has a good application in many aspects, such as function optimization, combination optimization, work shop scheduling and so on.

ABB IRB1200 robot has six joints and six degrees of freedom. Three axes determine the position of the robot wrist and the other three axes determine the attitude of the robot wrist. There are two kinds of joints: moving pair and rotating pair. According to the serial joints of the robot from the base to the end effector, the coordinate system can be established, and the pose of the robot can be described by the method of homogeneous transformation. The D-H method is often used to establish the coordinate system on the robot connecting rod. By describing the relationship among the robot connecting rods in the fixed coordinate system, the homogeneous transformation matrix of the robot from the base to the end can be obtained. The forward and reverse kinematics analysis of the robot is carried out, but the robot has 6 degrees of freedom, and the working process is redundant. The optimization of the end trajectory can give better play to the advantages of the robot. The genetic algorithm based on intelligent control technology can be used to optimize the multi-objective of the robot arm. The gridding method can be used for path planning of mobile robots, and the walking space model of mobile robots can be established.

4.2 Neural Network Prediction of Robot Cutting Force

BP neural network simulates the transmission mode of biological neural network, and conducts information transmission by adjusting the connection mode of neuron nodes. BP neuron model mainly includes input layer, hidden layer and output layer. BP neural network is an algorithm for fitting by calculating the square of network deviation as the objective function and using gradient descent method to modify the weights and thresholds of network. It is mostly used for function approximation, pattern recognition and classification.

Because of the complexity of cutting materials and the influence of other external factors, it is difficult to obtain the cutting force by using traditional mathematical modeling method and empirical coefficient method. While the neural network only needs sufficient sample data to realize the non-linear mapping from input to output.

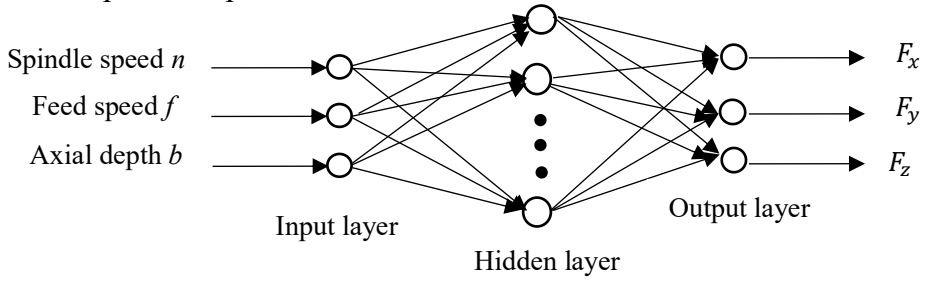

Fig.2. The neural network of the robot

The experimental databases of cutting parameters can be established in advance for different cutting tools, and the fitting results can be generated according to the experimental data. The corresponding relationship between the output value and the target value of the neural network can be analyzed. The neural network of the robot is shown in Fig. 2.

5. Conclusion

In view of the fact that the intelligent control technology in undergraduate teaching only pays attention to the theory teaching, but not to the actual operation, this paper puts forward the method of combining software and hardware to carry out the teaching of new engineering course. From hardware wise, the experimental equipment is simple, the robot, controller and software are complete. Students can easily operate on the computer. Students can use IRC5 to set the robot's trajectory online. From software wise, it has strong practicability. When students carry out genetic algorithm and neural network control, using the toolbox of MATLAB can simulate the robot's trajectory and the target fitting of cutting parameters on the computer. Computers in the university are abundant, and computer simulation can solve the shortcomings of insufficient understanding due to the lack of experimental equipment.

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